

Mattias Tagseth

**Studies of the waterscape
of Kilimanjaro, Tanzania
Water management in hill
furrow irrigation**

Thesis for the degree of Philosophiae Doctor

Trondheim, February 2010

Norwegian University of Science and Technology
Faculty of Social Sciences and Technology Management
Department of Geography

 **NTNU**
Norwegian University of
Science and Technology

NTNU

Norwegian University of Science and Technology

Thesis for the degree of Philosophiae Doctor

Faculty of Social Sciences and Technology Management
Department of Geography

© Mattias Tagseth

ISBN 978-82-471-2000-2 (printed ver.)
ISBN 978-82-471-2001-9 (electronic ver.)
ISSN 1503-8181

Doctoral theses at NTNU, 2010:22

Printed by NTNU-trykk

Abstract

The present study analyses the waters of Kilimanjaro Region, Tanzania, conceptualised as a waterscape constituted by material, institutional and ideational aspects. It draws on studies of the water management and the historical geography of hill furrow irrigation systems, based on 16 months of fieldwork.

Hill furrow irrigation systems are operated by groups of farmers who continue to use and develop long-standing traditions. Their practices and technology are of relevance to debates about indigenous intensive agricultural systems in Africa, concerning their emergence, sustainability and prospects for development. Groups of self-organised irrigators and their practices are targeted by several development initiatives, in water management seeking to control their water use, and in irrigation redevelopment aiming to replace existing technology and organisation. These concerns define the need for improved knowledge of the hill furrow irrigation systems of Kilimanjaro.

The main objective of this thesis is to contribute knowledge of water management and water use in hill furrow irrigation in Kilimanjaro Region. In order to achieve this objective, research proceeds along two lines of enquiry. The first concerns water management, where the study seeks to analyse and describe the operation, water use, tenure and management in hill furrow irrigation schemes by groups of farmers. The study seeks to analyse the ideas and implementation of initiatives in water management for the Pangani River Basin targeting these systems. The second line of inquiry is the historical geography of irrigation and changes in water use. Here, the study seeks to develop methods drawing on written and oral sources in order to examine changes in irrigation from a regional and long-term perspective. This will permit testing and reconsideration of dominant perceptions of hill furrow irrigation and its water history, and form the basis for a discussion of the explanation of change in irrigated agriculture.

I maintain that the approaches to water issues employed in this thesis and elsewhere can be analysed through different conceptualisations of the waterscape, encompassing not only the perception and representation of water issues, but also the material and institutional aspects of the waterscape. Aridity or water shortage does not speak for itself; water problems and their prescribed solutions are situated knowledges

of the waterscape, and are socially constructed within specific contexts. Material aspects are addressed as a question of how and why these systems have changed from a regional and historical perspective. This is relevant not only as a contribution to the study of the development of intensive agriculture, but also in order to test dominant perceptions of the hill furrow and its water history that are used to guide policy and interventions in hill furrow irrigation. Institutional aspects are examined as a question of the local organisation of these systems in terms of their operation, water use and tenure arrangements. Further, these aspects are addressed through the analysis of ideas, implementation and experience with water policy and institutional reform targeting hill furrow irrigation systems, influenced by global water discourse and actors.

The thesis consists of five research papers and a synthesis. The latter describes the methodological approach, which combines qualitative and some quantitative analysis of various forms of interview data with participant observation from fieldwork in rural Kilimanjaro and engagement with actors in the water sector through interviews, conversations and workshops as well as written sources. Approaches to the explanation of change in irrigation are reviewed and some implications for irrigation in the region discussed. Approaches to the organisation of irrigation are reviewed, demonstrating that this is an enduring theme in social science, related to broader debates about the institutions of society.

Working with an inclusive conception of institutions (and hydraulic tenure), the study describes how hill furrow schemes are organised, either through more formal groups, often with elected leadership, or through a neighbourhood and lineage-based model under the leadership of a furrow elder. The local organisation of water use according the latter type is examined through a case study, which describes it as embedded rather than a strong single-purpose organisation. Theoretical and methodological triangulation is applied, and the organisation studied at a normative-institutional level, but also in terms of interaction and access to water for different social groups.

A series of initiatives in water management for the Pangani River Basin came in the wake of a hydropower redevelopment project completed in 1995 led by the Norwegian Agency for Development Co-operation (NORAD). The initiatives were related to a wider water policy process in Tanzania. They drew inspirations from a

global water management discourse, which is analysed in terms of the influence of ‘state-centred’, ‘market-based’ and ‘community-based’ approaches to improved water management, related to development ideologies. A strategy of river basin management was developed from the 1990s, seeking to establish water licences under statutory law as the only legitimate basis for access to water, to introduce volumetric water pricing as an instrument of demand management, and to curtail water use by the construction of ‘control gates’ in furrow intakes. The process of implementation is analysed as a meeting between a ‘modern’ water management system and an ‘indigenous’ water management system. It was characterised by non-cooperation and conflict, not only over water as a resource, but over norms of proper water management, such as over the issues of water pricing and custom as a basis for legitimate water use.

Change in irrigation as water use (and land use) change is addressed as a methodological and empirical question. Oral political history indicates the practice of irrigation in late 17th century Marangu, while the history of sedentary patrilineages as the central institution in irrigation management shows the expansion of the system in upland Marangu in the 19th century. The establishment of irrigation schemes in the 19th century can be related to dry season cultivation of finger millet, a crop that was phased out with the increase in agroforestry in the highlands and expansion of arable cultivation of maize in the foothills in the early to mid-20th century. Surveys made for administrative purposes and contemporary reports are analysed to test two hypotheses about changes in irrigation. The results show that the dominant understanding – that the extent of irrigation is a result of late 20th century increases in population – is false and needs to be moderated. A competing thesis of decline in irrigation fits the development only in limited areas and underestimates the dynamic vitality of the system. On the basis of this regional and long-term diachronic analysis, a hypothesis of restructuring is put forward, where a decline in the number of schemes in the densely settled highland areas since the 1930s has been offset partly by an increase in irrigation in new areas in the foothills and lowlands and partly by an increase in scale. It is argued that change in irrigation is not determined by a single factor such as population, but that technological change and the intensification process and changes in political economy (in terms of market, economic policies, and development planning) have to be considered.

Ideas of water are explored in terms of ideas of improvement in water management and local perceptions of water relevant to the operation of irrigation. The analysis suggests that the water management reform process is influenced by development ideologies in the global water management discourse as well as a national tradition that can be described as technocratic. Its implementation was guided by notions and interpretations of a water crisis. Local ideas of water management differ from those associated with the initiative, which in turn influenced how water management was contested.

Acknowledgements

Professor Haakon Lein has acted as my supervisor for this project. His influence was important in getting me started with research in this region, in introducing me to water and development, and through discussions and critiques, particularly in the study of water management reform processes. Professor Michael R. H. Jones also supervised this study from 2006, and his timely feedback and advice was important in organising the synthesis. Professor Ragnhild Lund acted as opponent in a staff seminar to discuss the first draft of the thesis, with valuable commentary and suggestions.

My father, Bjørn Tagseth, while never insisting that I pursue this interesting but challenging line of work, offered valuable support as a discussion partner, and has been sorely missed after his death in 2008. Professionally, he was important in introducing me to social science and in teaching me how to survey research literature. *Mzee* Michael Minja acted as my research assistant for my first fieldwork, and subsequently until 2003, when he succumbed to fever with malaria following one of our field trips. He introduced me to the society and culture of Mt. Kilimanjaro primarily by helping me negotiate information. August Swai, William O. Mrita, Pius Shirima and Trinity Makundi have contributed as research assistants in Mwanga and Moshi R. Districts, Kilimanjaro. Frank N. Mbise and Beate Aamodt have offered generous hospitality in Meru, and valuable practical assistance and friendship. Hundreds of informants in rural Kilimanjaro have contributed information and shared insights. Friends in Marangu have been important in my introduction to society and culture in Rural Moshi, Kilimanjaro; especially *Mwalimu* Elisabeth and Violet Kundyia, T. Makundi, the late M. Minja and Irwan Msacky. *Mzee* A. Mneney, former administrative officer of Vunjo and local historian, offered advice and access to his records on oral history. Marangu West Ward and East Ward staff as well as *Mangi* Augusto Marealle and relatives offered advice, access to records and practical assistance facilitating the research. A considerable effort by a number of mechanics kept me mobile during 80K km on African roads. *Bw.* ‘Steelie’ Urrio of Samanga village introduced me to *Fundi* Juma Msangi from Ugweno, who also taught me basic Land Cruiser repair and more.

Numerous water people, including I. J. Matcha, Regional Hydrologist, Kilimanjaro and his staff, and J. Sarmett, Pangani Basin Water Officer, have contributed

through interviews, discussions and providing access to documentation. The cooperation with colleagues involved in the 'Pangani Project' at NTNU and the University of Dar es Salaam coordinated by Professor James Ngana during 1997-2003 has been an important influence. Colleagues that I met through the International Water History Association, especially Professor Terje Tvedt, Mai-Britt Öhmann and Petri S. Juuti, have discussed various aspects of the study. Professor Ophelia Mascarenhas discussed indigenous knowledge in irrigation, advised me on sources, and taught me PRA methodology in a field course. Nathalie Gomes discussed indigenous knowledge in water management and commented on a paper. Timothy Clack prompted me about the local perception of water. Colleagues at the Department for Human Geography at Stockholm University welcomed me as a visitor in the fall term of 2002, and as a student in a research course in 2004. Professor Mats Widgren introduced me to the research network on People, Land and Time in Africa. Together with Lowe Börjeson, and Thomas Håkansson he discussed historical geographical aspects of the study and the region, especially at workshops in the Usambaras in 2006 and at Usa River, Arusha in 2002. Ludger Wimmelbücker commented on the historical aspects of one of the papers. John Sutton and Daryl Stump discussed and encouraged further study of change in irrigation at Usa River and in a seminar on intensive agricultural systems organised by the British Institute in Eastern Africa at the Society of Africanist Archaeologists conference in Bergen in 2004. Anonymous reviewers and the respective editors have been helpful in improving the papers. The Research Council of Norway funded the study, which was also supported by Nordisk Forskerutdanningsakademi. Aslak Raanes, Tuva Tagseth and Pål Tengesdal have assisted with the graphics, while Catriona Turner and Nancy Bazilechuk have helped with my English. Last, but not least, I would like to thank Kirsti and Eivind for all their love, support and encouragement, for enduring my absence in the field (and otherwise), and for discussions.

Trondheim, August 17, 2009

Mattias Tagseth

Contents

Abstract	i
Acknowledgements	v
Contents	vii
Introduction	3
The structure of the thesis	4
The context of research on water in the Pangani River Basin	5
Global discourses of water and impacts in Tanzania	8
The water problems of Kilimanjaro	12
The problem of hill furrow irrigation in Kilimanjaro	14
Local perception of water and irrigation	16
Water history in research on the hill furrow	20
Water management in research on the hill furrow	22
Objectives and research questions	26
General objective and research questions	26
Specific objectives and research questions	27
Water management and the organisation of water use	27
The historical geography of irrigation and water use change	28
Concepts and theoretical considerations	29
Explanation in irrigation studies	30
Approaches to the local organisation of irrigation	41
Debates and trends in thinking about the organisation of irrigation	41
Metaphors in the understanding of irrigation organisation	53
Discussion; the organisation of irrigation	60
The waterscape	64
Methods	69
Rapid appraisal of water management and changes in irrigation	71
Household enquête	71
Grouping variables and analysis	74
Intensive strategies; ethnographic fieldwork	76
Re-engagement: Fieldwork in the water sector and in rural Kilimanjaro	79
Design issues	81
Documentary sources	82
Methods to assess change in irrigation	84
Methodological and theoretical triangulation	87
Process and the format of the thesis	88
A summary of five papers	90
Conclusions	93
The organisation of water use	93
The local organisation of water use	94
Water management reform and policy issues	96
Changes in farmer managed irrigation	99
Methodology	99
Directions and magnitudes of change	100
Explanations of change	103

General conclusions	106
The organisation of water use	106
Changes in farmer managed irrigation	107
Approaching the Kilimanjaro waterscape	108
Reference list	110
List of appendices:	
Appendix 1: Irrigation amongst the Chagga in Kilimanjaro, Tanzania. The organisation of <i>mfongo</i> irrigation (paper 1)	139
Appendix 2: Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania (paper 2)	175
Appendix 3: The expansion of traditional irrigation in Kilimanjaro, Tanzania (paper 3)	211
Appendix 4: The 'mfongo' irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania (paper 4)	247
Appendix 5: Models of water resource management: Tanzanian water policies between principles and practical applications (paper 5).	269
List of Tables:	
Table 1 Theoretical approaches to the organisation of irrigation	51
Table 2 Metaphors of water management and associated concerns	59
Table 3 Three dimensions of the waterscape	67
Table A1:1 Reported irrigation by wealth rank	157
Table A1:2 Reported irrigation by gender of household head	163
Table A1:3 Reported irrigation by membership in furrow owning lineage	164
Table A1:4 Reported irrigation by attendance in work party previous year	164
Table A3:1 Changes in the number of mfongo irrigation schemes in three sectors of the southern slopes of Mt. Kilimanjaro	233
Table A3:2 Mt. Kilimanjaro rural population and annual growth rates 1890-2002	235
Table A4:1 Characterisation of scientific and local knowledge	250
Table A4:2 Cultivated acreages in highland and lowland locations	253
Table A4:3 Type of organisation by zone	260
Table A4:4 Elements of 'traditional' and 'modern' water management systems	262
Table A5:1 Three models of water management	279
List of figures:	
Figure A1:1 Locations at Mt. Kilimanjaro	143
Figure A1:2 Hydrology and canals in Komalyangoe, Marangu (schematic)	150
Figure A1:3 Furrows, paths and farms in lower Komalyangoe	152
Figure A2:1 Location of Mt. Kilimanjaro in eastern Africa	178

Figure A2:2	Mt. Kilimanjaro and the location of the case study area	189
Figure A2:3	The canal network of Komalyango, Marangu	194
Figure A2:4	The Kisu area, Komalyango village	200
Figure A2:5	The <i>N</i> lineage and key events in canal development	202
Figure A3:1	<i>Mfongo</i> canals, meadows and agroforestry groves at Marangu, Kilimanjaro	214
Figure A3:2	Domestic drawing point on a secondary canal	217
Figure A3:3	The topography and hydrology of the Pangani River Basin	219
Figure A3:4	Furrows (...) at Kilema, Mt. Kilimanjaro	220
Figure A3:5	Topography and place-names on Mt. Kilimanjaro	223
Figure A3:6	The (...) water rotation in a <i>mfongo</i> irrigation scheme (...)	229
Figure A4:1	Location of the case study areas on Mt. Kilimanjaro	251

Introduction

The theme of this thesis is water management and water use in hill furrow irrigation. It is based on studies of the management and history of water from the Kilimanjaro Region, Tanzania. This region contains a great number of stream diversion irrigation schemes, most of which are constructed and operated by the farmers themselves. The use of this technology represents the continued development of a long-standing tradition of 'hill furrow irrigation'. The technology and practice at Mt. Kilimanjaro can be termed *mfongo*¹ irrigation, from the local vernacular. During an initiative to change water management in Kilimanjaro and the Pangani River Basin, which came in the wake of a hydropower redevelopment project, I came to realise that several aspects of these systems were inadequately investigated and understood, and poorly represented in planning. These were the concerns that first led me to research on *mfongo* irrigation. My initial concern with planning, among other things, was met through a first phase (*c* 1995-2001) of engagement with the water of Kilimanjaro (see Tagseth 2000a, Tagseth 2002a, 2002b). In the second phase reported on here (*c* 2002-2009), I have moved forward from the immediate urgency of water and development in order to contribute in new and possibly better ways to the improved understanding of water issues.

The overall objective of this thesis is to contribute new knowledge of water management and water use in hill furrow irrigation. This is done through examining problems of water management related to the organisation of water use and to changes in irrigation, with Kilimanjaro as the case study. In order to achieve this objective, research proceeds along two lines of inquiry. The first of these is water management and the organisation of water use, where I seek first to contribute to methodology, analysis and improved knowledge of the operation, water use, tenure and management of *mfongo* schemes by groups of farmers. I seek, further, to contribute to the analysis of ideas for and implementation of a water management initiative for the Pangani River Basin. The second line of inquiry is the historical geography of irrigation and changes in water use. There is significant interest in the origin and subsequent development of hill

¹ *Mfongo* (pl. *,mfongo, mifongo*) denotes a furrow or ditch in Chagga languages spoken at Mt. Kilimanjaro.

Studies of the waterscape of Kilimanjaro

furrow irrigation among historians, archaeologists, anthropologists and geographers. There are, however, few empirical studies of change in these systems, and some work is needed to establish methodologies in order to examine such changes empirically. An important objective of the second theme is to analyse changes in water use and the establishment of water infrastructure, in order to test dominant hypotheses about change, and to provide a basis for discussion about the explanation of such change.

These objectives are addressed with reference to material from the southern slopes of Mt. Kilimanjaro, on the basis of fieldwork in Moshi Rural District (Kilimanjaro Region), and among actors in the water sector in Tanzania, carried out in 1995-96, and intermittently in 2001-2003. In the five attached papers, and in this text, I also draw on relevant data from fieldwork in Ugweno (Mwanga District, Kilimanjaro Region) carried out intermittently in 2002-2005 and from stays in Meru (Arusha Region) in 2003-2005. In providing these papers with a context, I also seek to strengthen the analysis by bringing in the question of the perception and representation of water in the review more strongly than has been done in the papers. This can be seen as reflecting a development in my own interest through this research process.

The structure of the thesis

This overview, together with five attached papers, constitutes a body of work examining problems of water management, especially with respect to the organisation of water use and changes in farmer managed irrigation. The following provides introductory reviews of global discourses of water and their impact in Tanzania, water problems at Mt. Kilimanjaro, and outsider and local perceptions of the hill furrow. I then review some aspects of water history and water management perspectives on the hill furrow. After this, the general and specific objectives and the research questions addressed in this thesis are presented. I then discuss central concepts in this study and theoretical considerations. Here, I present two interrelated debates on 'hill furrow irrigation' (Adams & Anderson 1988, Adams 1989) in East Africa. The first concerns the history of water use. The second is focused on the organisation of irrigation. I then proceed to discuss how the emerging concept of 'waterscape' can be used to structure and reflect on the study of water and society. Following this, I present and discuss methodological

issues. After this, a summary of the five papers is presented. The thesis concludes with a presentation of the main findings and conclusions of the work.

The first of the attached papers (Appendix 1, Tagseth forthcoming) is entitled 'Irrigation amongst the Chagga in Kilimanjaro, Tanzania. The organisation of "mfongo" irrigation'. The second paper (Appendix 2, Tagseth 2008a) is 'Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania.' The third paper (Appendix 3, Tagseth 2008b) is 'The expansion of traditional irrigation in Kilimanjaro, Tanzania'. The fourth paper (Appendix 4, Tagseth 2006) is 'The "mfongo" irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania.' The fifth and last paper (Appendix 5, Lein & Tagseth 2009) is 'Models of water resource management: Tanzanian water policies between principles and practical applications'. Papers two (Tagseth 2008a) and three (Tagseth 2008b) are focused mainly on problems of water history, while papers one (Tagseth forthcoming), four (Tagseth 2006) and five (Lein & Tagseth 2009) are focused mainly on problems of water management. A summary of these papers is provided on pages 90-93.

The context of research on water in the Pangani River Basin

Mt. Kilimanjaro is an important part of the headwaters of the Pangani River Basin, because orographic precipitation falling here and in other mountain areas in the region forms a substantial proportion of the runoff. The water of this basin is heavily used by rural communities around the two towns of Arusha and Moshi, for irrigation by smallholders and by estates, for water supply and for hydropower. The region has been the site of conflicts of interest between broad sectors of water use since the 1930s. An important event in the development of the basin was the redevelopment of a 66MW hydropower station at a downstream location at Pangani Falls, completed in 1995 with Nordic development assistance amounting to NOK 820 million, under the management of the Norwegian Agency for Development Cooperation (NORAD). The project has been seen as a success in technical terms (Færøyvik 1995, OECD 1996), and thus provided a showcase for the capacity of Nordic actors in the hydropower industry. It is also significant as the largest project handled by NORAD to that date. However, worries were voiced early on in the process about the availability of water to run the

Studies of the waterscape of Kilimanjaro

plant, which is located in a downstream location, and about the implications for water management. NORAD demanded changes in the water management system in the area in order to protect the plant's viability, which proved to be more problematic than the technical aspects (inter alia OECD 1996, Andersson et al. 2006). Curtailing or restricting growth in the use of water for agriculture could improve the performance of the plant, but was problematic in other respects. When changes came slowly because they were controversial, NORAD recommended to the Norwegian Minister for Development Cooperation that further assistance in hydropower development be withheld (Rudberg 1994) and made this known in Tanzania.² The involvement by NORAD was thus important in formulating an initiative in water management in the 1990s and as a precursor to later involvement by the World Bank and the International Union for the Conservation of Nature (IUCN).

The challenges of water management and the Norwegian involvement attracted the interest of researchers at the Norwegian University of Science and Technology (NTNU) in the Pangani River Basin. The Department of Geography at NTNU became involved in a multidisciplinary research cooperation between NTNU and the University of Dar es Salaam under the coordination of Professor James Ngana during 1997-2003, funded by NORAD. The project 'Water Management in the Pangani River Basin' had an applied character, and sought to meet immediate needs for knowledge as expressed by the Pangani Basin Water Office (PBWO), Tanzanian authorities, NORAD and consultants engaged in the hydropower redevelopment project (University of Dar es Salaam 1996:1) during an initiative to implement Integrated River Basin Management. This cooperation forms part of the context of the present study.

The problems of water management reform in this region were subject to debate in the Nordic press and among friends with a relationship to Tanzania through work. The planned intervention in traditional irrigation attracted my attention as a significant problem of development at a phase where I was looking for research problems for my first fieldwork. At the Department of Geography at NTNU, Haakon Lein and Axel

² Kirsti Sevaldsen, personal communication, 1996, based on fieldwork in Moshi Rural District.

Baudouin initiated research on water management in this region from 1994 (see Tagseth 2000b). Lein supervised my master's study and advised me on a proposal that won minor funding from the Norwegian Research Council. The topic was framed as the meeting between river basin planning and traditional rights and practices. I considered it important to examine the impact and reception of this initiative in water management in districts where poor smallholders maintained and used their own 'traditional' irrigation schemes in order to sustain their livelihoods. Following many interesting challenges in living and carrying out fieldwork in rural Tanzania and in managing and learning how to do research, this resulted in a monograph that was submitted as a dissertation for the Cand. Polit. degree, *Knowledge and development in mifongo irrigation systems- Three case studies from Mt. Kilimanjaro, Tanzania* (Tagseth 2000a). A successful application for funds from the Research Council of Norway led to a research fellowship at NTNU in 2002. This has allowed me to further develop my analysis of the implementation of the initiative in water management (see Tagseth 2002a, Tagseth 2002b, Tagseth 2006/paper four and Lein & Tagseth 2009/paper five), and also to develop some new themes.

The present study is independent of the University of Dar es Salaam / NTNU project in terms of objectives etc., and is focused more on problems of water management for and water use in the hill furrow systems and less on the implementation of River Basin Management in the context of hydropower redevelopment. It thus shares only part of the problem definitions of the aforementioned actors, but it is nevertheless relevant to ask how it can contribute with respect to the objectives of the 'Pangani Project.' The proposal for research cooperation on 'Water management in the Pangani River Basin' (University of Dar es Salaam 1996, Tagseth 2000c) sought to frame and define research problems. A number of important issues and relevant questions were raised, some of which could not be adequately addressed during the project implementation. With regard to geography and social science, the proposal emphasised the need for more knowledge on the spread, organisation and management of irrigated agriculture in the region. Another issue to address was the conflict between different water uses (University of Dar es Salaam 1996). The latter was seen primarily as a task for economists, but was to some extent addressed from other perspectives (among others

Studies of the waterscape of Kilimanjaro

Mujwahuzi 2001, Røhr et al. 2001, Tagseth 2002a, Lein 2004). There was also some investigation of local level water conflicts (Sevaldsen 1997, Reed-Erichsen 2003). With reference to the detailed problem areas defined as central to the Pangani project (University of Dar es Salaam 1996, Tagseth 2000c: 7), the present study seeks to contribute in two specific areas: The first is the origin, spread and dynamics of the development of irrigated agriculture. Here, a lack of historical data had been identified as problematic. One response to this concern is the first published quantitative analysis of temporal changes in hill furrow irrigation (Tagseth 2002b), which questioned the dominant assumption that the many hill furrow schemes on the slopes of Mt. Kilimanjaro are a response to population growth in recent decades. Within the scope of this thesis work, methodology has been developed for research on the establishment of irrigation schemes and changes in irrigation at the local level (Tagseth 2008a/paper 2). Furthermore, a broader basis for the regional and temporal analysis of change in irrigation has been established (Tagseth 2008b/paper 3). The present study thus addresses questions that were initially defined as important, but not dealt with in depth under the scope of the 'Pangani project'. Second, I seek to contribute with regard to the question of the local organisation of irrigation in papers one (Tagseth forthcoming), four (Tagseth 2006) and five (Lein & Tagseth 2009). Paper one (Tagseth forthcoming) addresses questions about the social organisation of the use, control over and access to the water of the irrigation scheme. Paper four (Tagseth 2006) identifies and describes different types of organisation of irrigation schemes, thus responding to an expressed need for knowledge about different organisational solutions. It also discusses an encounter between a water management model based on 'indigenous knowledge' and a model of water management based on 'scientific knowledge'. The encounter between the initiatives in water management and local models of water management is also addressed in paper 5 (Lein & Tagseth 2009).

Global discourses of water and impacts in Tanzania

The global discourse on water evolved from the 1972 Stockholm conference, through the UN conference on water in Mar del Plata (1977), and in the 1980s as the International Drinking Water and Sanitation Decade (UNESCO 2003: 24). The problem of water management and the prospect of increasing water scarcity have

attracted increasing attention (inter alia Postel 1992, Falkenmark & Lundqvist 1995). The fact that water is central to sustain life and society is often unnoticed as long as water is available, resulting in what Clarke (1991) terms 'water blindness', which often limits the success of development projects. A 'climate-centric' bias exists in the temperate West, and has contributed in keeping water marginal to the global agenda of environment and development until the 1990s (Tvedt 1992), when the Dublin Statement (International Conference on Water and the Environment 1992) was prepared for the Rio Conference (United Nations Conference on Environment and Development 1992a). This signalled a shift in global water policy recommendations from increasing supply and providing for basic needs (United Nations Water Conference 1977) to demand management and devolution of water management (United Nations Conference on Environment and Development 1992b). The concept of national per capita availability of freshwater was developed in order to assess and predict scarcity or stress, and it was warned that two-thirds of Africa would develop serious water scarcity by 2025 (Falkenmark 1989).

Water was given a high priority in Tanzania under President Julius Nyerere's drive towards *Ujamaa*, or 'African socialism' (1967-1985). Safe domestic water for all was seen as important in a basic needs strategy for development, and a very ambitious programme was set up to provide this in all villages within two decades as a free service organised by the government and supported by international donors (Therkildsen 1986, 1988, Mujwahuzi 2002: 16-17) along with better health services and schooling. In Bender's (2008) analysis, the construction of piped water systems on Mt. Kilimanjaro during *Ujamaa* (1967-1985) was part of a nationalist project. Nyerere sought to use water development as a means to establish national presence inside rural communities, to undermine 'traditional' forms of authority and strengthen the position of the national single party (TANU) in local affairs in Kilimanjaro, and further, to seize control over the region's most precious resource. The Tanzanian model attracted considerable interest and support internationally during this period. Tanzania may well have been among the models when the Mar del Plata conference adopted 'water for all' by the end of the 1980s as an objective of the International Drinking Water and Sanitation Decade (ODI Water Policy Programme 2002). In Tanzania, the grand but economically

Studies of the waterscape of Kilimanjaro

unsustainable plans hampered progress in water provisioning (Boesen 1986), and in a repeat survey Mujwahuzi (2002:75) could not find any improvement in terms of water use in piped households or reduction in distance travelled to fetch water over a period of 30 years. The failure of the centrally planned economy, declining agricultural productivity and terms of trade, combined with the withdrawal of donor support (see Boesen et al. 1986, Havnevik 1993) forced a major shift, including the adoption of structural adjustment policies, economic liberalisation, and the dismantling of the single party state after 1986. Among other things, this implied a less active role for the state, and it led to the abandonment of ambitious programmes for social service provision, including that of safe water.

Under the guidance of the World Bank and bilateral donors (see van Koppen et al. 2007:150-151), the whole water sector has been prepared for reforms. This has involved the development of a new water policy (United Republic of Tanzania 2002), drafting of a water sector strategy (United Republic of Tanzania 2004a) and proposals for legislative reform (United Republic of Tanzania 2004b).³ Through these developments, Tanzania has embraced global trends in water management, which emphasise demand management, devolution and increased private sector participation, among other things. Donor support was central to the programme to provide free domestic water to all during *ujamaa*, and new donor policies have been important in changing Tanzanian water policy. Dar es Salaam became the site of a major water privatisation scheme (Vidal 2005), where a World Bank campaign metaphor or promise was that '*privatisation brings the rain*' (Masty & Komba 2001). The use of this metaphor represented an attempt to draw on cultural models of water and governance as a means to legitimise policy. Despite World Bank funding, the level of service and investment was poor, and with rising water prices the project became so unpopular that the ten-year lease contract with City Water, a Biwater-led consortium, to manage the Dar es Salaam water supply was cancelled by the government in May 2005 just before elections, after less than two years. Biwater filed a case for damages with the World Bank's business tribunal in The Hague, but lost (Rice 2008).

³ The 'Water Resources Management Act, 2009' was passed on April 28, 2009, but has not yet entered into force (United Republic of Tanzania 2009).

The global policy shift in water management formulated during the 1990s (see International Conference on Water and the Environment 1992a) was based on a conception of an emerging global water crisis (inter alia Falkenmark 1989, Postel 1992, Falkenmark & Lundqvist 1995). Some analysis (Falkenmark & Widstrand 1992) was based on warnings that projections of population growth would not fit with finite water resources in the future. The content of global water policy recommendations followed trends in development thinking of the period (Blaikie 1998, Tagseth 2002a), as seen in the 'Dublin Statement' (International Conference on Water and the Environment 1992). One of these was the reduced role of the state, which can be seen in the objective of devolution of water management to the lowest appropriate level and increased public participation (Dublin principle 2). A second was the call for the recognition of water as an economic good (Dublin principle 4) and for demand management through water pricing, which can be seen as a neo-liberal answer to water problems. The development of an understanding of scarcity can be a powerful discursive construct (Mehta 2001, Kaika 2003, Swyngedouw 2004, Kaika 2006, Mehta 2007) or a development narrative (Roe 1991), which can be used to bring about certain changes. It can also refer to 'biophysical facts' (Mehta 2001), such as a changing availability of water. Scarcity, aridity or drought can thus be analysed in terms of climate (i.e. nature, material aspects), the human-made (i.e. social processes) and as discursively mediated (Bakker 2000). Interpretations and narratives of water crisis were instrumental in communicating the urgency of water issues and the idea that 'there is no alternative' to the emerging 'international consensus' on recommendations for improved water management.

Tanzania does not experience water stress, if assessed according to the national scarcity index criteria (UNESCO 2006: 135), but in the headwaters of the Pangani River Basin in Kilimanjaro, it is reasonable to say that the availability of water is a constraint on development (Andersson et al. 2006, 25). The notion of 'water crisis' or scarcity in this region can be seen both as referring to biophysical (and social) phenomena and as a discursive construct. Water scarcity has been seen as an effect of drought, lack of coordinated planning and inadequate enforcement of statutory law (United Republic of Tanzania 1994). The understanding of 'water crisis' led to the formulation of an

Studies of the waterscape of Kilimanjaro

initiative in water management supported by the Norwegian Agency for Development from the early 1990s, and to the establishment of the first River Basin Board and Office in Tanzania to govern the Pangani River Basin. The initiative and cooperation with the basin water office were taken over by the World Bank and in later years by the IUCN 'water and nature initiative' (see Lein & Tagseth 2009/paper five).

The water problems of Kilimanjaro

Mt. Kilimanjaro with the glaciated peak Kibo has become the prime African icon in the global discourse on climate change (Lein and Tagseth 2009/paper 5), following remote sensing studies documenting glacial retreat (Hastenrath & Greischar 1997) and a paleoclimatic study (Thompson et al. 2002) that predicts the disappearance of the glaciers on Mt. Kilimanjaro by 2015 to 2020 and warns about implications for the local populations. A change towards a drier environment, desiccation, has periodically been a matter for concern in Africa (Swift 1996, Fairhead & Leach 1996, 2000) and eastern Africa (Geilinger 1936, Anderson 1984). There are now new worries about the implication of climate change on regional water availability (IUCN 2003, Bergkamp et al. 2003, Andersson et al. 2006, 43, 65). The Kilimanjaro glacier is important as an icon and as a tourist attraction, but its use as an indicator of global warming has been questioned (Mote & Kaser 2007). The alpine zone is arid and small and the glaciers at Kibo are negligible as a source of runoff. According to Røhr (2003: 45, 89, 151) no surface runoff comes from the area between 2800 and 5895 m.a.s.l., and he sees dramatic changes in water availability affecting irrigation and hydropower as unlikely (Røhr 2003: 148). The prospects and indications of declining precipitation identified in the precipitation records from the settled areas below (Ngana 2002a, Hemp 2005)⁴ may, however, warrant the existing interest in research on the regional climate.

In North-eastern Tanzania and the Pangani River Basin, population is concentrated on the mountain slopes and plateaus, and the plains are relatively sparsely populated. This

⁴ Hemp's (2005) use of one of the three stations (Moshi Met., Met. Dept 9337004) can be questioned. This is because there is a clear jump in the data series, and I suspect that the station has been moved. The use of the Kilema Mission (Met. Dept. 9337015) data seems reasonable. My regression analysis confirms a declining trend over the 20th century, but this is not a recent onset. I do not have the data to verify the analysis of records from Rombo Mission. Past descriptions of the glaciers and their retreat by the geographers Meyer (1890) and Geilinger (1936) tend to support the interpretation that there have been changes in local climate since the late 19th century, as suggested by Mölg et al. (2008).

uneven pattern was present in the 19th century (Kersten 1869: 242, Baumann 1891: 12-15), and documented in later periods (Gillman 1936, Department of Lands and Surveys 1952, Porter & Thrower 1966). The geographer Clement Gillman (1936) pointed to water as the most important factor in explaining the geography of settlement in Tanzania. His case for 'geographical controls' (Gillman 1932), where access to domestic water figured prominently, may have been overstated and determinist. However, the existence of limited but fertile highland areas well endowed with precipitation and runoff that could provide for irrigation made possible the development of dense agricultural settlements.

According to Raum (1940), children in Kilimanjaro started playing with small water conduits and participating in applying water to the fields from an early age, and were introduced to the centrality of water, its technology and culture. Metaphors for success and fertility can draw on irrigation, as exemplified by the blessing '*may you cultivate below an irrigation furrow.*'⁵ Knowledge of water as well as knowledge drawing on water-related metaphors can be passed on in the form of riddles and proverbs. Riddles take the form of a question, for example: '*Father left me a bowl from which I have been eating ever since*', with the correct reply, '*The irrigation canal!*' (Mosha 2000: 61). Proverbs can take a form such as: '*A heavy/pregnant small cloud was to become rain, but did not*' (Marealle 1947: 17),⁶ meaning that one should not imagine that every cloud will bring rain, but rather use the furrow to irrigate one's farm. From the local perspective, it is obvious that everyday activities such as cooking, washing clothes or raising a crop depend on the ability to access water. The variation in precipitation from year to year affects economic growth nationally and the price and availability of food at the household level. Water has been an issue in regional planning for a long time. Yet, it is possible to say that there has been a lack of appreciation of the centrality of water to society and economic activities in planning. Water access problems that were not resolved at the planning stage are factors limiting the success of two important development projects in the Pangani River Basin. The first of these is the Lower Moshi Irrigation Scheme, which was funded with USD 31 million by 1992 from the Japan

⁵ *Rema seri ya mfongo* (Kivunjo). Fieldwork, Moshi Rural District 1995-1996, 2002.

⁶ *Kipfilepile kirundu kechiva mvuo, kilawe* (Kivunjo).

Studies of the waterscape of Kilimanjaro

International Cooperation Agency aiming to increase irrigated rice production with green revolution technology (Burton & Chiza 1997, Beez 2005, 33-34). The second is the rehabilitation of the hydropower plant at the Pangani Falls funded by NORAD, the Finnish International Development Agency and the Swedish International Development Cooperation Agency, completed in 1995, in which the water was to be used for increased power production downstream. Both of these demanded a great deal of water, and led to increased water scarcity and conflicts over water in the region (Burton & Chiza 1997, Mung'ong'o 1997, Andersson et al. 2006, 17).

The problem of hill furrow irrigation in Kilimanjaro

Farmers in Kilimanjaro continue to develop and utilise irrigation technology based on stream diversion canals locally termed *mfongo*, following a tradition of hill furrow irrigation which goes back to the late Iron Age in eastern Africa (Sutton 2004, Stump 2006a). The technology does not rely on external subsidy or inputs to any great extent, but rather on locally available materials and labour. Most irrigation systems remain under the control of their users, and rely on home-grown models of organisation, management and labour mobilisation. Hill furrow irrigation has contributed to stabilising food production through strategies of supplementary irrigation, and is used to intensify and diversify agriculture under conditions of land scarcity. The hill furrow has been used as an example of indigenous knowledge in water management (inter alia Goldsmith & Hildyard 1984, Adams 1992, Goldsmith 1998). In Kilimanjaro, the independent practice of farmer-managed irrigation by self-organised groups has often been seen not as a resource but as a problem. From the perspective of irrigation extension, the hill furrows have been seen as unorganised, technically inferior and inefficient (Daluti 1994). An objective is to change the organisation and infrastructure and to incorporate them in the portfolio of the irrigation authorities. From the perspective of the water management authorities, these groups are seen as problematic, characterised as 'stubborn' (inter alia Guttormsen & Luhumbika 1995), being 'uncaptured' water consumers who maintain customary rights to water and who resist demands that they seek licences from the water office and pay volumetric water fees. In Scott's (1998:2-3) terms, they are illegible. Most of the *mfongo* are based on customary and thus unregistered rights to water, which has made it possible at times to claim that

since the *mfongo* have no statutory right they represent illegal abstractions. Most are not in the inventory of the Irrigation Division of the Ministry, which has made it possible to overlook them in planning. They substitute labour for capital and are thus seen as inferior as irrigation schemes by the irrigation engineers. They can be complex in terms of water distribution, and are operated by self-organised groups usually not registered with and not accountable to the national authorities. Organisational solutions can be non-bureaucratic (type 1 described below and in Tagseth 2002b, Tagseth 2006/paper four), thus leaving them ‘unappealing’ (IUCN 2003:65) or incomprehensible to administrative authorities and development agencies, even though they have helped local water users solve management problems for generations and are integrated with local society and culture. More complex are situations that defy the formulas of the irrigation agronomist, making benefits and performance difficult to calculate. These difficulties come from command areas changing with water availability and other circumstances, and the widespread use of complex cropping patterns including intercropping, staggered planting and agroforestry.

The practice of irrigation was commented on by 19th century travellers, who marvelled at the high standards of agriculture (inter alia Johnston 1886). It is possible to say that this developed into a part of the aesthetisation of the Chagga people at Mt. Kilimanjaro as industrious peasants and of the Kilimanjaro environment as bountiful and hospitable. Emerging with modern geography and colonial environmental science was another outlook that emphasised the limited potential of the African environment (Gillman 1932), and that scorned the practice of hill furrow irrigation for wasteful use of water and wasting the soil (Teale & Gillman 1935, Curry 1939), an idea that is still present in some descriptions of the technology. One could relate these negative assessments to environmental problems and problems of efficiency, but also to the desire of outside actors to capture self-managing groups of irrigators, and to interests seeking a redistribution of water to other sectors and areas. Global concerns about desiccation, deforestation and especially soil erosion were on the rise in the 1930s with the economic depression, the emergence of the Dust Bowl (Anderson 1984) and the rise of a modern tropical geography. These concerns had regional expressions in the debate on the Kilimanjaro environment, with respect to threats to the environment from

Studies of the waterscape of Kilimanjaro

overpopulation (Griffith 1930), deforestation as a cause of declining water availability (Teale & Gillman 1935), soil erosion resulting from irrigation (inter alia Curry 1939) and concern about a regional change in climate (Geilinger 1936). These studies introduced persistent themes in the outlook on the Kilimanjaro environment. Bender (2006) identifies the change in outsider perception of *mfongo* irrigation, which he dates to the 1920s, and associates this with the emergence of regional scarcity of water. This change coincides with a phase where new settlers took over and revitalised estates at Mt. Kilimanjaro confiscated from Germans during World War 1, which led to intensification of localised water conflicts. It could also be argued that it was the construction of a hydropower plant at Pangani Falls downstream, planned in the 1920s and commissioned in 1935, which established water scarcity at a regional (i. e. river basin) scale.

Local perception of water and irrigation

In addition to such outsider perceptions and science of water and the environment, there are also local perceptions and culture of water in the irrigating communities in the region. *Mfongo* irrigation, its technology, practices and institutions are locally recognised as a cultural heritage of the Chagga, of which people are proud. Thus, when a man in Marangu built a new hotel in the 1990s, a *mfongo* was constructed across the compound for ornamental purposes, as a way of representing to tourists who the Chagga are (Mosgrove 1998), and Marangu as the '*land of water*' (Kipepeo Tours, 2009).⁷ In the pre-colonial periods water specialists and some princes were believed to control the rain⁸ (see Marealle 1947). The provisioning of water in the past could thus be seen as a source of power at a symbolic level. During my fieldwork in Marangu, Mt. Kilimanjaro and Ugweno, North Pare, many informants⁹ expressed concerns about declining precipitation and spring discharge. Claims from oral history are difficult to interpret as evidence of hydrological change, and when I first encountered such reports in Marangu,¹⁰ my initial analysis was that these were expressions of nostalgia and a local

⁷ In an etymological interpretation, the place-name Marangu is constructed from *mora mora ngu*, describing much water/ well watered (interview, A. Mneney, Kilimanjaro-Mamba, 1995, see also Dundas 1924).

⁸ Fieldwork; Moshi Rural District 1995-96.

⁹ Fieldwork; Moshi Rural District 1995-1996, 2001, 2002, 2003 Ugweno, Mwanga District 2004, 2005.

¹⁰ Fieldwork: Moshi Rural District 1995-96.

discourse where the process of social and economic change is seen as moral decline affecting the landscape.¹¹ Having compared these local perceptions with the precipitation records, I see that the descriptions of droughts and a decline in precipitation and runoff since the wet 1960s also have some substance.¹² My informants mentioned several possible causes for changes in runoff, including the planting of exotic trees with high water consumption. One of the examples mentioned by informants is the planting of eucalyptus at the Una River, which is a localised change in the landscape resulting from Teale & Gillman's (1935) recommendation to plant more trees in order to improve water availability. The selection of water demanding eucalyptus for this purpose probably did reduce the discharge. During fieldwork in Ugweno, Mwanga District, my informants claimed that there was a reduction in precipitation even if no clear trend had yet been identified in the records (according to Gillson et al. 2003). These changes were related by my informants to the prevailing condition of war in the world, changes in the atmosphere, reduction in the (sacred) forests where precipitation could be caught and the fact that few people participated in the main annual rain ceremonies due to the adoption of religions from outside.¹³ Here, the local insiders and many outside observers tend to find common ground in the perception that that the presence of forest affects the amount of precipitation,¹⁴ while other theories of causation would be more difficult to relate to for a scientific community¹⁵ or in the development discourse.

¹¹ The idea of development as moral decline or breakdown of the old order of society is rarely mentioned in development theory textbooks, but it was important not only in the work of Bruno Gutmann (inter alia 1926), the ethnographer of the Chagga, but also in the history of social science, for instance in the work of Durkheim, Tönnies and others who struggled with the problem of modernisation in the West (see Lee and Newby 1983).

¹² Kilema Mission data (Met. Dept. station 9337015) 1911 to 1990. For long-term fluctuations in precipitation, see Tagseth (2000a: XV-XVI).

¹³ This is based on fieldwork (Ugweno, 2004), but an interest in local discourses of rain was inspired by S. Feiermann (inter alia 1990) and M. J. Sheridan (inter alia Gillson et al. 2003).

¹⁴ The idea that the presence of forest increases precipitation is commonsensical, but has been a matter for debate. The theory that forests attract rain has support in local perception and is present in environmental policy (United Republic of Tanzania 1994) and in many scientific studies (see for instance Hemp 2005). The thesis has little support in the main empirical study undertaken on this matter in Tanzania (Sandström 1995).

¹⁵ There is agreement between many insiders and outsiders, for instance about a relationship between the modernisation process and declining precipitation, and between forests and precipitation, which may be superficial and hide different ideas of causation. Scientific discourse emphasises increased concentration of carbon dioxide in the atmosphere and also a loss of tree cover. Local discourse tends to blend these with indigenous theory where the condition of war influences the atmosphere and is the antithesis of rain,

Studies of the waterscape of Kilimanjaro

Informants at Mt. Kilimanjaro reported on rain rites as something used to control the environment in the past. However, members of the community in Old Moshi at Mt. Kilimanjaro are campaigning for the return of the skull of *Mangi* Meli, which was taken to Germany after he was hanged as a rebel in 1899, because they need it in order to perform rituals to stop destructive and erratic rainfall and restore spring discharge, among other things (Arusha Times 2005). This reflects the continued existence of a local discourse of rain, which may be revitalised in the presence of a renewed insecurity or in seeking to legitimise power. Some specialists or priests in North Pare have combined symbolic and some administrative control over water in hydrological regions. One of these controls the river he refers to as the Ruvu rather than the Pangani, where he has the power to sanction new abstractions.¹⁶ It remains, however, doubtful whether such forms of control were ever comparable to what is known from Bali (Lansing 1987). In the Pare Mountains, traditional arrangements to coordinate water use in some catchments are known,¹⁷ but this is not the case for Mt. Kilimanjaro. Here, there is little data on traditional institutions to coordinate water use at a catchment level, but one case of negotiations held over water distribution for a whole chiefdom has been reported (Volkens 1897:250). In Kilimanjaro (and beyond), it is possible to argue that there was a notion that the autochthons, ancestors who 'first' settled in or dominated the land, control the condition of the land. As far as such arguments or rain and fertility are voiced at Mt. Kilimanjaro today, they can be seen as counter-hegemonic to the discourse of development (see Feiermann 1990 with reference to the Usambaras, and Mshana 1992 with reference to Ugweno). The notion can be extended to smaller matters, which I was reminded of during participation in a ceremony hosted by Meru friends.¹⁸ Here, it was successfully argued in negotiations over the division of an inheritance, presided over by an elder specialist, that in dividing the land it was necessary to follow the will of the deceased so that the land would maintain its fertility, even if this meant giving land in inheritance to daughters, which was contrary to the

and with worries about the possible effect of the loss of the shrines of the land, its sacred groves and forests on precipitation.

¹⁶ Fieldwork, Mwangi District 2005.

¹⁷ Fieldwork, Mwangi District 2003. See also Mascarenhas et al. (1985) for Same District / South Pare.

¹⁸ Participant observation, Meru, February 2005.

rules of inheritance in local custom. Some similarities are found in the realm of irrigation. First, it is important to have a descendant of the canal initiator as the head of the group in order to ensure success in irrigation. Second, there is a danger that the scheme will fail or that the water will disappear when a scheme is taken from its owners.¹⁹ Conflict or injustice can thus be understood as an influence on water access.

Water was traditionally seen as a source of fertility and less as a source of erosion, but this appears to have changed quite a lot. Lessons about irrigation management in the early colonial period were incorporated not only in the grandfathers' instructions but also in the initiation rites for boys (Gutmann 1958 [1932]: 10, 82-3, 341-5). This was important not only in terms of training and instruction about irrigation management, but also implicated the symbolic powers of irrigation water to confer fertility to the initiates and to transform them into men (see Bender 2006). Despite many changes, it is possible to argue that indigenous cultural models of water remain an influence on water management at the local level (Tagseth 2009).²⁰ Further, it is possible to argue that the conflict over water management reform is not only a struggle about the control over water, but also over the meaning of water.²¹ There is thus a cultural politics of water management (Gelles 2000). I have addressed some of these issues concerning the ethnography of water use in the papers, while working from a naturalistic perspective and with an interest in cultural interpretation and local knowledge related to the environment. The cultural aspects of water in the region have also been addressed by Mosgrove (1998) and by Beez (2005), who have been able to show that outsider perceptions of and practices towards irrigation can also be seen as based on different cultures of water.

¹⁹ This has been argued by informants, especially in relation to instances of difficulties in irrigation rehabilitation in Marangu (Moshi R. District) and Ugweno (Mwanga District) where the former owners have not been consulted.

²⁰ This can refer to locally developed models and practices relating to irrigation (Tagseth 2000a, Tagseth 2009), some of which appear to be based on more widespread Bantu ideas of water (see Odner 2000).

²¹ In a discussion of the relevance of political ecology, Mung'ong'o (2009) emphasises the need for greater knowledge of the social meanings of ecosystem resources such as water imbued by local groups, and argues that struggles over meaning are as much a part of the process of resource allocation as are struggles over surplus or the labour process.

Water history in research on the hill furrow

The hill furrow technology in eastern Africa has attracted interest on several accounts. A first main theme in this thesis concerns water history. In broad terms, water history concerns ‘the historical understanding of, and research in, the relationship between water and humankind’.²² Overviews can emphasise the technological and environmental history of water (Juuti et al. 2007), or work towards dividing the field further into water control in a technological sense (Tvedt & Jakobsson 2006a), the political economy (or possibly an emerging political ecology) of water control (Coopey & Tvedt 2006), and ‘worlds of water’ (Tvedt & Oestigaard 2006), referring to the meaning of water and its cultural and ideological aspects. These interpretations of water history share a clear relevance to a basic concern in geography, the question of how people and society relate to and interact over nature and their environment.

The interest in the site at Engaruka can be seen as a starting point in historical research concerning the hill furrow. At this location at the foot of the Rift Wall in northern Tanzania, a group of people practised irrigated farming from the 15th to 18th centuries (Sutton 2004, Stump 2006a). This site has inspired debates on the causes for the emergence and perhaps especially the demise of this irrigation-based community. This site has also been used in defining the ‘history of the fields’ as a research subject (Sutton 1989), encompassing the description of practices of pre-colonial intensive agriculture and the explanation of intensive practises such as terracing and irrigation, some of which have disappeared (Håkansson 1989, Widgren 2004a, Östberg 2004, Stump 2006a). The dates of origin of pre-colonial irrigated agriculture in eastern Africa, beyond 15th to 18th century Engaruka and irrigation from the early 19th century at Arusha, remain poorly understood (Stump and Tagseth 2009, citing Spear, 1993: 122, 1997: 38, 41, Sutton 2004, Laulumaa pers. comm.). It is, however, reasonable to say that irrigation in what Adams and Anderson (1988) termed the ‘Kilimanjaro cluster’²³ of hill furrow irrigation has a long history. At a general level, the studies available from

²² Bylaws, International Water History Association (<http://www.iwha.ewu.edu/> [accessed 20.03.2009]). See also Ertsen and Melosi (2009).

²³ In the Kilimanjaro cluster I would include the mountain areas of the Pangani River Basin and their foothills (the Usambaras, South and North Pare, Mt. Kilimanjaro, Mt. Meru) as well as oasis communities (Arusha Chini, Kahe, Taveta) and the nearby hill areas Machakos and Taita in Kenya.

oral history based on genealogies and chiefly reigns suggest that hill furrow irrigation was practiced in several mountain areas within the ‘Kilimanjaro cluster’ (Usambaras, South Pare, North Pare and Kamba as well as Kilimanjaro), and in some riverside ‘oases’ in the plains (Taveta, Kahe) by the 17th to 18th century²⁴ (see Stump and Tagseth 2009). The explanation of instances of intensive agriculture is a classic theme in tropical geography (Gourou 1966 [1947]: 98-117), and there is a current debate on the causation of the emergence, abandonment and about the sustainability of intensive agriculture in the historical geography of eastern Africa (Sutton 1984, Håkansson 1989, Östberg 2004, Widgren 2004a, Börjeson 2004, Håkansson & Widgren 2007). The culture, cultural history and meaning of water have been investigated by Mosgrove (1998), Sheridan (2001, 2002), Beez (2005), and Bender (2006). Despite this interest, and some few studies with intensive methods (archaeology by Stump 2006a and landscape studies by Börjeson 2004) there are still few detailed empirical studies of change in such intensive systems, and especially in the case of irrigation. Despite some lines of work trying to address change in irrigation, for instance by Grove (1993), Devenne (2006) and Davies (2006), there remains a problematic understanding of practices existing as timeless traditions and a problematic notion of a timeless pre-development past. This can be addressed through innovation in methodology (Tagseth 2008a/paper two) and through a diachronic and regional analysis of the written and oral record of irrigation (Tagseth 2008b/paper three). There are also efforts to use field archaeological methods to document change (Stump 2006a, Stump 2006b). These themes could be broadly related to the concern with change and continuity in water history as a theme established by Glick’s (1970) study of irrigation and society in medieval Valencia. The present study does not address the comparative method, which is the other main approach to water history, used by Wittfogel (1957) to substantiate a thesis that despotism originated in and was necessary for hydraulic societies. Wittfogel’s work has, however, continued to incite debate (see for instance Leach 1959, Geertz 1972, Lansing 1987, 2004), some of which is relevant to the hill furrow in eastern Africa. One of the interesting criticisms was by Gray (1963), who used the case

²⁴ Some indications from oral history relying on genealogies (Beez 2005: 92, Sheridan 2002), migration histories and political history (fieldwork 2002, 2004, Ugweno and Lembeni Wards, Mwangi District) might go somewhat beyond this and could be analysed further.

Studies of the waterscape of Kilimanjaro

of the acephalous, ‘irrigation-based society’ of the Sonjo (Batemi) in the arid Rift Valley in Tanzania to argue against such necessary connections in a book that is now a classic on the organisation of indigenous irrigation. More recent attempts to make Wittfogel relevant include an answer to Gray by Beez (2005) based on a detailed ethnological study of irrigation in Kahe in Kilimanjaro, as well as a discussion of irrigation and social stratification at the local level by Davies (2009). Håkansson and Widgren (2007) have also used the comparative method in the study of intensive agriculture in Tanzania in relation to a debate on the relationship between intensive agriculture and society. In this thesis, I will present, firstly, a diachronic analysis of the development of the hill furrow infrastructure and water use (Tagseth 2006/paper four, Tagseth 2008a/paper two, Tagseth 2008b/paper three). Secondly, I will analyse historical factors as an influence on current water management problems (Tagseth 2006/paper four, Lein & Tagseth 2009/paper five).

Water management in research on the hill furrow

A second main theme in this thesis concerns aspects of water management. This theme is characterised by a number of debates, concerning such issues as irrigation scheme management, the improvement of water management, but also hydraulic tenure, cultural aspects of water and the politics of water, among others. This thesis deals with two main issues in water management. The first of these is the local organisation of water use. The second relates to the efforts to change or improve water management through policy and interventions by actors in government, NGOs and aid agencies.

Reference to the concept of ‘water management’ usually directs attention to the government agencies that implement policy, plans and regulations. It is reasonable to say that this is what is usually understood by water management, as the ‘planned development, distribution and use of water resources’ (Johansson, 1983: 138, cited in Lein & Tagseth 2009 / paper 5). My intention is to examine water management in this conventional sense, involving the development of water policy, planning and management activities and administrative practice directed at smallholder irrigation and water control. However, I also include the local organisation of water use, the

institutions and practices (and planning) of groups of irrigators running their own schemes, in my conception of water management.

Borrowing from Blaikie and Brookfield's (1987:74-83) concept of the primary 'land manager' as the central decision maker in Soil and Water Conservation, I suggest that there are *primary water managers* who make both everyday and more strategic decisions about water use and about investments in irrigation. Such managers are sometimes individual men and women (i. e. 'water users'), community leaders (village chairmen etc.), leaders in irrigation (furrow chairmen and irrigation committee members) or groups (furrow communities as well as more formalised groups). Collective decision making can be formalised (i. e. through the general meeting of water users, or through the parley or *baraza*), but often it works through casual meetings, or the decision to follow the example of an individual (See Blaikie & Brookfield 1987: 75). In the aggregate, the decisions made under a range of influences from local, regional, basin and global scales by these 'primary water managers', usually affecting field, farm and scheme levels, are central to changes in irrigation and water use affecting higher levels (the catchment, the river basin). The ability of actors in water management in government, NGOs and aid agencies to change water use and investments in irrigation depends on their ability to influence these 'primary water managers'. The interaction between actors in the government, NGOs and aid agencies with the 'primary water managers' is thus an important issue.

It is now often acknowledged that lack of success in the establishment of new irrigation schemes often has organisational rather than technical causes, which justifies an instrumental interest in organisational aspects of irrigation. There is, however, a related social science question of how the organisation of irrigation can be understood. The contributions of Gutmann (1913, 1926) on the organisation of irrigation were oriented towards theories that can be labelled 'old institutionalism'. A seminal study in irrigation organisation is Fleuret's (1985) study of the social organisation of water control in Taita. He drew attention to the organisation of the hill furrow as a problem of social science. Fleuret was critical of functionalist approaches to irrigation organisation (inter alia Hunt & Hunt 1976, Coward 1979) and over-reliance on work from Asia. He

Studies of the waterscape of Kilimanjaro

pointed to how water management was ‘inextricably embedded within broader social relationships’ (Fleuret 1985:106), and stressed the need to relate irrigation management to structural and ideational features of Taita social organisation. The management of irrigation can be seemingly effortless or incidental, because water relations are governed by social relations. This contrasts with another and more managerial approach, which emphasises the need for a strong single purpose organisation for successful management (Ostrom 1990, 1992a) and which describes and evaluates the organisation of irrigation in terms of its ‘operational rules.’ Approaches inspired by new institutional economics in Kilimanjaro have been used by Davidsen (1997) and by Gillingham (1999). While this ‘Common Pool Resource’ or ‘Common Property Resource’ perspective has been important in pointing out the role of institutions in resource management, I will maintain in this thesis that there are problems in the analysis of these institutions originating in the apolitical and ahistorical approach to resource management.

Related to the question of local organisation of irrigation are studies of the micro-politics of water management, including studies of transformations (modernisation) of irrigation in the Kilimanjaro lowland (Beez 2005, Lerise 2005), and the negotiation between peasant water users and recently privatised estates on the slopes (Reed-Erichsen 2003).

Associated with the themes relating to water management, there is debate over indigenous knowledge in water management (inter alia Goldschmidt & Hildyard 1984, Adams 1992, Goldschmidt 1998, Lein 1998, Stump 2006b), and especially on its relevance for development. Based on a critique and lessons of dramatic modernisation in African agriculture, there are debates about how ‘indigenous agriculture’ best can be assisted, and how indigenous knowledge, seen not as an obstacle to development but rather as an underutilised resource, can be mobilised in rural development (Tagseth in press) and natural resource management (see DeWalt 1994). In the 1980s there was an emerging idea that indigenous irrigation in Tanzania could be used as a resource for

development (Mascarenhas et al. 1985, Burra & van den Heuvel 1987).²⁵ Based on problems experienced with large-scale and agency-managed irrigation schemes, there was also an emerging interest in small-scale irrigation development. Some (inter alia Barnett 1984, Adams and Anderson 1988, Adams 1990) warned, however, that the bureaucratic control of irrigation rather than the scale was to blame. This has again led to an interest in learning from management models and practices in existing 'farmer managed' or 'indigenous' irrigation (inter alia Adams and Anderson 1988, Gomes 2004, N. Gomes personal communication 2005). I refer to this debate in one of the papers (Tagseth 2006 /paper 4) and elsewhere (Tagseth 2000a).

A second important issue in water management for the hill furrow concerns efforts to change or improve water management through policy and interventions based on the international consensus on these issues from the 1990's.

Statutory water management interacts with irrigation extension and broad socioeconomic processes in influencing water use at the local level. There is an extensive literature that contains problem descriptions, analysis and prescriptions (inter alia United Republic of Tanzania 1994, Daluti 1994, Ngana 2002b, IUCN 2003), as well as policy and project analysis (inter alia Mung'ong'o 1997, Usher 1997, Beez 2005), and analysis of conflict and competition between sectors and actors (Mujwahuzi 2001, Lerise 2005) in this region. My analysis is focused on the visions or ideas of better water management, emanating from international forums, their translation to national policy and their implementation in a regional and local setting, which is historically and geographically contingent (Lein & Tagseth 2009 /paper five). Further, the local impact of the initiative in water management is analysed in paper four (Tagseth

²⁵ This idea, and the mobilisation of traditional irrigation during the 'Freedom from Hunger' campaign during a severe drought in 1987, led to several 'traditional irrigation rehabilitation' projects in the wider region, including the establishment of District- based irrigation rehabilitation programmes funded by SNV in Arumeru, Mwanga, Same and Lushoto (Burra and van den Heuvel 1987, interviews with TIP staff in Moshi, 2002, and Mwanga, 2003). Belgian COPIBO initiated a project in the lowlands in Mwanga, while FAO initiated the project 'rehabilitation of traditional irrigation', which focused on one scheme in lower Hai at Mt. Kilimanjaro. Despite some projects to rehabilitate individual furrows in later years, for instance funded by the United Nations Development Programme, the overall impact in the Mt. Kilimanjaro Districts remains limited.

Studies of the waterscape of Kilimanjaro

2006) which describes a conflict between a ‘modern’ water management system and an ‘indigenous’ water management system.

Objectives and research questions

General objective and research questions

As stated in the introduction, the general objective of this thesis is to contribute knowledge of water management and water use in hill furrow irrigation, with Kilimanjaro as the case. In order to achieve this objective, research proceeds along two lines of inquiry, with two principal objectives. Correspondingly, two principal research questions have guided this thesis work.

-How is the use of water for agriculture organised? (Q 1)

I will look at this especially with reference to the local and basin levels, but also to some extent at global, national and catchment levels. Specific objectives and questions relating to the social organisation of water use, and water management reform are found below. Three of the research papers are relevant to this question (Tagseth forthcoming/paper one, Tagseth 2006/paper four and Lein & Tagseth 2009/paper five). In this synthesis, having introduced issues of water management for the hill furrow, I will proceed to expand on theoretical and methodological issues for the study of irrigation organisation.

The second research question relates to the development of irrigation.

-What changes have occurred over time in farmer managed irrigation? (Q 2)

I will look particularly with reference to water use and the development of the irrigation infrastructure, and to some extent change and continuity in local organisation and water management. I will start as far back as oral traditions allow, but examine 20th century changes in more detail. Specific objectives and research questions relating to methodology, changes in water use and infrastructure development and the explanation of change in irrigation are found below. Three of the research papers are relevant to this question (Tagseth 2008a/paper two, Tagseth 2006/paper four, Tagseth 2008b/paper

three). Within this synthesis, having introduced the historical geography of hill furrow irrigation, I will expand on the explanation of the establishment and subsequent change in irrigation.

Specific objectives and research questions

There are two sets of specific objectives and research questions that correspond to the general research questions. I first present the specific objectives and questions related to the first theme of water management and the organisation of water use, before turning to those concerning the second theme of historical geography of water use.

1: Water management and the organisation of water use

1.1: The local organisation of water use:

The study seeks to contribute new empirical knowledge and analysis of the local organisation of water use in farmer managed irrigation. The objectives here are to contribute to the improved understanding of how the irrigation systems operate, and to improve the understanding of the social organisation of water use in farmer-managed irrigation. This is important as these systems are targeted for interventions in water management and irrigation improvement. My principal question here is:

-How do small scale farmers organise themselves in order to operate their own irrigation schemes, especially with regard to maintenance, water distribution and conflict management? (Q 1.1)

More specific questions related to this are: What are the concepts of tenure related to irrigation schemes and water? How is access to water negotiated? How do different groups compare in their access to water? What regional and temporal variations are there in the organisation of water use?

1.2: The problem of water policy & water management reform:

The study seeks to analyse how ideas of better water management, emanating from discourse and resolutions in global forums, come to influence policy formulation at a national level, and what subsequently happens in the application in regional and local

Studies of the waterscape of Kilimanjaro

settings with their own particular context influenced by of a history of water management efforts and long established conflicts of interest. The questions asked here are:

-What are the global influences on water policy in Tanzania and the Pangani River Basin? (Q 1.2.1)

-How do these influences translate into water management in this region? (Q 1.2.2)

-In what ways have specific and contingent factors impacted on the water reform process? (Q 1.2.3)

2: The historical geography of irrigation and water use change

The argument has been made that claims about changes in African agriculture and resource use should be better grounded in empirical and diachronic studies of such processes (Niemeijer 1996), and a series of studies has been able to challenge dominant assumptions of environmental change through an application of this insight and methodological innovations (e.g. Tiffen et al. 1994, Fairhead and Leach 1996). Despite claims about changes, empirical studies of changes in water use have been lacking. There is uncertainty as to whether locally initiated spontaneous and unchecked growth in farmer-managed irrigation has been or is likely to become a cause of increased water scarcity and water conflict in downstream areas.

A first objective under this theme is to develop methods to make it possible to examine changes in resource utilisation at the local level through oral history and landscape studies. A second objective is to identify changes in farmer-managed irrigation. In order to do so, it is necessary to develop methods to examine changes and identify phases, and if possible quantify such changes on the basis of oral history, landscape or archival sources. This is a precondition for addressing the question of causation of irrigation development. These concerns are expressed in the following questions:

Objectives and research questions

-How can questions of origins and changes in irrigation best be addressed empirically? (Q 2.1).

-What have been the directions and magnitudes of changes in (the extent of) farmer-managed irrigation? (Q 2.2).

-How can the present study contribute towards explanation of such changes? (Q 2.3).

Concepts and theoretical considerations

This discussion of the theoretical perspectives of the thesis concerns three main themes. The *first* of these concerns **the explanation of irrigation**, its emergence and the subsequent changes in the use of irrigation technology. This section elaborates on a theme that has been introduced, but not explored in detail in the papers (see Tagseth 2006/paper four, Tagseth 2008a/paper two, Tagseth 2008b/paper three). There are thus several types of explanation that can be made relevant to irrigation in Kilimanjaro, and I will argue that it is difficult to maintain single-factor explanations. The *second* section is an analytical review of theoretical **approaches to the organisation of irrigation** and some key debates. Further, I use Morgan's (2006) hermeneutic metaphor that there are different *ways of 'reading' organisations*, to discuss the different strengths and weakness of studies of the organisation of irrigation which draw on different master metaphors. I also reflect on the use of changing perspectives on irrigation organisation in my own work.

The *last* of the three themes is the **'waterscape'**, an emerging concept used in the water literature, but with different meanings (see Swyngedouw 1999, Mels 2005, Tvedt & Jakobsson 2006b, Tvedt 2007). I will argue that the concept of the waterscape can be useful as an aid to think about water issues and to highlight the different conceptualisations of the problem of water in geography and the social sciences, and discuss how three main conceptualisations of the waterscape have been addressed in my research.

Explanation in irrigation studies

Much of the work reflected in the papers has been driven by a motivation to improve the understanding of hill furrow irrigation. In this section I review and summarise some theories of causation relevant to hill furrow irrigation in order to relate the case of *mfongo* irrigation to a debate on the explanation of irrigation and intensive agriculture.²⁶ One of the papers (Tagseth in 2008b/paper three) reviews two important theses or theories of change in irrigation that have been used in the management of water in the Kilimanjaro Region. According to the first of these, it is assumed that hill furrow irrigation represents an old tradition that is expected to die out or be replaced with new technology as a result of the development process. According to the second thesis, there is an increase in hill furrow irrigation driven by population growth. I now turn to a review of explanation in irrigation studies from the scholarly debate relevant to the case of hill furrow irrigation at Mt. Kilimanjaro. These theories can be grouped into the evolutionary, cultural diffusion and ethnicity, the institutional, the population-based, political economy, and nature (ecology) with adaptation (see Östberg 2004, Tagseth 2008a/paper two).

The ethnographer and missionary Gutmann (1913) asked questions about the livelihood of the Chagga, and sought to explain this in terms of **evolution** from primitive to more complex forms. He saw hunting as the earliest phase, followed by phases of innovation in agriculture and later the integration of livestock in the economy through adoption from the nomadic pastoralists. He also attempted an analysis of the components of the agricultural repertoire and used the symbolism or ritual associated with different crops as a source. The cultivation of tubers and beans was seen as an early innovation in agriculture and the cultivation of millet and banana as later imports through cultural contacts before the integration of American cultivars. These changes in livelihood had effects on society, where banana cultivation led to commitment to permanent settlement, and millet to investment in irrigation. The development of local and regional

²⁶ In historical geography, history and archaeology, intensive agriculture is often indicated or defined by the presence of terraces and irrigation infrastructure, but there has been debate over its definition. Definitions based on population density, cultivation intensity, yields or the existence of tradable surpluses and labour inputs can be made relevant, but in particular, it is the existence of the extensive hill furrow systems that has informed the interpretation of pre-colonial and early colonial agriculture at Mt. Kilimanjaro as an intensive system (Stump & Tagseth & 2009).

markets permitted differentiation. Cultural contacts with other areas in the region are mentioned as a source of cultivars. For example, he suggested that maize had been introduced by migrants who had travelled along the Pangani River from the Usambara Mts. c. 200 km to the south. Many aspects of the study, most importantly the development seen as unilinear evolution from primitive (hunting and gathering) to more advanced (farming), are clearly outdated. Some specific details on the relative antiquity and origin of crops are highly questionable, for instance when finger millet, one of few crops known to be indigenous to eastern Africa,²⁷ is seen as younger than some tubers originating in other areas. Among the ideas that can be relevant today is agricultural change through the adoption of new practices and cultivars through cultural contacts in the region, and the outlook on the agricultural society as having developed in situ. There are also two specific observations on irrigation. The first is the desire to cultivate millet at high altitude as a motivation to develop irrigation, which points towards adaptation to that ecological niche. The second is the practice of irrigating taro around the springs with water control. Gutmann does not elaborate on this, but in my analysis, it is possible to imagine that at some point in time, the use of small wetlands and springs for cultivation during dry periods may have been conceived as an obvious solution to improve water control somewhere in the highlands in the wider region.

Culture-based explanations can be divided into several types. There existed an idea in anthropology and archaeology from the colonial period that the remains of irrigation, terraces and other structures on the ground were left by a ‘lost’ civilization widely distributed along the Rift Valley. Irrigation and terracing technology were seen as beyond the capabilities of the present population, and were instead attributed to a hypothesised ‘*alien race coming from the North*’ (Wilson 1932: 257) believed to be unrelated to the present populations. The hypothesis of this Azanian culture was justified by the assertion (with reference to irrigation practised by the Marakwet) that ‘*they are too barbarous to have learned it themselves (...)*’ (Huntingford 1933:161). This thesis is now more or less obsolete and discredited. One lesson of relevance to the current debate could be to be careful about the assumption that possession of a

²⁷ Finger millet is referred to as *mbege*, meaning ‘grain’ in the Chagga languages, suggesting that it was older or more basic than other grains with more specific names (Philippson and Montlahuc 2006: 66).

particular culture (ethnicity) is a precondition for success in irrigation. The cases discussed in the papers and in this synthesis are mostly drawn from related groups with Bantu culture and languages. A common assumption is that groups speaking Bantu languages are associated with agriculture while groups speaking Maa languages are oriented towards pastoralism. There are, however, several examples where groups speaking Maa languages practice irrigation (Marakwet, Il-Chamus, the Arusha). Such irrigation locations in the Kilimanjaro cluster include Arusha Chini and Mt. Meru (the Arusha) (Spear & Nurse 1992), and Loitokitok Division / Rombo at the foot of Kilimanjaro in Kenya (Maasai) (Krugmann 1996, Homewood et al. 2009: 32). There are thus no necessary connections between broad cultural affinity and the practice of traditional irrigation, as culture and economic strategies can vary independently (Spear & Nurse 1992). It is generally accepted that these three communities had learned from Chagga (and Meru) during different periods (Krugmann 1996, Stump 2006b: 104-109). It is reasonable to assume considerable repeated interaction historically among communities within what Adams and Anderson (1988) referred to as the 'Kilimanjaro cluster' of irrigation (see Stump & Tagseth 2009). This may have led to the spread not only of hill furrows, but also of what appears to be a more regionally specific technology of collection tanks (Kichagga spoken in Moshi: *nduwa*; Chasu spoken in the Pare ranges: *ndiva*, Kishambaa spoken in the Usambaras: *ndiwa*).²⁸ Troll (1963) described the spread or diffusion of irrigation technology as a problem of cultural geography and cultural history. There are some examples where the spread of irrigation has been traced, by Glick (1970) concerning the import of irrigation technology by the Moors to Spain, and worldwide for the *qanat* ('horizontal well') from origins in Persia (Troll 1963, Lightfoot 2000). Any knowledge beyond the cases mentioned above remains limited, however, in addressing the question of how irrigation technology and organisation have diffused throughout the region.

A well-known theme in the explanation of irrigation is the debate on 'irrigation and society,' which can be seen as a form of **institutional explanation**. This can incorporate

²⁸ The terms *ndiva*, *nduwa* and *ndiwa* are possibly related and all denote a pool or pond. Alternative terms in Kichagga dialects may have religious connotations: *Ruwa* (God, lake, pool), *Iruwaruwa* (pool), *Iruwa* (God, lake, well) (Field notes; Parker 2008).

arguments that livelihood influences social organisation, or, conversely, that a certain livelihood requires some form of social organisation. Wittfogel's (1957) thesis is that irrigation and defensive works (at least on a larger scale) required the development of despotic power, and he used his reading of the case of the Chagga as a 'hydraulic tribe' to substantiate this. It is, however, clear that hill furrow irrigation in eastern Africa has been developed by people with acephalous social structure (Marakwet, Taita, Sonjo), as well as by people who developed chieftaincy and political centralisation (Chagga, Wagweno & Pare, Shambaa). Even in terms of local organisation, there appears to be a considerable variation between irrigating communities that may require further study. Results reported in this study (Tagseth 2008a/paper two) suggest that irrigation was developed prior to political centralisation at Mt. Kilimanjaro.²⁹ This weakens a hypothesis that the Chagga were able to develop irrigation because they had political centralisation. Past studies of irrigation establishment (Stahl 1964) may have overemphasised the direct role of the nobility in hill furrow development. There remains, however, a question as to whether the argument should be turned on its head. It remains possible that the development of a productive agricultural base that could yield a surplus and the development of a division of labour between districts and social groups were prerequisites for the development of centralised chieftaincy. But neither in this sense was irrigation a requirement in eastern Africa. Dundas asserted (1924: 302) that irrigation at Mt. Kilimanjaro was adopted after the centralisation of chieftaincy in larger counties, but this is probably wrong (Tagseth 2008a/paper two). There is also some doubt as to whether the need to coordinate irrigation (Dundas 1924:284) contributed to the development of stronger institutions of chieftaincy. His assertion that chiefs had direct control over water distribution (Dundas 1924: 302) should be interpreted in relation to the context of his work (below). According to informants from Marangu, the headmen (*wachili*) controlled some few schemes, while *Mangi* Augusto Marealle of Marangu claimed that the chiefs had little direct involvement.³⁰ Dundas wrote his history of the Chagga as the District Commissioner of Moshi, as a central actor in the implementation of indirect rule. The British administration had a strong

²⁹ A similar case can be made for the Usambara Mts., where political centralisation took place sometime during the 18th century based on Attems (1967: 74), Fleuret (1978: 26-28), Feierman (1974: 42-7, 1990: 65) and Kimambo (1996).

³⁰ Fieldwork, Marangu, Moshi Rural District 1995.

Studies of the waterscape of Kilimanjaro

interest in empowering chiefs as their agents, and according to Dundas's memoirs, the British even created chiefs (Dundas 1955: 133-134). Research in the region (Moore 1986, Wimmelbücker 2002) suggests that the monopolisation of and control over trade was a more central factor in explaining political centralisation.

The development of irrigation and land use at Mt. Kilimanjaro has been discussed in relation to Neo-Malthusian and Boserupian explanations (inter alia Holand 1996). **Population growth** has been presented as the dominant factor in explaining agricultural change in the region (inter alia Maro 1974, 1988), including irrigation and water use (Mbonile 2005). I maintain that the centrality of the independent variable of population has been overstated, and that other factors including market, policy, technological innovation and diffusion have to be included in the analysis (Tagseth 2008b/paper three). Börjeson's work (2004, 2007) has made it easier to argue that all the population-based theories are related in their emphasis of population as a central and independent variable. Brookfield (1972) made a similar argument and criticised the resulting lack of attention to explanations of intensification based on social production and trade, as well as ecological factors.³¹ Neo-Malthusian theory claims to predict resource crisis (or population checks) as a result of exponential population growth compared to a limited resource base. While Neo-Malthusian explanation predicts depletion of the resource base as a consequence of population growth, Boserupian (Boserup 1965) theory emphasises population growth as a cause of agricultural intensification. Based on studies of arable grain production, Boserup predicts an evolution from forest fallow to bush fallow, short fallow, and annual cultivation to multicropping with increased population density. Irrigation appears as a somewhat marginal theme in her main work, but in this framework, irrigation (usually) appears as a late stage along with annual cultivation and multicropping in an evolutionary intensification process (Boserup 1965: 15-16, 38, Boserup 1976: 26) and is associated with land-saving systems (Boserup 1976: 27, 30). Irrigation practice, especially on a larger scale, is associated with population concentration or with military (coercive) power (Boserup 1976:32-33). The emergence and later development of irrigation in Mesopotamia is associated with

³¹ Brookfield (1984) adds a concern with the 'social conditions of production'.

population growth (Boserup 1983: 387-388), and, correspondingly, irrigation schemes are seen as vulnerable not only to warfare but also to population decline leading to the abandonment of intensive practice (Boserup 1983: 393). In many situations, however, it has been difficult to explain irrigation or other practices of agriculture commonly understood as 'intensive', such as terracing, stall-feeding or manuring, in terms of land scarcity.³² This may have motivated the hypothesis of the siege, identified and criticised by Börjeson (2004), according to which the population had to concentrate due to insecurity, which in turn forced intensification. In the case of the hill furrows at Mt. Kilimanjaro, it was first argued by Johnston (1886) that hill furrow construction was motivated by a need to stay on high ridges due to security concerns. This argument has been taken up by Southall (1961: 161, discussed in Stump 2006b), who emphasised hostile relations with the Maasai, and Bender (2006), who emphasised internal raids and wars.

There are several problems with the primacy of population as the explanation of adoption of and subsequent change in irrigation in these three population-based models of explanation. The idea that the extensive infrastructure of hill furrows at Mt. Kilimanjaro is a result of population growth in recent decades or since independence (1961) does not fit the available data on the past extent of the system (Tagseth 2002b, Tagseth in 2008b/paper three). Furthermore, there is a regionally uneven development where very high and increasing rural population densities are associated with decline in irrigation in favour of *kihamba* agroforestry,³³ which is higher yielding than irrigated grain production.³⁴ This, among other things, raises questions about the assumptions

³² The population-led model of agricultural intensification has been challenged for several agronomies in eastern Africa, by Håkansson (1989, 1995) with reference to Pare and Usambara, Östberg (2004) with reference to Marakwet and Börjeson (2004, 2007) with reference to Iraqw, as discussed in Stump & Tagseth (2009). See also Davies (2008), with reference to Pokot.

³³ Chagga agroforestry is a system with more than 100 crops integrated with trees and livestock. In terms of vertical structure, there are creepers (such as beans, pigeon peas and sweet potato), a field layer (with crops such as taro and including fodder plants such as Guatemala grass), a bush layer (primarily coffee), above this the banana plants and then smaller trees (fruit trees and grevillea often looped for fodder) below some tall trees (species such as *Albizia Maranguensis* for nitrogen fixation, shade and timber) see Tagseth (2000a 98-99) on *Kihamba* land use.

³⁴ I am not aware of any reliable calculation of the economy or yield of the very complex *kihamba* agroforestry system. Much attention has focused on the coffee, but banana is the economically most important crop in the system (see von Clemm 1964). Transition from maize to banana alone can increase the calorie output 2-3 times (Huijzendveld 2008) A simple transition in land use from maize to banana

Studies of the waterscape of Kilimanjaro

that population growth is the primary cause of a 'water crisis' at Mt. Kilimanjaro. It is still possible to maintain that the increasing scarcity of good land is an influence on agricultural change at Mt. Kilimanjaro, but there are problems with the Boserupian prediction that irrigation is a late innovation in an intensification process. Among other things, this is contradicted by knowledge of the early adoption of irrigation (Tagseth 2008a/paper two). It is also contradicted by the practice of irrigating the swidden, known historically from Mt. Kilimanjaro (inter alia Curry 1939) and from the current practice of combining irrigation and bush fallow in some locations in North Pare (personal observation, Ugweno, Mwangi District 2003). In these cases irrigation may be labour intensive but it is not land intensive, or it could alternatively be understood as specialised (see Sutton 1989). Boserup's thesis (1965) was developed from studies of grain-based systems, and it could thus not be expected to predict the change (intensification) from irrigated arable to agroforestry (see Bailey & Mumford 1968, Holand 1996) with shading and mulching as methods of water control, a trajectory which led to a decline in the number of irrigation schemes and stability in water abstraction with an average population growth of 2.1% in Marangu from 1939-1993 (Tagseth 2002b:55). The thesis that insecurity led to population concentration and hence to irrigation as a form of intensification needs consideration. Insecurity in Kilimanjaro could relate to increased internal warfare in the wake of the Swahili trade, to competition with the Maasai and also to the violent processes whereby the Germans established domination and eventually lost it to the British. The colonial library tends to emphasise hostile relations between pastoralist Maasai and sedentary farmers, and the related 'siege hypothesis' (see Börjeson 2004), thus silencing trading relations and migration between the two types of community and livelihood that can be examined through oral history. As a general explanation it can be weakened by the observation that furrow infrastructure in some areas was abandoned during a period of increased insecurity with the expansion of the Swahili trade in the period after c 1850 (Tagseth 2008b/paper three). Rather, it seems that political turmoil may have led to an uneven regional development, and was associated with abandonment of infrastructure in some

implies reduced labour intensity, but as a whole, it is reasonable to say that the *kihamba* is more labour intensive than irrigated maize production. It is conceivable that rice can compete with the *kihamba* in terms of output, but these forms of land use do not compete for the same land.

locations and investment in others, where increased mortality and migration may have been involved.

There are at least two types of theory focusing on **political economy**, one emphasising regional political economy/regional political ecology and another emphasising the community level. Studies emphasising the regional political economy suggest that irrigation was mainly a specialisation where people who lacked livestock could produce a surplus of grain to exchange with pastoralists for livestock and livestock products through regional trade (Håkansson 1995, 2003). This agricultural surplus could be invested in livestock, which Håkansson argues was the main form of accumulation and a requirement for the brideprice. The argument is based on studies in the Pare Mountains, but has been repeated with reference to Mt. Kilimanjaro (Håkansson 2007). The available evidence suggesting that a similar process of regional specialisation was central to the development of irrigation at Mt. Kilimanjaro is weaker at present, however. I have not heard directly here that people started an irrigation scheme because they were poor in cattle, while this is transparent in some oral history accounts from North Pare.³⁵ It is clear, however, that the Chagga took part in a regional trade network in the pre-colonial and early colonial periods, and that some agricultural products were bartered for cattle at the 'Maasai markets' on the lower slopes (see Gutmann 1913: 502). But existing references to trade in finger millet, the main irrigated crop (Volkens 1897: 136-137, Widenmann 1899:69), hint mainly at trade and regional economic differentiation between Mt. Kilimanjaro districts, and also at a more complex integration with the long distance (Swahili) trade (Stahl 1965: 42).

Regional processes were also among the early concerns in political ecology, which linked the decisions of a 'primary land manager' to the world system through a 'chain of explanation' (Blaikie 1985, Blaikie & Brookfield 1987). In seeking to explore a historical and regional political ecology of landscape transformations in northern Tanzania, Håkansson et al. (2008) ask how land use changes (which can include changes in water use) can be explained as an effect of world systems, in terms of

³⁵ Fieldwork, Ugweno Division, Mwangi District 2003, 2004.

Studies of the waterscape of Kilimanjaro

changes in the 'mode of exploitation', among other things influencing the ability to retain labour to invest in 'landesque capital' (see Brookfield 1984, Håkansson & Widgren 2007). An example of a significant change in world system connections is the emergence and growth in direct coastal (Swahili) caravan trade involving Mt. Kilimanjaro from the late 18th century through the 19th century. Moore (1986: 31-32) emphasised a direct connection between the demand for provisions for these large groups of people on the move and increased food production and irrigation. But the changes were apparently more complex, with increased hostilities leading to the devastation of some districts and the abandonment of their irrigation infrastructure, and growth and investment in irrigation in others (Tagseth 2008b/paper 3). Unlike the process in the Pare Mountains where decentralisation took place, the trade was associated with political centralisation into fewer and larger polities on Mt. Kilimanjaro, which may have increased the capacity to build larger irrigation schemes in the 19th century (see Stahl 1964). The period of the direct coastal caravan trade appears to have been a period of change with considerable overall expansion in irrigation, since the dating of specific pre-colonial furrows through oral history methods at Mt. Kilimanjaro by various researchers has produced 19th century and a couple of late 18th century dates (Stump & Tagseth 2009). Further connections between changes in irrigation and wider political and economic processes are discussed by Huijzendveld (2008), Håkansson (2008) and in my third paper (Tagseth 2008b). Taken together, these studies show an uneven regional development of irrigation in and around the highlands in north-eastern Tanzania, with periods of intensification or investment in irrigation as well as disintensification or disinvestment in irrigation. The latter is shown by a decline in highland irrigation during the German (Huijzendveld 2008) and British colonial periods (Håkansson 2008, Tagseth 2008).

The second type of political economy explanation emphasises processes internal to a society. Fleuret (1985) has suggested that the initiation of an irrigation scheme was part of a strategy to attract more settlers and thus dependents, and Sheridan (2002) suggests that it was part of a strategy to create 'wealth in people.' Irrigation can hence be seen not as a result of high population density, but rather as a motivation of immigration to the area leading to further investments in the land. There are further questions of how

the surplus produce of irrigation was appropriated and circulated at Mt. Kilimanjaro. Agricultural produce was appropriated by the elite (lineage heads, nobility) and redistributed. Finger millet as the main produce of irrigated farming could be easily stored and traded, but it was especially important as a key ingredient in the brew *mbege*. According to Dundas (1924), making beer was the *raison d'être* of irrigation. Beer was significant, not only because you could get drunk, but because it could be invested in social relations. Not only livestock, but large quantities of beer were exchanged in marriages. According to informants (fieldwork, Marangu 1995-96, 2002) beer was used to pay tribute, and to command labour parties, for instance when a house was to be constructed. In general, pre-colonial agricultural production was often not simply a matter of subsistence (Brookfield 1972). While some of the production appears to have been oriented towards trade or regional exchange, the central role of *mbege* in irrigated agriculture hints at a considerable 'social production' (Brookfield 1972) of surplus to be invested in social relations and used in the mobilisation of labour at Mt. Kilimanjaro.³⁶ In the late 19th century, *mangi* Sina of Kibosho held vast quantities of grain in his stores (Volkens 1897: 136-7), which could be used to retain warriors and increase his power.

Last on this list are explanations emphasising **nature**, or ecology. These can focus on how this environment can be exploited effectively or on natural processes as an influence on change in irrigation. Irrigation can of course be seen as a response to aridity.³⁷ This is commonly assumed in the case of the arid location Engaruka, but cannot be maintained with reference to average annual conditions for the subhumid higher altitude settlements at Mt. Kilimanjaro, which can receive roughly 2000mm of precipitation annually, and it is somewhat problematic even for the semiarid foothills, which receive roughly 750mm annually. This anomaly has been a puzzle in the explanation of irrigation at Mt. Kilimanjaro (inter alia Dundas 1924, Teale and Gillman 1935). Nature is a factor in explanations describing irrigation as a flexible adaptation to the mountain environment to exploit possibilities offered by ecological differences

³⁶ Alcohol had a wide social and economic significance in East Africa, and *mbege* was used in the mobilisation of warriors in Old Moshi, Kilimanjaro, in the late 19th century (Willis 2002).

³⁷ This understanding is in agreement with a classic and common understanding of irrigation as the 'Artificial watering of land for growing crops. Irrigation enables crops to grow in regions with inadequate precipitation.' (Irrigation 2008).

Studies of the waterscape of Kilimanjaro

along the gradient and by seasonality (Kimambo 1996, see also Tagseth 2000a: 18, 84). Common in the uplands in the Kilimanjaro cluster is the use of not only the long rainy season (*masika*) and the short rainy season (*vuli*), but also a third irrigated season. The variation along the gradient allowed efficient utilization of labour through the seasons, and thus the three seasons do not represent triple cropping of the same plot. In upslope areas of Mt. Kilimanjaro, grains (maize, finger millet) do not thrive during the main rains due to low temperatures and excessive cloud cover, and are planted in the period following the *masika* rains, when these crops are susceptible to drought and consequently benefit from irrigation (inter alia Tagseth 2006/paper four). Davies (2008) criticises the concept of adaptation for reliance on a false distinction between nature and culture, and argues against seeing the intensification of agriculture as the inevitable outcome of a specific set of environmental, demographic and technological circumstances.

There has been much speculation about environmental change as a factor explaining the abandonment of irrigation at Engaruka. Fosbrooke (1957 discussed in Stump 2006b: 158-159) and later Sutton (inter alia 2004) have long argued that decline in runoff due to catchment degradation could be a cause of decline in irrigation (see Stump 2006b: 86), but there is still limited knowledge of past hydrology or land cover there. Wästerberg (2003) has pointed out how the period of occupation (*c.* mid- 14th to mid-18th century) in that arid environment corresponds broadly to the Little Ice Age in Europe (13th to 19th century), which was a wet period in this region. There is thus the possibility that a decline in runoff due to climatic change led to a decline in irrigation at Engaruka. Correspondingly, there is the question whether climate change may have had an opposite effect at Mt. Kilimanjaro, where the need for irrigation in the sub-humid and semiarid areas thus increased with declining or more erratic precipitation. Testing this hypothesis would require a better understanding of both historical change in irrigation and of the regional climate history than is available at present. There are, however, indications that irrigation was practised before the end of the Little Ice Age, by the 17th century in Marangu, Mt. Kilimanjaro (Tagseth 2008a/paper two). It may also have been practised in Machame, Mt. Kilimanjaro, which in oral histories is claimed to

be a source of diffusion of the technology to Mt. Meru by the 17th century (Spear 1997, discussed in Stump 2006b: 105).

The discussion above shows that it is difficult to maintain single-factor explanations, including the dominant one of population growth, in the explanation of change in hill furrow irrigation at Mt. Kilimanjaro, so that further discussion would focus on the varying contributions of several factors. Given the long history of irrigation and the geographical variation in a mountain region, it is not likely that changes in irrigation would be explained by a single model of agricultural change (Stump & Tagseth 2009). There are alternative theories based on evolution, culture, ethnicity and diffusion, the institutional, population, political economy and nature, including adaptation, that can contribute. The effect of changing policies and development planning on irrigated agriculture should also be considered (Tagseth 2008b/paper three).

Approaches to the local organisation of irrigation

It is increasingly acknowledged that not only the technology, but also the organisation of irrigation is important in determining the success or failure of irrigation schemes. Most of the literature on irrigation organisation has instrumental objectives relating to the development and management of irrigation. In the following section, I provide an analytical review of trends, approaches and debates relevant to the study of the East African hill furrow, to inform and provide context for my analysis of the local organisation of irrigation. I first review some approaches to the organisation of irrigation from the social sciences, and then present six metaphors in the analysis of irrigation organisation and water management. Finally, discuss my analysis in that context.

Debates and trends in thinking about the organisation of irrigation

Bruno Gutmann's (1913) *Feldbausitten und Wachstumsbräuche der Wadchagga* is interesting as an early contribution on the ethnography and organisation of irrigation, drawing as it does on extensive studies of the rapidly changing society at Kilimanjaro during the onset of colonialism. This early work by Gutmann describes the organisation of irrigation as a normative and symbolic system, which is integrated with the religion

Studies of the waterscape of Kilimanjaro

and celebrated in central rituals of a society seen as analogous to an organism. In later work (Gutmann 1926), he described the different categories of ownership of irrigation canals and some institutional arrangements for the distribution of water through an irrigation scheme, and thus introduced *water rights* as a research subject. He studied the symbolism of water, which had life-giving as well as cleansing properties. The need to share irrigation water could be used as a metaphor for other social relations in teaching youth (Gutmann 1958 [1932]: 10, 48-49). The description of the normative system of society was a central overall objective of his studies (Gutmann 1926, see also Winter 1979, Moore 1986), and the normative system explains performance in water management. Gutmann's general approach was described and discussed as a 'folk-organic theory' by Winter (1979: 158-211), and it is somewhat related to the sociology of modernisation in Tönnies' and Durkheim's work (1966 [1895]). Gutmann saw society as being in a state of dissolution, where the former (pre-colonial) order of society was breaking down under the influence of colonisation and modernisation (see Winter 1979). Durkheim saw the description and analysis of the normative system underlying the social order as an important objective in social science (Lee & Newby 1983). Norms or institutions were seen as objects with a real existence outside of interaction, rather than as abstractions. One challenge to Gutmann's programme came in the form of Moore's (1986) time-oriented legal anthropology, which went beyond concerns of the integration of society through stable normative systems ('social facts') to examine the changing use ('process') of customary law and the changing content of conflict handled in various arenas through different periods. The legacy of Gutmann belongs to a group which I would characterise as 'Old Institutionalism'. This type of theory shares with approaches drawing on the New Institutional Economics a concern with integration in terms of social order and integration through the normative system, rather than social conflict. An important difference is between a holistic approach in the Old Institutionalism (the normative system of society) and a partial approach in New Institutional Economics (the normative system of a Common Property Resource).

The notion of and debate over 'irrigation and civilization' or 'irrigation societies' are among the enduring themes in social science (Lansing 2004). The debate over 'Irrigation and Civilization' was (re)launched by Wittfogel (1957). Inspired by

comments in early Marx (inter alia 1973 [1939]) on an Asiatic mode of production and on the organisational requirements of water technology in the Orient (Marx 1979 [1853]),³⁸ Wittfogel launched a thesis that despotism originated in and was necessary for hydraulic societies. Wittfogel relied on a comparative methodology and drew on the case of the Chagga of Kilimanjaro, among others, as reported in the Outline of World Cultures database (Human Relations Area Files) to support his case. Wittfogel's thesis has continued to incite debate (see for instance Leach 1959, Geertz 1972, Worster 1985, Lansing 1987, Mosse 2003, and Lansing 2004). Some of this debate on historical materialism concerns determinism (variously based on mode of production, technology or on natural conditions), but there has also been debate about whether irrigation historically depended on state coordination and resource mobilisation or whether it depended on self-managing irrigators' associations. Some of the debate has focused on how irrigation systems in Bali, Tamil Nadu and Sri Lanka are organised.

The case of irrigation and society in Bali, Indonesia was used by Wittfogel (and Marx) as an example of oriental despotism and the dependency of irrigation on a strong state. Geertz (1972) argues that irrigation in Bali was not centrally controlled, and emphasises the irrigation associations (the *subak*) as autonomous self-managing local systems. Some self-managing irrigation systems have leaders or governing bodies, while other systems, for instance some Swiss canal systems (*Bisse*) of medieval origin, are regulated without central authority or official mechanisms for arbitration (Netting 1974). Lansing (1987) agrees that irrigation in Bali did not centralise state power. But neither was water management left entirely to the local level farmer associations. Lansing (1987, 1991) shows how the regional coordination of water use in 151 irrigation schemes was orchestrated by religious rather than state institutions. Mosse (2003), however, reintroduces the role of state politics, where the funding of irrigation scheme (re)construction and the gifting of schemes was important in building political power in southern India.

³⁸ 'Climate and territorial conditions, especially in the vast tracts of desert extending from the Sahara through Arabia, Persia, India and Tartary, to the most elevated Asiatic highlands, constituted artificial irrigation by canals and waterworks the basis of oriental agriculture (...) This prime necessity of an economical and common use of water (...) necessitated in the Orient (...) the interference of the centralizing power of government' (Marx 1979 [1853]: 125).

Wittfogel's reading of the case of the Chagga was based on the work on Gutmann (inter alia 1926) and Dundas (1924) as represented in the database. There are three main problems with his use of this case. These works require a careful reading, among other things because they are associated with the colonial ideology of indirect rule, which depended on the strengthening and incorporation of local authority, and may have overemphasised chieftaincy as a basis of power historically.³⁹ Further, the dependence of irrigation on chieftaincy cannot be demonstrated simply by showing their co-existence in the same society. Irrigation at Mt. Kilimanjaro was usually organised based on kinship and local association, while the administration of irrigation schemes by the *Mangi* were exceptions (Gutmann 1926, Tagseth 2000a, Tagseth forthcoming/paper one). There is thus some parallel to the debate about how irrigation is organised in Asia. Last, from a broader perspective, hill furrow irrigation in eastern Africa is associated with communities centralised under chiefs (Ugweno and North Pare, districts on Mt. Kilimanjaro, Usambara) and acephalous communities (in Taita, Marakwet, Pokot, Sonjo). This observation weakens the idea of necessary connections between political centralisation and the practice of hill furrow irrigation in eastern Africa. What may remain is a question of how social stratification, power and irrigation are related at the local level (Davies 2009). Related to Wittfogel's concern with how the requirements of irrigation technology influenced society is a concern with how ecological determinants or factors have influenced the social organisation of different irrigating communities (Geertz 1972, Wade 1995).⁴⁰ There is still no systematic comparative study of the organisation of hill furrow irrigation systems in eastern Africa, and thus the foundation for discussing the influence of environmental factors is insufficient.

³⁹ The concern with indirect rule applies mainly to Dundas, but he was influenced by Gutmann whose main concern was with syncretism. Colonisation strengthened chiefly power in relation to other local interests and groups. In relation to the extensive authority of the *Mangi* to allocate land, Gutmann (1913:500) remarks that '*Dieses Bodenrecht hat sich aber erst mit der deutschen Herrschaft voll durchgesetzt gegen alte Sippenrechte und Häupter.*'

⁴⁰ Wade's (1995:2041) objective is 'to show that one can get a good way toward an understanding of why country X has irrigation institutions of type A, while country Y has irrigation institutions of type B, simply by using readily available ecological data.' Wade's analysis is focused on the four variables population density, irrigation requirement, temperature and topography.

Conflict perspectives on the organisation of irrigation can draw on a Marxian political economy, political ecology, or on Weberian inspirations. A political economy approach can frame the problem as a question of who gets what, where, when and why in terms of water (Chambers 1977). Questions of how access to water is contested can be related to a political ecology of water. Questions can also be framed in terms of how technological and social change (the green revolution) influence access to land and water and struggles over natural resources at the local level (Scott 1985, Beez 2005, Lerié 2005). Similarly, there is a question of how formal irrigation development (Beez 2005) and water management reform (Tagseth 2000a:75-85, Reed-Erichsen 2003) can be seen as biased against self-organised smallholder irrigators whose right to water is based on custom rather than statutory law.⁴¹ External intervention, such as water management reform, has an impact on local struggles over resources. It can erode existing rights, and either expand the rights of the state or strengthen new claimants to the resource (Meinzen-Dick & Bruns 2000). Conflicts over water can be seen not only as conflicts over resources and tenure, but also as conflicts over meaning and social change (development) (see Adams et al. 2003 for a related discussion). Conflicts over the improvement of water management in Kilimanjaro can thus be analysed as a conflict between sectors and actors (Mujwahuzi 2001), as a question of contested resources (Tagseth 2002a). They can also be seen as conflicts between ‘modern’ and ‘traditional’ ideal models of ‘good’ water management (Lein 1998, Tagseth 2006/paper four) or between competing ‘classic/state led,’ ‘neo-liberal’ and ‘neo-populist’ development paradigms (Tagseth 2002a, Lein & Tagseth 2009/paper five).

⁴¹ Customary rights in land as well as in water coexist with statutory rights in Tanzania (Tagseth 2006/paper 4), but with somewhat better protection of customary land rights. Nevertheless, even in relation to land, the statutory system of land rights can be seen mainly as a source of insecurity of tenure for smallholders (Sheridan 2008). Registration of land rights under the statutory system is a difficult and expensive process with an uncertain outcome (Sheridan 2008: 515), which motivates the continued widespread use in the Kilimanjaro Region of a customary institution evolving around the socially and symbolically significant *masale* (*dracaena* ssp.) plants (Chagga languages, sg. *isale*), to mark boundaries and graves, to establish tenure and to manage conflicts and their resolution (Moore 1986:82, 193, 196, 251, Tagseth 2000a: 98-99, 120, Sheridan 2008). The same plant is sometimes used to mark the place where sacrifices for the furrow are made, as reported from Kahe (Beez 2005: 96-98). This suggests that *masale* can be used to mark and strengthen water or scheme tenure, even if its significance is clearly wider.

Studies of the waterscape of Kilimanjaro

Related to the study of conflict is the study of conflict resolution. 'Negotiation' is the keyword in the literature on the resolution of conflict, which draws on the debate over property rights and emphasises the concept of legal pluralism (Meinzen-Dick & Bruns 2000, Boelens & Doornbos 2001). Property rights are here seen not as a relationship between a person and a thing, but as social relationships between people with relation to some object. Water rights are socially negotiated between individuals or groups. They are fluid and changing, and can derive from many sources, like the water resource itself (Meinzen-Dick & Nkonya 2005). Meinzen-Dick and Bruns (2000) argue against the tendency to use a narrow legalistic interpretation in the treatment of water rights that overemphasises statutory law, and the assumption that formal rights and rules are the only relevant definition of rights. The focus on the use of statutory legal systems to regulate the use of water resources in the water reforms in Tanzania, in spite of the fact that Tanzania operates under a plural legal system, is identified as problematic (Maganga et al. 2004, Juma and Maganga 2005, Andersson 2006, 56, see also Tagseth 2000a: 75-81). The question thus concerns water allocation and water rights as a negotiated social process between different claimants, the tensions and contradictions within and between interacting normative repertoires and the use of competing arenas of conflict resolution. Based on work in the Andes, Boelens and Doornbos (2001) argue that a peasant irrigation system can be analysed in terms of Moore's concept of a 'semi-autonomous social field'. The semi-autonomous social field (Moore 1973) has capabilities to make rules and enforce compliance, but is set within a larger social matrix which can and does invade it. It can be affected by norms and forces in effect under different normative systems, such as statutory and customary law,⁴² and actors in the social field can sometimes choose to mobilise these outside norms and forces in local negotiations or confrontations. There is thus a question of how different interest groups seek to defend and control rule-making amidst conflicting normative frameworks (and arenas), while drawing on statutory water rights, rights accrued by investment in a scheme, riparian or prescriptive principles in customary law, sale, inheritance or acquisition by force. Access to water is gained through negotiation, a process of defending, voicing or clarifying rights to water through different strategies,

⁴² Non-state normative orders can include customary law, but also religious law, 'project law', and forms of self-regulation (Boelens et al. 2005:6).

arenas and institutions in an environment where different power relations and different conceptions of water rights exist (Reed Erichsen 2003). The sampling of conflicts and investigation of their resolution through field survey (Reed Erichsen 2003) or analysis of conflicts sampled from court records etc. (Maganga 2002, Maganga et al. 2004) can yield new insights in the practice of water management and the interface between 'formal' and 'informal' institutions (Sokile et al. 2005).

Gray's (1963) classic work on the organisation of irrigation from Tanzania is a study of irrigation among the Sonjo (Batemi). The question of water management and water access is approached as a question of class or structural position in terms of water tenure. The community is made up of major water rights holders, minor water rights holders, temporary water rights holders, priests and water clients, and the analysis of irrigation organisation is the description of this social structure. Gray's structural analysis is inspired by the then-dominant trend of structural functionalism in British social anthropology (inter alia Radcliffe-Brown 1952), and shares with it the tendency to describe a society as an integrated system existing in a stable, timeless equilibrium. This was a theoretical position, but Gray also defended the lack of historical analysis with reference to a lack of historical traditions among his informants. Contemporary anthropological critique of structural functionalism warned that structural analysis alone could not interpret change, and advocated the study of 'social organization' as complimentary to, and distinct from, studies of 'social structure' (Firth 1951: 35-36, 40). Gray's approach can also be contrasted with a classic study from an irrigation-based village in Sri Lanka by Leach (1961). Leach supported an empiricist and materialist position, and was critical of Radcliffe-Brown's (inter alia 1952) schema for the interpretation of structure and function. The study is based on a very detailed documentation of kinship and tenure at plot level in an irrigation scheme, and documents change over two generations. The analysis is thus based the actions of villagers rather than on a description of their customs. Leach questions the notion of traditional society existing in social equilibrium, the understanding of social structure as real, and describes the notion of social solidarity as mysticism. He thus questions the validity of explaining social stability in terms of the normative system, and he maintains that tenure in the irrigation scheme is not dependent on rules.

Studies of the waterscape of Kilimanjaro

Radcliffe-Brown, Leach and Firth, and to some extent Gray and Gutmann engaged in broader debates on the institutions in society, which can be made relevant to debates on natural resource management and water management, and the debate on institutions and community. Leaving these classics behind for now, I turn to two approaches that still belong to the mainstream of understanding the organisation of irrigation. These are the analysis of structure and function, followed by the interest in ‘rules’ in common pool resources theory.

In influential studies by Hunt and Hunt (1976) and Coward (1979), the irrigation scheme is seen as a system analogous to an organism. The analytical question is the survival of an irrigation scheme, which can be predicted on the basis of how ‘fundamental tasks’⁴³ or functional needs of the system are served. Included among such tasks or needs are: water acquisition, water allocation, system maintenance, resource mobilisation and conflict management (Coward 1991). The analytical problem is the prediction of sustainability or scheme survival: What is needed to maintain equilibrium? This is evaluated or predicted on the basis of the stability of the system rather than on studies of the histories (biographies) of schemes or changes in populations of irrigation schemes. The analytical schemes are primarily intended for analysis of isolated irrigation schemes, and this analytical and methodological focus has its limitations (Lansing 1991, Mosse 2003). More difficult to counter are the problems of describing of irrigation organisation as an apolitical and a-historical system (Mosse 1997, Mehta et al. 1999, Cleaver 2000). The association between stability in the system and the ability to sustain irrigation over long time periods is axiomatic, but could be questioned on the basis of empirical studies of survival and change in irrigation systems that fall outside this paradigm.

Common Pool Resources (CPR) theory has been fronted by Ostrom (inter alia 1990, 1992b), and is related to the New Institutional Economics. She directs attention to civil society as a third way between the state and the market, thus avoiding a ‘tragedy of the

⁴³ *‘In all cases where irrigation systems have been in operation, there are institutional and social arrangements which organize fundamental tasks...’* (Coward 1991:46).

commons'. Her work has been central in demonstrating the importance of institutions in natural resource management. Ostrom's argument draws on game theory, especially a discussion of the prisoner's dilemma. Institutions are conceived as norms referred to as 'rules' operating at three levels, the constitutional, the collective choice and the operational. Ostrom sees these rules as the result of design or rational choice, where co-equal resource appropriators enter into contract-like agreements. She imagines how users sit down outside the game, and that each of them declares that *'I commit myself to follow the set of rules we have devised in all instances except dire emergencies if the rest of those affected make a similar commitment and act accordingly'* (Ostrom 1990: 99-100). It is suggested that whether the CPR can be 'enduring' (sustainable) or 'successful' can be predicted in terms of eight design principles,⁴⁴ distilled from the comparative study of a number of cases from secondary literature⁴⁵ (Ostrom 1990, 1992a: 67-80). The irrigation scheme is seen as a CPR, governed by a set of norms referred to as 'rules'. Irrigation organisation can be studied and evaluated through the study of these rules operating at the three levels (Ostrom 1990). Further, it is argued, design principles can be used in order to 'craft' (i. e. design, appraise, and modify) institutions for successful self-managing irrigation systems (Ostrom 1992a). Researchers have applied this model to hill furrow irrigation in eastern Africa (inter alia Adams et al. 1997a, Gillingham 1999), but Adams et al. (1997a: 708) warn that while *'field enquiry can sometimes generate a consistent set of "rules" about issues of irrigation systems management and water allocation that are recognized in the local community, (...) informal collective management of indigenous irrigation systems may deviate considerably from the simplified models of social organization ascribed to water user associations'*. Adams et al. (1997a) and Gillingham (1997, 1999) suggest that the insights offered by constitutional and collective choice rules are somewhat limited in explaining how an irrigation system 'really works', and focus instead on very inclusive understandings of operational rules, in places to include theft and rule-breaking.

⁴⁴ The eight design principles relate to clear boundaries (1), links between appropriation or outtake and provision or input (2), the ability of those affected by rules to participate in modifying the rules (3), monitors are users or accountable to the users (4), sanctions are graduated (5), there is rapid access to low cost arenas for conflict resolution (6), the rights of users to devise their own institutions is not challenged by external government (7), larger systems are organised in multiple layers of nested enterprises (Ostrom 1990:90).

⁴⁵ See Sabatier (1992).

Studies of the waterscape of Kilimanjaro

Flexibility in management, the use of rules, and indeed circumventing and breaking rules, are important in the performance of these systems, for instance in how they cater to women's needs for water (Adams et al. 1997a).

According to Johnson (2004), the literature on common property has become divided between a body of scholarship that uses deductive models of individual decision-making and rational choice to explain the ways in which different types of property rights arrangements emerge and change over time (i.e. Ostrom 1990, 1992b, Bromley 1992), and one that is more empirical, influenced by notions of entitlements (Sen 1980, Leach et al. 1999) and moral economy (Scott 1976), whose questions, aims and methods are more modest, and historically specific. Similarly, Mosse (1997: 468-469) contrasts a school drawing on institutional economic analysis aiming to derive general principles for farmer-managed irrigation with a second school emphasising the force of tradition, social rights, value systems and moral codes in generating and preserving co-operative resources management. The latter school draws on concerns of 'moral economy' (Scott 1976, discussed in Mosse 1997, see even von Clemm, 1964), interested in the social being (*homo sociologicus*) as opposed to the rational, self-interested individual (*homo oeconomicus*).

There are now several types of responses to functionalist and CPR theories that draw on sociological and anthropological theory, emphasising the social, cultural and historical embeddedness of water management (Fleuret 1985, Mosse 1997, 2003, Mehta et al. 1999, Bruns and Meinzen-Dick 2000, Cleaver 2002). Fleuret (1985) studied how irrigation organisation was embedded with other institutions, and emphasised how water relations depend on other social relations and how 'ideational aspects' influenced water management. Mehta et al. (1999) sought to draw on the broader debate on institutions in social science in order to improve or broaden the conceptualisation of institutions, while criticism of the rediscovery of institutions (Mosse 2003, Cleaver and Franks 2005, Cleaver and Toner 2006, Mehta 2007) now appears to be leading into an emerging post-institutional paradigm. Cleaver (2002, Cleaver and Franks 2005) thus seeks to re-conceptualise institutions, institutional formation and collective decision-making while drawing on the concept of 'institutional bricolage.' (Mehta et al. 2001,

Concepts and theoretical considerations

Table 1: Theoretical approaches to the organisation of irrigation.

Approach	Exponents	Period	Characterisation, concerns
Water and civilization	Marx Wittfogel	1850s 1950s-	The technology of irrigation requires a strong (despotic) state
Environmental determinism	Wade	1970s-	Environmental influences on social organisation
Technological determinism	Beez	2000-	Irrigation technology influences local organisation
Old institutionalism	Gutmann (related to Durkheim)	1890- 1930	Integration perspective, stability Structure Institutions as objects Social change as the dissolution of the old social order
Structuralism	Gray	1960s	Structural positions in relation to water tenure
Empiricism, (Political economy)	Leach	1960s	Actor / methodological individualism Process
Structural functionalism	Coward, The Hunts	1970-	Integration, preconditions for stability Structure & function
New institutionalism	Ostrom	1980-	Preconditions for stability. Institutions as rules 'Crafting,' institutional design
Political system/ conflict/ Political economy	Scott Chambers Lerise	1980-	Who gets what, where, when and why How is access to water contested? Conflict perspectives
Symbolic system/ cultural system (idealist)	Lansing Gelles Mosse, Sheridan, (Fleuret)	1990s-	Embeddedness of resource management Cultures of water Symbolic power (Interactionist?) Integration and conflict perspectives
Legal pluralism, Negotiation	Meinzen-Dick Boelens	2000-	Plural normative frameworks Actor perspectives Conflict (as negotiation)
Post-institutionalism	(Leach et al.) Cleaver, Mehta, Mosse	1990s- 2000-	(Environmental entitlements) 'Bricolage,' institutional innovation

Studies of the waterscape of Kilimanjaro

discussed in Franks and Cleaver 2007). This involves the patching together of institutional arrangements from the cultural resources available to people in response to changing conditions. This also involves a shift from conceptualising institutions and property regimes as things (objects, 'social facts') to what people do (in terms of interaction and practice). Institutions are thus not necessarily robust and enduring, they have to be continually re-enacted and reproduced (Lund 2001, discussed in Cleaver & Franks 2005). Cleaver (2000: 366) suggests that *'institutions are partial, intermittent and often invisible, being located in the daily interactions of ordinary lives.'* She questions the *'possibility of consciously and rationally crafting institutions for collective action'*, and supports instead *'ideas about multiple processes of institutional formation combining both conscious and unconscious acts, unintended consequences and a large amount of borrowing of accepted patterns of interaction from sanctioned social relationships'* (op. cit.). The formation of institutions in natural resource management is thus conceptualised as a socially embedded process, under the influence of historical factors, power relations and worldviews, rather than a deliberate and transparent managerial activity. Institutional innovation is carried out by 'bricoleurs' who have complex social identities and multiple affinities, and make decisions based on conscious and unconscious rationalities. Institutions tend to elude design, and external crafting is seen as problematic (Cleaver & Franks 2005). Franks and Cleaver (2007) suggest that actors construct mechanisms of water governance both consciously and non-consciously through processes of management and everyday practice. The management of traditional irrigation can thus be seemingly effortless, not because of strong special purpose organisations, but because the management of water is the management of social relations (Fleuret 1985). Designed Water Users Associations in Kilimanjaro can thus fail to produce a local legitimacy comparable to that of some traditional water management institutions (Vavrus 2003, Beez 2005, Cleaver & Toner 2006).

An organisation can be viewed or analysed in many ways. In the use of studies of irrigation organisation, it is often necessary to ask what social science theory the different approaches draw on, and how this influences their questions and results. It is possible to distinguish approaches to the organisation of irrigation through some basic

strategic choices in social science. The emphasis can be on structure or on agency and interaction (while structuration or practice can be seen as mediating between these). There are also differences between studies that frame questions in terms of social integration or social conflict, and there are differences between studies with prescriptive (normative) objectives and studies with descriptive (positive) objectives. There are also differences between general rational choice approaches and more contextualised approaches. This review has described how the ideas of what the local organisation of irrigation is, and of how it can be examined and described, have changed over time. These changes and positions in the analysis of the local organisation of irrigation relate to broader trends in social science and wider debates of institutions in society and in natural resource management. Rather than new paradigms replacing old ones, the tendencies summarised in Table 1 represent schools or epistemic communities whose approaches and concerns coexist and tend to re-emerge. The contributions of different modes of analysis, each conveying a partial understanding of what the organisation of irrigation is, are explored further in the next section on how the analysis of irrigation organisation is guided by different metaphors.

Metaphors in the understanding of irrigation organisation

One way to analyse and systematise these approaches can be through their reliance on different metaphors. Lakoff and Johnson (2003: 4, 36) describe metaphor as a way of conceiving one thing in terms of another, and claim that most of our conceptual system is metaphorical in nature. Morgan (2006) approaches the general question of organisations through a hermeneutic master metaphor; there are different ways of 'reading' an organisation. Morgan (2006) argues that different readings of organisations can be distinguished by their use of different metaphors, where ways of seeing and analysing organisations are guided by the assumed likeness of organisation to other objects or concepts. It is thus possible to argue that past contributions on the organisation of irrigation can be distinguished through their use of different metaphors. While simplifying Morgan's general scheme of how organisations are 'read' and applying it to the organisation of irrigation, I will analyse how the irrigation scheme and its organisation are seen as like an apparatus of dominance, a machine, an organism, a cultural/symbolic system, an arena, or a process. Such metaphors inform different and

Studies of the waterscape of Kilimanjaro

partial understandings of what irrigation organisations and other commons are, and are often linked to scenarios and prescriptions for action (see Ostrom 1990: 3, 7-13).

Six different metaphorical approaches to irrigation organisation can be identified (see Table 2). The *first* of these sees the organisation of irrigation as a *system of domination and appropriation*. An interest among scholars in links between irrigation and statehood has existed since the 19th century. A causal link between the need to develop large hydraulic works and the development of despotic states was postulated by Wittfogel (1957). The approach is mainly linked to macro-analysis, but locality studies can draw on this approach to examine relationships between irrigation and social organisation, and, further, to focus on how the construction of an irrigation scheme becomes an arena for the appropriation (*aneignung*) of technology, but also of land, water, produce, aid funds and water user fees, among other things (Beez 2005).

A *second* set of metaphorical approaches sees the irrigation scheme as like *a machine*. The machine metaphor is linked to the social construction of irrigation as a factory and as a bureaucracy. Large-scale irrigation, initiated from the colonial period onwards, was often a high modernist enterprise modelled on the factory. In the example of large-scale irrigation at Gezira in British Sudan, uniform plots were constructed for a large number of tenants who had to grow specific crops for mandatory sale to the irrigation company, while engineers scheduled and supervised water delivery (Ertsen 2006). It was, however, more common that a portfolio of irrigation schemes was developed under a state irrigation bureaucracy. The idea that irrigation is best organised under a state irrigation bureaucracy has lost ground over the past several decades. A different use of the machine metaphor can be found in the analysis of what goes on at the irrigation scheme level. Ostrom (1990, 1992a, 1992b) sees the irrigation scheme as a 'Common Pool Resource' (CPR). Such CPRs can be successfully governed by communities through institutions crafted through contract-like agreements between co-equal users. The CPR is analysed and evaluated in terms of its norms, referred to as 'rules' operating at three levels (the constitutional, collective choice and operational). The method draws on a comparative analysis across cases rather than a causal or processual analysis, with the objective predict which institutional arrangements will lead to 'enduring' or

‘successful’ CPRs. Through the description and analysis of the commons as a ‘set of rules’ regulating the actions of equal users and established through contract-like agreements, the CPR perspective can be related to the machine metaphor.

The *organism* is a *third* and influential metaphor. The metaphor of the organism was used in a now unfashionable direction of what I would label ‘old institutionalism,’ which shares with the ‘new institutionalism’ (inter alia Ostrom 1990) a concern with the normative system. Regarding irrigation organisation, ‘old institutionalism’ is represented in Gutmann’s (1913, 1926) studies from Kilimanjaro. While the new institutionalism tries to analyse the commons isolated from society and its surroundings, Gutmann was concerned with how the norms and symbolism of irrigation were integrated in the normative system and religion of society at large. It is possible to argue that this concern has reappeared in recent analysis of the symbolism of irrigation (Tagseth 2000a, 115-120, Sheridan 2002, Beez 2005, Tagseth 2009). Gutmann saw this society as similar to an organism (Folk-organic theory, see Winter 1978). More influential in recent decades are models that see the individual irrigation scheme as analogous to an organism, and that draw on inspiration from structural functionalism.⁴⁶ Hunt and Hunt (1976) and Coward (1979, 1991) argue that there are fundamental tasks (or systemic needs) which have to be served if an irrigation system is to survive, and that analysis should focus on how these needs are served (fundamental tasks are described below). The objective is to analyse preconditions for stability, which is seen as equilibrium in an irrigation system. The analytical focus is thus on the individual scheme (see Lansing 1991, Mosse 2003). Based on Morgan (2006), it would, however, be possible to draw on organic metaphors to ask questions of the boundary of a system or about the relationship between an organisation and its environment. Organic metaphors are widely used across scientific, religious and lay ways of knowing the world. Organic metaphors are also present in local theory, which compares the irrigation scheme to the body, gender and fertility (Sheridan 2002, Tagseth 2009).

⁴⁶ According to Radcliffe-Brown (1935), the concept of function applied to the study of human society is based on an analogy between social life and organic life, focusing on ‘needs’ or the necessary conditions of existence of societies or their social structure: *‘The continuity of structure is maintained by the process of social life (...) The social life of the community is (...) defined as the functioning of the social structure. The function of any recurrent activity(...) is the part it plays in the social life as a whole and therefore the contribution it makes to the maintenance of the structural continuity’* (Op. cit, 396).

A *fourth* metaphor describes the organisation of irrigation as a *cultural phenomenon*. Under the cultural metaphor, it is possible to ask questions of shared meaning, meetings between different cultures, enactment and social construction. The local organisation of irrigation can be seen as dependent on local knowledge (Tagseth 2000a), where irrigators draw on known models of cooperation and conflict while interacting in order to negotiate access to water and organise repairs. Gutmann (1913) introduces the question of the ethnography of water management. There is thus a concern in studies of natural resource management and culture (see Fleuret 1985, Mehta et al. 1999, Cleaver 2002) with how natural resource management is embedded. The process of institutional innovation has been described by Cleaver (2002) as 'bricolage' (emphasising institutional innovation and the reuse of familiar models of organisation), in contrast to Ostrom's concept of 'crafting' institutions (emphasising institutional design). Gelles (2000) has described how conflict over irrigation development and water in Peru is structured by the culture of water ('cultural politics'). Culture, or tradition, can thus be involved in the mobilisation of resistance to outside interests in water management and development. Similarly, conflicts over water and development in the Kilimanjaro region have been described as a conflict between 'modern' and 'traditional' models in the case of irrigation rehabilitation (Sheridan 2002) and in water management reform (Lein 1998, Tagseth 2002b, Tagseth 2006/paper four). Management reforms and development projects can thus be seen as cultural encounters. The concern with the cultural politics of water management borders on the next type of analysis.

The *fifth* way of 'reading' irrigation organisation and water management is based on the assumption that the water commons is an *arena*, which can be analysed as a political system or in terms of political economy. While managerial approaches that draw on machine metaphors and functionalist approaches that draw on organic metaphors tend to see conflict as an abnormal disturbance, the metaphor of the arena points at conflict and politics as central to water management. These conflicts, and their resolution, can be the object of study. The study of conflicts is interesting because the associated costs and problems can sometimes be avoided, but also because conflicts are drivers of change. At the local level, this can lead to more attention to interaction and negotiation over

irrigation and water within schemes (Tagseth forthcoming/paper one) and between schemes (Sevaldsen 1997, Reed Erichsen 2003). Lerise (2005) analyses irrigation redevelopment in Lower Moshi, Kilimanjaro as a struggle over water and land along the River Rau, where development projects and policies influence the processes of redistribution of those resources to those who have political and economical resources. Related is the study of how access to water is negotiated within conflicting normative frameworks and in competing forums (Meinzen-Dick & Bruns 2000). At higher levels of water management, it is possible to examine conflicts of interest between actors and sectors in a river basin (Mujwahuzi 2001, Tagseth 2002a, IUCN 2003). Conflicts over water as a resource in the Pangani River Basin exist between hydropower and irrigation, between large-scale, small-scale and commercial irrigation, upstream and downstream users and between water demanding donor projects (inter alia Mujwahuzi 2001, Tagseth 2002a). It is also possible to see conflicts over water development as conflict between competing ideal models. One example is the analysis of conflicts over water management in Kilimanjaro as a meeting between a 'modern' water management system and an 'indigenous' water management system (Tagseth 2006/paper four). Another type of model conflict is between strategies of improvement in water management that draw on competing 'classic/state led', 'community-based' and 'neo-populist' development paradigms (Tagseth 2002a, Lein 2004, Lein & Tagseth 2009/paper five).

A *sixth* metaphor is *flux* or flow. Heraclitus (540-480 BC)⁴⁷ used the river is as a metaphor to emphasise process and change as the essence of reality. Somewhat paradoxically, this type of perspective could still be made more central in water studies. Morgan (2006: 241ff) mentions the use of either dialectics or flow diagrams in the analysis of organisational change. Reference to the dialectics of water is mostly limited to urban political ecology (Swyngedouw 2004). An example of flow diagrams is found in Barnett (1984: 39-40), who describes the development of management problems through increased control mechanisms leading to increased resistance and thus to increased control mechanisms in a 'bureaucratic vicious circle.'

⁴⁷ 'everything is flow', 'On those who step in the same river, different and different waters flow' (Heraklitus n. d., known from fragments only).

Studies of the waterscape of Kilimanjaro

First, equilibrium models in ecology have been challenged by a flux paradigm, a change which also has an impact on the social science of the environment (see inter alia Behnke et al. 1993, Zimmerer 1994, Scoones 1999, Gillson et al. 2003). A question is thus whether it is possible or necessary to develop water management systems that can cope with uncertainty, are more resilient to drought, or able to exploit flows opportunistically, rather than planning for an average flow that may rarely occur (see Lankford and Beale 2007). Some indigenous water management systems, such as spate irrigation and flood recession irrigation, are designed to exploit variable flows opportunistically. A more flexible approach could involve increased use of the allocation of proportions of flow (common in indigenous management systems) rather than volumetric allocations of water (common in statutory water management systems). Many farmer managed irrigation systems also change regimes of allocation between states of plenty, normal and drought, a system that can be used more systematically in irrigation and river basin management (Lankford & Beale 2007).

Second, the concept of flux can involve a shift in the focus of analysis from irrigation organisation understood in terms of rules or institutions, as objects or 'social facts', to processes of social interaction over water, and to questions of how and in what forums rules are upheld (see Tagseth forthcoming/paper one). Further, it can involve a change in the focus from the concern with preconditions for stability or equilibrium in irrigation systems associated with the machine and organic metaphors to questions of how and why irrigation systems and their management change, and to the processes that sustain them.

A third implication could be challenging the problematic notion that 'traditional irrigation' (with resource use, society and environment) was a stable and closed system existing in an equilibrium which was interrupted and brought out of balance by rapid change (whether this change is ascribed to colonisation or later development processes). The problematic notion of a timeless static pre-development past is not limited to Africa (Fairhead and Leach 1995, Olwig 2001, Mosse 2003), but has been able to feed on a scarcity of historical knowledge. Dissolving this two-stage model of development

Concepts and theoretical considerations

requires a diachronic analysis based on better data. Against this background, I initiated the development of a diachronic and regional analysis of change in a paper on changing practices in farmer-managed irrigation in a small hydrological region (i.e. the Himo Catchment) (Tagseth 2002b), and this analysis had been expanded and elaborated on in a paper on change in the irrigation technology at Mt. Kilimanjaro (Tagseth in 2008b/paper three).

Table 2: Metaphors of water management and associated concerns

Metaphor	Question, analytical focus
Domination	-how do irrigation schemes and water management systems act as instruments of domination and appropriation? -how does irrigated agriculture affect social stratification? (political economy 1)
Machine	- how are irrigation schemes governed by norms (rules)? (new institutionalism) - irrigation as a factory-like activity - irrigation as part of a state bureaucracy
Organism	-how are the systemic needs of the scheme served in order to secure the stability of the irrigation system? (functionalism) -relationship between norms of irrigation and of society at large (old institutionalism) - symbolism of irrigation and water in Bantu & local theory (community, hydraulic solidarity)
Culture	-as a technology, irrigation is culture -how do people draw on known models to associate and negotiate over water management? -how do different understandings of water influence the form and content of water conflicts? -how is the problem of water management perceived or socially constructed?
Arena	-who gets what, where, when and why? (political economy 2) -how is access to water negotiated and contested? (a political system)
Flux, flow	-how and why do irrigation organisation and irrigation systems change? -how and why does access to water change -resource access examined through processes of entitlement rather than institutional rules

Discussion; the organisation of irrigation

In this section, I sum up observations on metaphorisation, relate to dimensions identified in the debate on the organisation of irrigation and discuss some more specific issues and positions relating to this thesis.

The concept of metaphor tends to highlight the possibility that there are many, but partial truths of what goes on in irrigation management. At times, (social) scientists can be compared with the group of blind men presented with an elephant in the well-known parable ascribed to Buddha.⁴⁸ One, having felt the head, claims that an elephant is like a pot. A second, having encountered the ear, maintains that the elephant is like a basket. One who had been presented with a tusk said the elephant is a ploughshare. Those who knew only the trunk said it was a plough. Each organisational metaphor generated important insights, but taken to an extreme, these insights can encounter severe limitations (Morgan 2006:4, 337). Both lay and scientific knowledge can be seen as rooted in particular social and political commitments, needs and contingencies. Hence, Mehta et al. (1999:11-12) maintain that scientific knowledge in natural resource management can be seen as *'always partial, without absolute or certain claims to truth'* (Mehta et al. 1999:11-12). The analysis emphasises the partiality of knowledge inherent in the different metaphors. It also helps to reveal and can help to give an understanding of the complex and multifaceted nature of the organisation of water use. The comprehension of one concept in terms of another allows us to focus on one aspect, but a metaphorical concept also tends to keep aspects that are inconsistent with the metaphor out of view (Lakoff & Johnson 2003: 10). Following organisation theory (Morgan 2006), there is thus a question of how different perspectives on the organisation of water use can contribute, and how they can be combined. Thus, the metaphor of domination can be valuable in terms of insight, but through an inherent dystopic tendency, it may be a hindrance to attempts to improve water management. Further, it tends to deny the possibility of community, or 'hydraulic solidarity' (Lansing 1991). The analysis based on the machine metaphor might lead to a prescription for organisations emphasising control and division of labour that may work well in

⁴⁸ Anon. n.d. 'The blind men and the elephant'
<http://www.cs.princeton.edu/~rywang/berkeley/258/parable.html> [accessed 16.06.2008]

straightforward tasks, repetitively producing standardised output with precision, while operating in a stable environment; however, some of the weaknesses relate to the absence of these preconditions. This can lead to Taylorist organisations that are inflexible and unable to adapt to changing circumstances, or to problems caused by creating a mindless and unquestioning bureaucracy. The organic metaphor can be more helpful in understanding the relation between an organisation and its environment, and the focus on systemic 'needs' can be helpful in analysing issues of 'survival,' or the sustainability of irrigation schemes. It may lead to an emphasis on unity and a romantic conception of community, which sees self-interested behaviour and conflict as pathological or dysfunctional. The association with concerns of structural functionalism tends towards an analysis that ignores politics and has difficulty in analysing change. The cultural metaphor can direct attention to issues of shared and different contested meanings of water. It can also be used to emphasise institutional innovation through re-use and adaptation of known models and learning. Limitations can relate to difficulties in relating to the materiality of water management. Viewing water management as an arena can bring us closer to how flows of water get divided. Such understandings can have the potential to increase the capacity for conflict resolution and management, or they can possibly be used to escalate conflict. The flux metaphor, emphasising questions of process or change, lies close to the changing nature of water and water management, but may still be poorly developed. A first way to deal with the partiality of scientific knowledge with reference to the organisation of irrigation is to provide a framework for the interpretation of various contributions in relation to their theoretical legacy and their context. A second way is to combine different approaches that shed light on different aspects of organisation.

The review has shown that, while overviews are scarce, the question of irrigation organisation is an enduring theme in social science, which encompasses several important dimensions and debates. Early, but persisting, concerns with irrigation organisation tended to focus on organisational requirements from technology and ecology, questions of the material conditions of society. This concern can be contrasted with later concerns of how the problem of water is socially constructed and of the meaning of water. A central question is that of the institutions of society and of natural

Studies of the waterscape of Kilimanjaro

resource management, where there are old institutional, neo-institutional and post-institutional positions. Structural functionalism has had a late but important influence on the analysis of irrigation organisation, and some elements of the critique of that approach from the history of social anthropology can be made relevant. There is thus a debate on organisation and law primarily as form, an object, or primarily as process. In analysing the organisation of irrigation, there are differences between approaches emphasising structure and those emphasising agency. Ways of mediating between these concerns would emphasise how structure and action reinforce each other, conceiving institutions more in terms of practice or structuration (Mehta et al. 1999:20). Another dimension can distinguish between the imagining of the human being as primarily a rational actor (*homo oeconomicus*) or as primarily a social being (*homo sociologicus*). There are differences between research with instrumental, prescriptive (normative) objectives and research with more descriptive (positive) or analytical objectives. There are also differences between approaches with nomothetic objectives that tend to be more reductionist, and approaches that are more ideographic, holistic and aim to improve the understanding of phenomena. Integration perspectives can be useful in bringing into focus questions of organic or ‘hydraulic solidarity’ (Lansing 1991) in the water commons, while they can also be seen as romanticising community. Conflict perspectives are needed due to concerns with social justice, and in the management or resolution of conflict.

The present study spans both material and cultural, symbolic aspects of irrigation and water management with some shifts in focus between papers. The historical development of a material waterscape is the focus of paper three (Tagseth 2008b), while the use of ideals of water management is important in paper four (Tagseth 2006) and paper five (Lein & Tagseth 2009). The institutionalisation or social organisation of water use is the focus of the first paper (Tagseth forthcoming).

For the purpose of this thesis, I retain the assumption that institutions are central to our understanding of natural resource management. In response to critiques of institutional analysis, I work with an open conception of what institutions may be and which institutions are relevant. Problems in institutional analysis also directed me towards an

interest in the social organisation of water use. Rather than struggling to isolate the water commons and natural resource management, I seek to examine institutions through an embedded, contextualised, politically and historically sensitive approach. Further, I work under the assumption that the analysis of institutional form should be combined with the analysis of processes or interaction, and with the analysis of the outcome of those processes. In terms of objectives, these are focused on the image of the social being rather than the rational actor. Through these positions and eclectic combinations, I seek to contribute to the understanding of irrigation organisation rather than to make more general prediction possible.

The analysis of the organisation of irrigation looks at water management in terms of broad models of 'good' water management in the development and application of water policy. Conflicts over the improvement of water management are analysed in terms of ideal models of 'modern' and 'indigenous' water management systems (Tagseth 2006/paper four, see also Tagseth 2000a, 2002b)⁴⁹ and in terms of three competing development paradigms from global discourse (Tagseth 2002b, Lein & Tagseth 2009/paper five). A broad typology of organisation in farmer-managed irrigation is also developed. A more detailed investigation is focused on the local organisation of irrigation according to one of these main types, assumed to be the most basic model.

The local organisation of irrigation is the main focus of paper one (Tagseth forthcoming), but the organisation of irrigation also appears as a theme elsewhere (Tagseth 2000a, Tagseth 2002a, Tagseth 2002b, Tagseth 2006/paper four, Tagseth 2009). In paper one (Tagseth forthcoming) I pursue a combination of three approaches to the social organisation of water use in order to achieve a thicker description. The first of these is at a normative-institutional level ('institutional form'), where norms of water use, roles and notions of rights in the irrigation scheme are described. The second is the level of practice and interaction ('practice', 'processes of entitlement'), which includes reports on everyday practice in water management as well as conflict and conflict management. The third level ('the real,' 'outcome') concerns outcome in terms of

⁴⁹ This concern can be related to the cultural politics of water management (see Gelles 2000).

Studies of the waterscape of Kilimanjaro

resource access for different social groups. The first of these levels can be related to institutional analysis, thus drawing on the machine metaphor, but with a somewhat broad conception of what institutions might be in order to avoid the reduction of a complex commons to a 'set of rules.' The second level analyses reports on practice and interaction, and borrows from perspectives that see the commons as an arena where actors can compete, form alliances and cooperate. There is also use of the cultural metaphor in the analysis of how shared cultural models influence interaction over the water commons, in defining what claims are seen as reasonable, and what constitutes behaviour that should be sanctioned. The third level borrows inspirations from the political economy concern of who gets what, where, when and why (Chambers 1977), but could also be related to Leach's concern with performance. This concern can also be related to the arena metaphor. The combination of approaches constitutes an act of theoretical and methodological triangulation, and is inspired by Denzin (1989). This is also an answer to Morgan's (2006) concern of how different metaphors shape our view of organisational life. There is also a variation, a use of shifting perspectives on irrigation organisation elsewhere in my work. The interpretation of local irrigation organisation as a cultural system is strengthened in Tagseth (2009), a further development of paper one (Tagseth forthcoming).

The waterscape

A concept in water studies that is still emerging is that of the waterscape. Scholars are applying it, along with a concept of the 'water landscape', but with different meanings. According to Hoag (2003), a concern with the waterscape in sub-Saharan Africa was introduced by Adams (1992). Adams (op. cit.) studies and criticises external interventions to develop Africa's water resources, and the persistence of a mentality that gives rise to grand schemes and sweeping environmental transformations that have often failed. His alternative vision involves development from below, building on the experience, diverse and flexible practices and indigenous technical knowledge of African land users. He relates this to a debate on environment and development rather than to a landscape concept. It has been suggested (Öhmann 2007) that the waterscape is a topic of my studies, with reference to the use of oral history to examine the development of the irrigated landscape (Tagseth 2008a/paper two), and the study of the

nature and relevance of local knowledge in water resource management (Tagseth 2000a). I have applied the concept of waterscape as an aid to help me think about water issues. How can this concept be conceived and applied in structuring the study of water and society? Drawing on Widgren's (2004b) analysis of the state of landscape research, three perspectives on the waterscape can be distinguished: 1) those emphasising the material aspects of water (e. g. as nature, 'resource' and morphology), often asking questions about the relationship between water (and technology) and society; 2) those primarily interested in the perception and representation of water and water issues (e. g. 'scenery', mental construction); and 3) perspectives interested in the institutional aspects of the waterscape (water commons, institutions and customs).

The *first* type of use is exemplified by some aspects of Tvedt's work (Tvedt 1997, Tvedt & Jakobsson 2006b). Here, the waterscape is conceived primarily as 'nature' (hydrology, drainage), which is a dominant approach to water studies, and the question is how different waterscapes have influenced different societies. Similarly, Worster (1985) was interested in the influence of hydrology ('aridity') on society. However, hydrology as pure nature is increasingly hard to come by, due to successive manipulations and investments by societies. It can be pointed out that the waterscape is neither pure nature nor culture, but rather hydrology as modified human action (labour) through a historical process. Swyngedouw (1999) sees it as hybrid socionature. Tvedt's arguments could be extended to these situations, changing the concerns from environmental determinants (see Geertz 1972, Wade 1995) to technological determinants (see Wittfogel 1957), a question of how society is formed by its technological mastery of water (Worster 1985: 5, 11). It would also be reasonable, then, to use the concept to refer to river and stream drainage as nature modified by human investment and activity, a built landscape of water. The evolution through subsequent investments and the result of this process would then be a waterscape. The evolution of the built waterscape is a concern in studies of hill furrow irrigation (Sutton 2004, Stump 2006a, Davies 2006), which I have addressed in several texts (Tagseth 2002b, Tagseth 2008a/paper two and Tagseth 2008b/paper three).

Studies of the waterscape of Kilimanjaro

The lexical definition of the *waterscape* in English usage is a picture of water (or sea) (Waterscape 1989).⁵⁰ It is the watery equivalent of a landscape painting, thus emphasising the perception and representation of water. In parallel to the concept of the landscape, it could then by extension be taken to refer to the representation of the water environment or the problem of water in pictures, narratives, descriptions, etc. This is the *second* type of use of the concept. A related question is how we come to understand and to exert forms of human control over water through its cultural appropriation and through the investment of meanings in water and its geographical manifestations (Cosgrove 1990: 2). According to Pálsson (1990: 7), *'the ecological "facts" of aridity and drought (...) do not speak for themselves. Experience of them is socially constructed, located in a specific context of world-making.'* The ideology of water (water management, water and development), important in many local, regional and global processes, could thus be seen as a question of the waterscape (see Adams 1992, Hoag 2003, Öhmann 2007, Loftus & Flumsden 2008). Following Pálsson (1990), there is a question of how water and aridity are constructed by various groups in diverse contexts. Similarly, Loftus (2006) asks questions of the relational, situated knowledges of the waterscape. There is also a related question of how representations of irrigation from the period of exploration (inter alia Johnston 1886) or the development of tropical geography and environmental science (inter alia Teale & Gillman 1935) first established persistent paradigms, perceptions and discourses of water problems. Following Loftus and Flumsden (2008), ideas of development are consolidated and contested in lived environments. The waterscape in this sense applies to the analysis of two conflicting models of 'proper' water management in Tagseth (2006), and to competing ideas of what constitutes desirable change (development) in water management (Lein & Tagseth 2009/paper five). The waterscape in this sense can also refer to the local perception of water and water problems, which may or may not be closely related to global discourses. This includes ideational aspects of water, such as the enchantment of norms and concepts of tenure (Tagseth 2009), or the use of cultural models and landscape memory (see Clack 2007) in the defence of customary water rights toward outside interests.

⁵⁰ According to Webster (Waterscape 1989: 1613), 'waterscape' is constructed from water + landscape, it is thus *'a picture or view of the sea or other body of water.'*

Table 3: Three dimensions of the waterscape

Dimensions of waterscape (adapted from Widgren 2004b)	Uses, examples	Question, problem description	Relevance to this study
'resource' morphology nature, built landscape of water	D. Stump J. E. G. Sutton M. Davies T. Tvedt D. Worster C. Wittfogel	-the evolution of a built landscape of water -'nature and society' -'how does variation in hydrology or the technological mastery of water influence variation between societies'	-The evolution of a material waterscape Tagseth (2008a, 2008b)
'scenery' image of water, the perception of water, its social construction, ideology, symbolism	Gísli Pálsson M. J. Sheridan L. Mehta D. Mosse A. Loftus and F. Lumsden	-how are water problems perceived, constructed and represented?	-Local perception of water (Tagseth 2009) -Perception of water problems varies between groups (Tagseth 2006) -Conflicting ideologies of 'improvement' in water management (Lein & Tagseth 2009)
'institution' institutionalised practice	F. Cleaver T. Mels H. Lein B. van Koppen B. Derman and A. Ferguson, F. Cleaver and A. Toner	-local organisation -water management reform	-The local organisation of irrigation Tagseth (forthcoming) -The study of water management reform processes (Tagseth 2002a, 2002b, Lein & Tagseth 2009)

Studies of the waterscape of Kilimanjaro

A *third* parallel between the waterscape and the landscape (*Landschaft*, see Olwig 1996) concept is the common usage in Dutch of the *waterschap*, which can refer to a hydrological region, but also to the social organisation that manages the activities in a region, exemplified by the Dutch *polder* (Waterschap 2007,⁵¹ see also Mels 2005) or the Balinese *subak* or irrigation society. In the latter sense, it can refer to the territory or command area of an irrigation canal as well as its social organisation.⁵² According to Mels (2005), it also referred to the waterway itself, thus having a triple meaning. The waterscape could thus be used to refer to a group managing a water commons, or more widely to the institutionalised practices of water management in a region. Such institutionalised practices can refer to the established norms, forums for negotiation and forms of conflict in the water commons. There is also a symbolic waterscape that can incorporate sacred places or institutionalised meeting places where binding settlements can be negotiated and ritualised.⁵³ The symbolic waterscape can also include sacred space or ‘symbolic space’ (see Aase 1994), where certain places or water shrines commanding such spaces were used to negotiate and ritualise the political dominance over a region through rain rites. Arguably, the study of water management reform processes (inter alia Lein 1998, Derman & Ferguson 2003, van Koppen 2003, Cleaver

⁵¹ Waterschap (2007) *‘wa-ter-schap (het ~, ~pen) 1 [Ned.] bestuur dat in een bepaald gebied voor de belangen van de waterlozing en waterkering zorgt en ook belast is met onderhoud van wegen en bruggen => dijkbestuur, polderdistrict 2 [Ned.] grondgebied onder het bestuur van een waterschap’*

1) board/organisation that manages the water discharge and dikes/embankments and the management of roads and bridges. => dike authority/organization, dike region. 2) territory/ region under the governing board of a waterschap. [my translation].

⁵² The Balinese *subak* incorporates all the terraces irrigated from one major intake or tank. All individuals who hold land and water rights in an area are citizens of the *subak*, which is separate from the village or residential unit. According to Geertz (1967: 229f), *‘The term subak is commonly translated as “irrigation society”, because of the central role this institution plays in the regulation of water supply. But the subak is in fact very much more: an agricultural planning unit, an autonomous legal corporation, and a religious community. (...) Effective power with respect to agricultural matters lies and seems always to have lain in the subak.’*

⁵³ Examples from Mt Kilimanjaro are the use of the meeting at the canal intake following cleaning by the group of irrigators, which clearly has power to negotiate and settle the terms of water distribution (Fieldwork 1995-96). A variation is the use in Mbokomu (Fieldwork 2002), where irrigators meet at a certain spot just below the collection tank on Saturdays during the season in order to decide water distribution, a practice that is more common in North Pare (Fieldwork, Ugweno and Lembeni, Mwanga District 2003, 2004). Direct negotiations between groups of irrigators regularly take place at the canal headworks at the river (Participant observation, Ugweno, Mwanga District 2003). I have also seen a meeting place where different groups of irrigators regularly meet in order to arrange the rotation of water between about a dozen schemes within an area of a few square kilometres and thus regulating a hydrological region (in Lembeni Division, Mwanga District). This type of practice or institution, which is not reported from Mt. Kilimanjaro, may have been central to the reported ability to coordinate water use in smaller catchments in the Pare Mountains.

& Toner 2006) is also relevant to the institutional aspects of the waterscape. The institutional aspects of the waterscape are approached through the study of local organisation of irrigation (Tagseth forthcoming/paper one), the categorisation of types of irrigation organisation (Tagseth 2006/paper four), and through the study of water management reform (Tagseth 2002a, Tagseth 2006/paper four, Lein & Tagseth 2009/paper five).

This discussion suggests that the concept of the waterscape is too loosely bounded to serve as a sharp analytical tool, but as an emerging concept it can be useful as a 'sensitizing concept' (Denzin 1989). Distinguishing these different uses of the concept, drawing in part on Widgren (2004b), is helpful in clarifying to me the different perspectives I have applied in the study of water management and water use in hill furrow irrigation (see Table 3). In this thesis, I approach the Kilimanjaro waterscape neither as pure nature or morphology, nor as a pure social construction. I seek to analyse and integrate the Kilimanjaro waterscape through three aspects, labelled 'resource', 'scenery', and 'institution.'

Methods

The research methods used in the thesis are presented and discussed in this section. The methodological approach, involving a combination of sources and strategies, is introduced. A rapid appraisal of a district and a series of semi-structured household interviews were important as systematic introductions to farming, land use, irrigation and resource management in the region, but ethnographic approaches and participant observation have also been central to this study along with documentary sources. The initial case study design and subsequent modifications are presented. Some specific issues are discussed, including grouping variables for quantitative analysis of access to water, methods to assess change in irrigation and the combination of methodologies and theories exemplified in the study of the local organisation of irrigation. Finally, the format of the thesis is discussed.

The methodology behind this thesis relies on a combination of data sources. Various types of interviews are of primary importance. Interviews have ranged in their degree

Studies of the waterscape of Kilimanjaro

of structure from a semi-structured enquête, through open-ended thematic interviews focused by a checklist, to field conversations. The research has involved periods of residence in the study area and in the region of about 16 months over the span of a decade. The study also draws on ethnographic fieldwork, involving participant observation and field conversations from periods of residence in rural Kilimanjaro. In addition, selected archive sources have been used, as well as published literature and administrative documents and reports.

Fieldwork can be seen as a process of *bricolage*,⁵⁴ a concept borrowed from Levi-Strauss (1966: cited by Denzin & Lincoln 1994:2), suggesting that the fieldworker is a jack-of-all trades or a professional do-it-yourself person. The qualitative researcher uses the tools of his or her methodological trade, deploying whatever strategies, methods or empirical materials as are at hand, inventing, or piecing together tools as required. Qualitative methodology is inherently multi-method in focus, where the use of multiple methods, or triangulation, reflects an attempt to secure an in-depth understanding of the phenomenon in question (Denzin & Lincoln 1994).

Fieldwork for the papers in this thesis was conducted from August 1995 to February 1996 and in periods during 2001-2003 in Kilimanjaro, focusing on Moshi Rural District. Fieldwork was conducted on the water sector mainly during 1995-96 and 2001-2003, directed at the water bureaucracy at the national, basin, and regional levels and irrigation extension officers mainly at the national and zonal levels, along with selected NGOs. In addition I draw on background information from the cultural cousins of the Chagga,⁵⁵ from periods of fieldwork in Ugweno and Lembeni Divisions in

⁵⁴ 'Construction (as of a sculpture or a structure of ideas) achieved by using whatever comes to hand; also: something constructed in this way' (Bricolage, 2009).

⁵⁵ A common practice in research is to define a 'tribe' and its area as the unit of study. This practice, and the legacy of indirect rule, has probably contributed to an overestimation of Chagga identity and unity and the underestimation cultural links between 'Chagga' groups and their cultural cousins described as 'Pare' and 'Meru'. Kichagga spoken at Mt. Kilimanjaro can be divided broadly into three or four mutually unintelligible languages. The database Ethnologue (Ethnologue report for Chaga (E30), 2005) groups four languages spoken on the slopes of Kilimanjaro (Machambe, Old Moshi, Vunjo and Rombo) together with Rwa spoken in Meru, Kahe spoken in the Kilimanjaro lowlands and Gweno spoken in parts of Mwanga/ North Pare into E30-Chaga (see Philippson & Montlahuc (2003, 2006) for information about the Chagga language group).

Mwanga District, Kilimanjaro Region (intermittently during 2002-2005) and stays in Meru, Arusha Region (intermittently 2003-2005).

Rapid appraisal of water management and changes in irrigation

The initial phase of the fieldwork in 1995-96 was strictly designed to focus on one catchment on Mt. Kilimanjaro (that of the Himo River, which is centred on Marangu in Moshi Rural District). The extensive strategy focused on this hydrological region was combined with an intensive strategy focusing on two communities or clusters within it. An upland community (Komalyangoe, Marangu West Ward) and a lowland community (Rauya, Marangu East Ward), were selected to represent different conditions. Some 250 interviews of different types were conducted in these three case studies.

A rapid appraisal was designed to capture variations in irrigation along the elevation gradient from *c.* 750 to 2000 m.a.s.l. at the catchment level. It was carried out with the assistance of personnel from Marangu West Ward and Marangu East Ward, and with an assistant recruited from a local NGO for the lower areas in Makuyuni and Kilima Chini wards. Some 16 schemes distributed through three agro-ecological zones (defined by altitude) were visited, and the leaders of these schemes were interviewed. Information was sought on the number of users as an indicator of the scale of the schemes. The current state of the schemes was assessed, and their managers were asked about the past and current use of the water. The period of scheme establishment and the management history of the scheme were also covered. Stream valleys in Marangu West Ward were climbed in order to record the irrigation schemes, and information was sought about their names and leadership from people living close to the irrigation intakes. Among other things, this information was used to supplement and assess secondary data from Marangu West Ward and the Pangani Basin Water Office. The study of water management and changes in water use and practices in irrigation at the catchment level has been used primarily in two publications (Tagseth 2002b and Tagseth 2006/paper four).

Household enquête

Two clusters in Komalyangoe and Rauya villages in Marangu were selected to represent two of the agro-ecological zones within the catchment, and were targeted for a more

Studies of the waterscape of Kilimanjaro

intensive study through interviews with irrigators, irrigation scheme and community leaders and elders. The first of these case study clusters represents an area where most of the hill furrows are maintained and where the organisation depends on a hereditary furrow chairman and an informal group of users. In the second case study cluster, there is a formalised Water User's Group with a board elected by the village general meeting. Two of the papers (Tagseth forthcoming/paper one and Tagseth 2008a/paper two) concern processes in one of these clusters, in Komalyangoe village.

Like most of the interviews conducted in rural Kilimanjaro, interviews in these clusters took place at the home of the interviewee, in the sitting room or more often in the courtyard of the compound, which is also in the private sphere at Mt. Kilimanjaro, where one customarily calls '*hodi*' while approaching the compound and awaits permission to enter. Interviews were undertaken with the aid of a research assistant for interpretation from Kivunjo (a language in the Kichagga group, the local vernacular in Marangu and neighbouring areas) or Swahili (widely spoken as a second language) and lasted between one and three hours. Use was made of the local vernacular in many interviews not only for the convenience of the informant, but also because it influenced the definition of the interview situation. Information was recorded with the use of a notepad rather than tape or video. Research assistant Michael D. L. Minja, a former occupational health officer, who had returned to his native Marangu to take up farming, assisted with translation in most of the interviews.⁵⁶ He introduced himself through locally recognisable social identifiers by referring to his close relatives, clan, village and sub-village, and he claimed to be independent of any organisation or government, acting only as my assistant. I was introduced as a guest who was staying in a certain area in central Marangu to carry out a research on the use of water for agricultural and domestic purposes, sent by my university in Europe on this assignment, as a part of my studies.

⁵⁶ During the Kilimanjaro fieldwork I had not yet started to recruit and communicate with informants directly in Swahili, but the limited knowledge I developed was useful in engaging in small talk, in following the interpretation, and it made it possible to function better as a person and make arrangements independently while staying in rural Kilimanjaro, where Kiswahili is widely spoken as a second language. During my engagement with Marangu, where few people speak European languages, and with the help of friends and some basic teaching aids, I started to achieve some working knowledge of colloquial Swahili. Embarking on this learning process was also important in order to achieve a better comprehension of local concepts and categories.

We sought to use tact and to be emphatic in approaching our hosts in the negotiation of rapport, while adopting an inquisitive but open and non-judgemental attitude. Interviewees were informed about confidentiality issues. Most⁵⁷ of the informants have been given anonymity. Offering anonymity and confidentiality, and refraining from the use of recording equipment made communication over local level resource use, economy, tenure and family history easier. Making the setting more formal through the use of props and requiring authorship from the informant could possibly have increased the reliability of the data, but it would have been more difficult to recruit informants, and information that is locally sensitive may have been withheld to a greater extent. Sensitive issues in the context of this research include household economy, ownership of land and other assets, as well as religion and ritual practice. Relations between irrigators and the water management authorities were strained during the initial fieldwork. I sometimes refrained from delving too much into sensitive conflicts, for instance into a case of sabotage under investigation by the police, in which a control gate in lower Marangu was dynamited just after installation.⁵⁸ Some problems were experienced, for instance when an angry informant wanted to hold me accountable for crop losses inflicted on him by contractors working for the Norwegian consultancy NORPLAN to install control gates because of my status as a Norwegian. However, in general we were shown considerable hospitality, as shown when chairs were usually brought out in the courtyard for us to be seated, and when our hosts sometimes shared their food with us, but primarily through a willingness to share time and information.⁵⁹

An enquête covered all 86 households with physical access to five irrigation furrows in the two clusters. This sampling strategy was motivated by the desirability of getting reports from several actors interacting over the management of the same irrigation scheme. The main research strategy has been qualitative, but this enquête has also been subject to quantitative analysis. Information from the households was sought on household composition and economy, the farming system and farming practices, water use and water management. An interview guide was used (Tagseth 2000a, appendix 1),

⁵⁷ Exceptions are officers in higher ranking positions, and some few informants on historical issues.

⁵⁸ Andersson et al. (2006, 56) reports that 20% of the 320 control gates remained operational.

⁵⁹ This is based on a reflection note by M.D.L. Minja, dated February 1996 with the title 'Our introduction, acceptance and views of our host villagers' and the author's field diaries 1995-1996.

Studies of the waterscape of Kilimanjaro

but time was often taken to probe and discuss issues raised during the interview. This guide, prepared in English, was revised after translation to Swahili and back to English to identify ambiguities, and again after a couple of test interviews. With repeat visits and travel to track down informants, the response rate in this series of interviews was brought above 90%. There are few adolescent informants, but other age groups are well represented.

Grouping variables and analysis

Some 55% of the household interviews were made with a male informant, 25% with a female informant and 19% with both a female and a male informant present. Female participation was somewhat higher in Komalyangoe, where 31% of the households were classified as de facto female headed. Most informants were poor by western standards. Over the period in which this study has been undertaken, despite economic growth and ambitious planning to reduce poverty in line with the Millennium goals, Tanzania has fallen from the rank of the 147th out of 174 nations to the 159th in terms of human development (UNDP 1995: UNDP 2007), life expectancy has fallen to 51 years (UNDP 2007), and the absolute numbers of poor people are on the increase, according to the Household Budget Surveys of 2001 and 2008 (McGregor 2008 citing United Republic of Tanzania 2008). In Tanzania, Kilimanjaro was perceived as prosperous compared to other regions. This economic status has been eroded over the past generation, especially by the decline in the terms of trade for coffee, even if tourism and mining have provided some new opportunities (but primarily in the neighbouring Arusha Region). Further, there exists a significant social differentiation, and the prevalence of poverty and hardship is indicated by persistently high levels of childhood malnutrition (25-35%) and mortality in comparison to national averages (Howard & Millard 1997: 29-32). Information about the socio-economic status of the households was needed as a grouping variable. Socio-economic or wealth status can be examined for instance through direct observation of indicators (i.e. housing, possessions etc. as discussed by Sevaldsen 1997: 30-32) or through socio-economic indicators from interviews (the frequency of meat consumption as discussed by Selvik 1996: 75-80). I chose to leave the interpretation of what constitutes wealth in the local context to key informants through wealth ranking, which is in line with methodology from participatory

development studies (Chambers 1994). Wealth ranking by local informants has been found to correspond well to socio-economic indicators from survey methodology (Adams et al. 1997b). Households were ranked according to 'wealth' by three key informants for each of the two case study clusters in independent sessions. The informants were also asked to identify a dividing line to define three groups. Agreement through rank correlation between independent informants was used as a test of reliability, and showed rho values significant beyond the 5% level. Validity was examined by asking informants after the ranking exercise about their reasoning. Informants identified factors such as income (non-farm work, cash crops, and remittances from migrants), assets (land, etc.) and capacity for work (health, age, etc.). A comparison with ranks from the household interview data through a 'shotgun approach' (Bernard 1994: 466-471) showed a significant relationship between wealth rank and demographic factors, and with measures of intensification and land ownership. The rank scores were reduced into a trichotomous variable and the mode of the three classifications by informants used in the analysis. Approximately one-quarter of the households were locally classified as poor, while half of the household informants were middle peasants, and a quarter of them were well off.

When 'ownership', or management rights in irrigation are retained within the families of the founders of irrigation schemes, it was reasonable to enquire into the relationship between kinship and access to water, which was operationalised as affinity by 'clan' (from interviews and field conversations). One-quarter of the households interviewed in the upland cluster were non-members of the respective furrow-owning patrilineage. The effect of gender, kinship and wealth status on access to water was examined in the analysis (Tagseth forthcoming/paper one). All segments of water users were thus reasonably well represented in this series of interviews. This series of interviews provided a great deal of data about water use and the management of a complex and intensive farming system, but was also important in introducing me to many people in different situations. Informants on more specific topics that had emerged as significant or interesting were recruited from among these informants, and they were also used in the snowball recruiting of new informants.

Studies of the waterscape of Kilimanjaro

In general, power, expertise and status in irrigation tend to have a strong masculine connotation (Zwarteween 2008). Traditional irrigation in the Kilimanjaro Region is no exception to this, with an elaborate gendered symbolism (Sheridan 2002, with reference to Mwanga District, see also Tagseth, 2009, for Moshi Rural District), and taboos against female participation (Kitunga 1989, with reference to Mwanga and Same Districts). Gender inequalities persist in 'traditional' (Kitunga 1989) and in 'modern' irrigation (Kissawike 2008) in the region, with some differences. Male control and ownership over water and land can be contrasted with the leading role of women in food production, and indeed as farmers. Women are reasonably well represented in my research material as informants about the farm system, land use and economy, water use, and about gaining access to water (and land). While women's perspectives are represented in reports about everyday practice, the dominating role of men in what goes on in the public sphere in the operation and maintenance of irrigation schemes means that male perspectives are reflected in my material about community level scheme management. The norms of gender and irrigation, and the masculine connotations of irrigation, may lead not only to a marginalisation of women in irrigation, but also to a tendency for female irrigators to undercommunicate their actual involvement in the community level micropolitics of irrigation, and perhaps especially towards me as a male outsider (because non-participation constitutes norm-compliance). Further, in the histories of irrigation schemes and water and land tenure, the perspectives of elders, especially of senior men, tend to dominate. This is not only because elders hold the position to narrate community history, but also because men as members of the sedentary patrilineage tend to hold the place-bound histories of settlements due to the virilocal settlement pattern.

Intensive strategies: ethnographic fieldwork

Several series of qualitative interviews were conducted, focused by topics. These topics included the oral history of land and water use, as well as the land tenure and settlement history of eight families (lineages) in Komalyangoe as remembered by their elders. Furrow elders in the highlands, and furrow committee members and village officials in the lowlands, were interviewed about the management and history of irrigation schemes. Within the clusters (Komalyangoe and Rayua), the information from repeated

interviews with the leaders of six furrows could to some extent be balanced against each other and against information provided by other elders.⁶⁰ Instrumentation adapted from Participatory Rural Appraisal methodology (National Environmental Secretariat 1992, Chambers 1994) was used in sketch-mapping irrigation schemes, charting seasonality, in ranking informants according to wealth, and examining the sexual division of labour. The ability to cross-check between informants, types of interviews and sources is among the main strengths of this intensive research strategy. Further, a longer and more intensive investigation improves the prospects of figuring out what the actors or informants think they are up to (Geertz 1983) in relation to more rapid strategies (Lindberg et al. 1993) or survey methodologies used alone.

Ethnographic fieldwork not only involves establishing rapport, the selection of informants, taking genealogies, mapping the fields, etc. Rather, it is defined by the intellectual effort to achieve ‘thick description’ (Geertz 1973:6), based on an open-minded and empathic engagement with the perspectives of the actors under study, and through observation of daily activities and interacting socially (Herbert 2000: 551-3). Clack (2007:81, citing Hammersley & Atkinson 1995 and Tagseth 2000a) has discussed my approach to ethnographic fieldwork in relation to an inclusive definition, where it is seen as ‘the interactive participation of researcher and subjects, overtly or covertly, over a period of time collecting whatever data becomes available to illuminate the research’. Ethnographic data do not lie about in the field to be collected. Rather, data are produced or constituted by observation *and* interpretation or categorisation (Aase 1997, citing Wadel 1991). I started this work in approaching resource management in agriculture in Kilimanjaro by applying ‘sensitizing’ (Denzin 1989:14) or open concepts of environmental management such as land use, water use, land tenure and water tenure. I then proceeded with the development of categories based on local definitions and conditions, and finally examined how ‘use’ and ‘tenure’ are interrelated in the local system where land use change can lead to change in tenure (the planting of permanent crops establishes permanent *Kihamba* tenure) and rights to use and manage water can be

⁶⁰ The information from six furrow chairmen (male elders) in the upland cluster (Komalyangoe) was supplemented with information from nine other elders. Six were of these were women, and a few were unrelated to the furrow-owning lineages. In the lowland cluster, interviews with four male village and hamlet leaders involved in irrigation were supplemented with information from four male elders.

Studies of the waterscape of Kilimanjaro

established through the investment of work in an irrigation scheme. I have been working on interpretive processes over time, and moving between scenes and the perspectives of peers in academia, consultants, government agencies in town, leaders in irrigation, elders, and water users in the several communities studied, and with friends ‘backstage’ in rural Kilimanjaro.

Having prepared myself through reading and by interviewing Water Officers, consultants and other actors about the water problems of the Pangani Basin and the Kilimanjaro Region, I had learned a lot about the perspectives and problem definitions of administrators, consultants and researchers. The move out to stay on a farm in Marangu in order to work with the local perspective on agriculture and water management in *mfongo* irrigation was an important choice. The process of examining local perspectives and conditions, struggling to understand these, and represent, translate and make them relevant to research and natural resource management became central tasks in my research. The interpretation of data from other sources has been guided by information from participant observation during periods of residence in northern Tanzania and especially in Marangu. Participant observation refers not only to informal field conversations, but also to many discussions and lectures ‘backstage’, ‘at home’ in Kilimanjaro, at the market or in the pub, or while giving people a lift. Background informants were important, especially in my introduction to society, culture and farming in Kilimanjaro. They also contributed in the discussion of preliminary findings and often raised new and better questions to bring to the interviewees, while sharing a meal in the evening, doing laundry in a shared courtyard, or going for a walk at the weekend.

A useful supplement to the ‘textual’ interview is walking with informants to see the irrigation scheme or other objects of interest, a form of participant observation. In oral history, this movement through the landscape can trigger stories linked to routes and sites, through what has been referred to as ‘mnemonics’ (Vansina 1985: 45-46) and as a ‘memoryscape’ (Clack 2005) where the past is recapitulated in the myths, memories and stories associated with places (Clack 2009: 325). The ancestral past is remembered and retold because it is important in defining identity, place and rights in resources (see

McCall 1995). The legends and narratives can be difficult to get to in formal interviews, but they are often cued by movement through the landscape or at certain places, as experienced when going to see and talk about an irrigation schemes in Mbokomu on Mt. Kilimanjaro and North Pare (discussed in Tagseth 2004).

Re-engagement: Fieldwork in the water sector and in rural Kilimanjaro

I re-entered the field in 2001 after five years of absence, initiating a period of about five years of commuting between field engagements, writing research papers for conferences and publication, and taking research courses. Taking up old contacts with informants in Moshi Rural District and in the water sector and establishing new contacts has been important in order to develop my research and keep it updated. The later phase of fieldwork in Moshi Rural District has been important mainly in the continued development of my analysis of the history and culture of the hill furrow, and to some extent aspects of water management at the community level. Contact with actors in water management and irrigation extension has been important primarily in the analysis of the water policy process and the water management reform process. Further, this also gave access to secondary data, which I could compare with historical data on water use.

Later fieldwork in Moshi Rural District has involved several shorter stays in Marangu, and travel to other locations in the district. The stays in Marangu allowed me to become better acquainted with that landscape while comparing it to a more extensive reading of historical sources on settlement and resource use since my initial fieldwork, and to visit and discuss new sites identified in oral history or historical sources. Irrigation schemes that I knew from the initial fieldwork were visited, and changes, maintenance and challenges since my initial fieldwork were discussed with scheme leaders and users. Doing repeated fieldwork can add depth of information, especially about processes, beyond that of a single fieldwork. To some extent this is the case for the Rauya cluster, the Marangu district and the Himo catchment. Information on selected topics, including irrigation extension (rehabilitation), land use and land use change was sought through interviews, meetings, and participatory sketch-mapping in Rauya and Komalyangoe villages in Marangu. Regarding the history of the irrigation infrastructure, information was sought not only about irrigation in general, but about specific schemes and sites

Studies of the waterscape of Kilimanjaro

beyond Marangu. A short list of schemes described in contemporary pre-colonial literature with descriptions that could make them identifiable was prepared. Combining my information with that of informants from Marangu, four sites⁶¹ were located and the schemes observed and informants interviewed. Two hill furrows identified through past oral history work⁶² have also been visited and information sought on their history, technology and management. Some 28 elders, farmers and furrow managers were interviewed during the later periods of fieldwork in Moshi Rural District. This contributed significantly to developing further knowledge on the history of water use, which is reflected in the development of my analysis through three texts (Tagseth 2000a, Tagseth 2008a/paper 2 and Tagseth 2008b/paper 3). Fieldwork in Mwanga District (Kilimanjaro Region) and participatory observation in Meru (Arusha Region) has contributed in my interpretation of water management and cultural aspects of water at Mt. Kilimanjaro in this overview, and in Tagseth (2009).

Continued fieldwork in the water sector, involving searches for documentation and contact with several informants associated with a number of institutional actors, contributed to the analysis of the water policy reform process and administrative practice (which is documented in the texts from Tagseth 2000a and Tagseth 2002a through Tagseth 2006/paper four to Lein and Tagseth 2009/paper 5). Establishing and maintaining contact with government officers and other actors in the water sector have been important parts of the fieldwork and a source of data, especially regarding water management practices and reform processes, irrigation extension efforts, and for secondary data on water use and the extent of hill furrow irrigation. Formal interviews, informal conversations and some participant observation have been important mainly as background information, while greater reliance has been put on documents. The Norwegian involvement in water management in the region facilitated the establishment of rapport with water officers during initial fieldwork (1995-96), but the list of ten institutions contacted also included actors in other positions in relation to the ongoing water management reform in the region. Most of these institutional actors were contacted again and several new contacts established during subsequent fieldwork

⁶¹ The sites are located in Mwika, Kilema Chini and Old Moshi, all within Moshi Rural District.

⁶² The site in Mbokomu, Moshi Rural District, is described by Stahl (1964) and Masao (1974).

(mainly during 2001-2003), expanding the list of institutions to 20.⁶³ These differently situated actors have offered contrasting perspectives and insights, and also provided documentation of management and extension efforts. An important objective of this latter phase was to pick up on, and re-examine what happened in the water policy reform process, and in the implementation of the water management initiative. A second objective was to obtain data that could be used to assess changes in water use. During the initial fieldwork, I benefited from the position of 'a student' and as a Norwegian in relation to these actors (the latter due to NORAD engagement in the water of the Pangani Basin). The role of 'a student' was impossible to maintain when I resumed fieldwork. NORAD engagement in the Pangani watershed had waned and other aid actors dominated the scene. However, several of my personal contacts in the water sector had advanced in their careers since my initial fieldwork, and were in a position to assist with information. The completion of my graduate studies and having published on water management issues in the region involved an obligation to provide feedback from my research. I have thus had to experiment with new roles, for instance as a participant in negotiations over water conflicts and as a participant in investigations for the hydrographic reports used to decide on water rights applications.

Design issues

As described above, the design initially involved the selection of one catchment and the selection of two clusters within that catchment. The use and management of resources in agriculture were studied in detail within these clusters. Engagement with a locality over time can provide for a deeper understanding of conditions there, and of processes with a broader significance. A potential cost of this engagement is a limited knowledge of how what goes on in this community relates to conditions elsewhere. An issue in the use of case studies is the possibility of generalising findings, which can be improved

⁶³ Some of these institutions can be mentioned. The Irrigation Department of the Ministry of Agriculture and Food Security and the World Bank-sponsored Smallholder Irrigation Improvement Project in Dar es Salaam as well as the Zonal Irrigation Office for Kilimanjaro were sources of information on activities and policy in irrigation extension. I have also had contact with and gone through some of the records of the Traditional Irrigation Improvement Project in Dar es Salaam, Moshi and Mwanga, but this information has thus far been used mainly to put other actors in perspective. Information about water policy came from contact with the World Bank-sponsored River Basin Management and Smallholder Irrigation Improvement projects, the Irrigation Division of the Ministry of Agriculture and Livestock Development, the Regional Hydrologist, Kilimanjaro, the Pangani Basin Water Office and contact with researchers in Tanzania and Norway.

Studies of the waterscape of Kilimanjaro

through design (Miles and Hubermann 1984: 27-48). While it would have been possible and to some extent reasonable to follow common practice and argue that a case that you have researched well is 'typical' without further validation, I have also proceeded to situate the cases within regional patterns of variation and to devise strategies for scaling up. This was the justification of the initial design with two clusters in one secondary study area. More extensive and 'rapid' approaches have been used elsewhere on Mt. Kilimanjaro, outside these clusters, in order to make it easier to achieve results that can be generalised, among other things. In subsequent work on the historical geography of irrigation (Tagseth 2008b/paper 3), two additional sections of the slopes were selected and combined with the existing case to represent the three main regions (Hai, Moshi, Vunjo) on the southern slopes of Mt. Kilimanjaro. This provided a broader basis for analysing regional variation and changes in water use, which led to some modification from paper 4 (Tagseth 2006/paper 4) where data from one catchment is used in the analysis of changes in water use to paper 3 (Tagseth 2008 /paper 3), where three areas representing three broad sectors of the southern slopes of Mt. Kilimanjaro are used in the analysis.

Documentary sources

Documentary sources have been important in this study. Documents from the East Africana Collection at the University of Dar es Salaam have been used, and I have consulted local level ward water files (Marangu), water rights files (Dar es Salaam, Hale, Moshi), the files of the Regional Hydrologist-Kilimanjaro and some records of the Pangani Basin Water Office. Documentation of the practices in water management has been sought from the local level upwards. The records of the case study villages were used, but at this level records are patchy. Much more detailed correspondence was found at the ward level (Marangu West Ward and Marangu East Ward). Here, I found flat files containing *c* 200 records in Swahili related to water. These document the mobilisation of traditional irrigation during campaigns that were launched during severe food crises due to drought. These are the 'war on drought' staged in 1974-1975, and the 'freedom from hunger' campaign staged in 1987. The records document a modest level of assistance from the irrigation authorities and the District administration, but there have been efforts to compile registries of irrigation on several occasions. Such lists from

the 1970s and 1980s were studied and compared with recent water office surveys and my own survey of smaller areas, and deemed too inaccurate as a basis for assessing change because of missing and inaccurate data. It is thus important to examine such sources critically. Among other things, ward level records can be used to document the outreach of policies and initiatives from above. Documentation and files from various offices can be analysed not only for content, but also in terms of their context. The presence of a District bye-law on water resources protection at the Ward level documents that regulations should be known to ward officials, and it should be possible to follow up with questions about how these were implemented. There had been several calls to register the schemes in this area for statutory water rights prior to the initiative following the establishment of PBWO, but the matter appears not to have received priority in the local and district administration.

Water sector records have been examined at several levels. At the office of the Regional Hydrologist, Kilimanjaro, I have examined water rights records and their records of water use as well as hydrological data. At the Pangani Basin Water Office I have examined water rights records, water rights application protocols, quarterly progress reports and other records and reports. The Pangani Basin Water Office gave access to databases of water use compiled on the basis of water rights records and on a field survey of water use carried through in 1992-1994. The Regional Hydrologist, Kilimanjaro, in cooperation with the District Authorities had done some updating of these in 1997. Through a field survey of smaller areas, it was established that the PBWO database was reliable for the southern slopes of Mt. Kilimanjaro, while irrigation in North Pare was found to be underreported, which is probably also the case for South Pare, and for Rombo on the eastern side of Mt. Kilimanjaro. Some water rights records could not be found at these lower levels, so I have supplemented the information from the archive of the Principal Water Officer at Ubungo in Dar es Salaam. Here, it was also possible to follow registered rights back to their origin with settlers and missions during British rule, in some cases to the original alienations of land by the Germans at the start of the 20th century. Few peasant schemes were registered for water rights, and registration following the Water Utilisation Act of 1974 was limited, so the registry reflects the colonial background of the water rights system and

Studies of the waterscape of Kilimanjaro

its original purpose to protect estate interests and to regulate water issues between estates and missions (see Tagseth 2002a, van Koppen et. al 2007, Lein and Tagseth 2009/paper five). Transparency in administration is not well developed in Tanzania. The water records are not public, and some problems of access had to be negotiated.

Historical sources on water use and water management come from the East Africana collection of the University of Dar es Salaam, and from published items identified and traced through bibliographical methods. More extensive archive work in Tanzania's national archives and in archives of the former colonial powers of Germany and Britain would have provided more knowledge, but was not undertaken due to limited time and resources.

Methods to assess change in irrigation

There has been considerable interest in the history of the hill furrow in eastern Africa, but empirical knowledge of the history of irrigation and intensive agriculture at Mt. Kilimanjaro is still limited.⁶⁴ Perceptions of the history and dynamics of irrigation, which appear to be based on deductions more than empirical study, are used in water management and to guide policy on the hill furrows, however (Tagseth 2008b/paper three). Assumptions about changes in water use have been made without adequate empirical investigation, and appear instead to be based on deduction from theoretical models of changes in resource use and agriculture. The importance of developing better methods to assess claims about environmental change against diachronic data sets has been demonstrated with respect to the land degradation debate (Tiffen et al. 1994) and the deforestation debate (Fairhead & Leach 1996, see Börjeson 2009 for a discussion relating to Kilimanjaro/ Northern Tanzania). Based on this background, I developed an understanding that there is a need for research methods in order to test claims about environmental change in order to inform the debates about water and development and the history of intensive agriculture. I have pursued this objective in two ways.

⁶⁴ See Stump & Tagseth (2009) for a review of the pre-colonial and early colonial history of intensive agriculture in Kilimanjaro, Maro (1974) for the British period and Maghimbi (2007) for the 1970s to 2000s.

The first of these seeks to contribute to the history of resource use by examining or reconstructing the development of water use and irrigation infrastructure in a locality, based on the assumption that wide-ranging changes would be manifested in changes at the local level. The method applies especially to paper two (Tagseth 2008a). Past research on the history of hill furrow irrigation had attempted to relate the establishment of irrigation schemes to the oral history of institutions. Thus, in Marakwet, (Kenya), Soper (1983) attempted to correlate the establishment of irrigation schemes with the institution of age sets. In the Kilimanjaro region, Stahl (1964) and Masao (1974) had sought to correlate the history of the noble lineages with the establishment of irrigation. I realised during fieldwork that the link between the nobility and scheme management was often weak, despite my expectations to the contrary based on Dundas (1924) and Stahl (1964), so my attention was subsequently focused on the sedentary patrilineage as the relevant durable institution in scheme management. The identification of the patrilineage as the organisational nexus of the irrigation scheme, and the central role of the hereditary furrow chairman, were important premises. This permitted a search for a history of the furrow-controlling family and its relation to specific irrigation schemes. The data from interviews about changes in irrigation and the development of the irrigation infrastructure is combined with previously recorded versions of oral history of the area in the analysis.

The second way is what I would term the processual or historical (diachronic) approach. Here, 'processual' refers to Moore's (1986) critique of reconstructions of past conditions and processes in Kilimanjaro, while 'historical' refers to the use of diachronic data sets in the study of change in African environmental and agricultural history (see Niemeijer 1996). When a baseline, a contemporary description of conditions at some point in the past, can be established, it can be compared with data on conditions in subsequent periods or with current conditions. This makes it possible to assess claims about changes in resource use against diachronic data series. This is the strategy that is used to describe changes in water use in two papers (Tagseth 2006/paper four, Tagseth 2008b/paper 3). The first of these is based on the study of a single catchment, following the restrictions of the design of the initial fieldwork. In developing this study further, an important objective was to gain a better basis for

Studies of the waterscape of Kilimanjaro

conclusions on changes in water use from a regional and long-term perspective. Several sites with long-established irrigation systems in Moshi Rural District were identified through 19th century sources and from the research literature and visited during 2002-2003. Among these were some examples of abandonment, but also examples of continuity over long periods. Scaling up the analysis of changes from one catchment (Tagseth 2006) to the southern slopes of Mt. Kilimanjaro (Tagseth 2008b/paper 3) required the use of past studies and records and some contemporary secondary sources to generate diachronic data sets for the three main regions of the southern slopes of Mt. Kilimanjaro. This methodology provided time series data with a long time frame against which it was possible to test hypotheses of changes in water use in a manner not previously attempted, at least not for hill furrow irrigation in eastern Africa. My strategy to identify sources and to use these as baselines against which to assess environmental change has required a realist reading of the sources, motivated by the need to test previously untested but dominant assumptions about change in the environment and water use against better diachronic data sets. While doing this, I have considered the positionality of the authors and the context of their texts. This involves an attempt at sorting out the 'changing environment' from the 'changing views' (Blaikie 1995). Other readings are possible. In many cases, the reasons for stability or changes in the descriptions of the Kilimanjaro environment must be sought not in changing conditions on the ground, but in the hegemonic paradigms or 'received wisdom' of the environment (Leach & Mearns 1996). There is thus also a case for focusing not on the explained, but on the explanation or narrative (see Blaikie 1995, Fairhead & Leach 1995, 1996, Brockington & Homewood 2001), which would mandate further study of the history and sociology of environmental science. The outlook on environmental problems can show stability as well as change between sets of actors and over time. For instance the outlook on the local practice of irrigation varies over time and between authors. Reference to the practice of irrigation has been used both as an example of high cultural standards, and as an example of environmental mismanagement. Traditional irrigation has been portrayed in a dystopic way, as a destroyer of the soil and responsible for water waste, but also as a cultural achievement and an insurance against food insecurity. While all this is acknowledged, a systematic reading of the different perceptions of irrigation and thoughts about its role in the society and economy of

Kilimanjaro is reflected only to a limited extent in the papers dealing with the history of water.

Methodological and theoretical triangulation

The study has involved some experimentation with methodological triangulation, primarily through the combination of oral history (interviews) with other (written) sources, and in the analysis of the local organisation of irrigation. Methodological triangulation conventionally involves the application of multiple methods in the analysis of the same empirical events (Denzin 1989: 13, 236). According to Denzin (1989: 234), it is '*convenient to conceive of triangulation as involving varieties of data, investigators, and theories, as well as methodologies*'. This wider application of the principle constitutes multiple triangulation. Denzin (1989: 237-241) mentions four basic types of triangulation: data triangulation, investigator triangulation, theory triangulation and methodological triangulation. I have carried out this study as a solitary researcher, and investigator triangulation does not apply to any extent. The concept of triangulation is now often applied simply to describe studies that combine quantitative and qualitative methodology, which is most evident in paper one (Tagseth forthcoming/paper 1). Data triangulation could apply, for instance in the combination of oral history and historical documents in paper two (Tagseth 2008a), where a historical map (Meyer 1890, Karte II) is used to verify that the upland case study cluster was part of the agricultural settlement in the late 19th century. Oral histories can also be compared with the physical landscape as discussed in regard to a furrow in the foothills in Marangu (Tagseth 2008a). Oral history was also assessed against archaeological work relevant to the history of habitation (Odner 1971, Fosbrooke & Marealle 1952a, 1952b). Methodological and theoretical triangulation are interwoven in the first paper (Tagseth forthcoming), where the organisation of water use is approached in three different ways: First, from a normative perspective – based on statements about norms/rules and what should happen; second, from reports on conflict and negotiations over water use – based on the actors' reports on their interaction; and, last, at the level of performance in terms of reported access to water for different social groups – based on quantitative analysis comparing the reported ability to access water by categories of users. The analysis of the management of an irrigation scheme is often limited to a

Studies of the waterscape of Kilimanjaro

normative-institutional level. The analysis of reports on conflict (negotiations) over water adds more knowledge in terms of the performance of the organisation of irrigation. The social process of irrigation organisation is even more rarely examined in terms of its outcome, which is at least in part due to the methodological challenge of investigating water tenure. An issue that can be a challenge in triangulation is how to balance sources when these disagree with each other. In the first paper (Tagseth forthcoming) I have put more emphasis on reports on the outcome of the water distribution process, which deviates from what the normative-institutional analysis would have led us to predict. This demonstrates weaknesses in institutional analysis of the norms of water use used alone, which can be related to both methodological and theoretical problems. It can be argued that it would be problematic to ascribe a truth value to any one of these approaches alone, as they reveal different and partial aspects of reality (see Denzin & Lincoln 1994: 2). However, the use of multiple methods, or triangulation, reflects an attempt to secure an in-depth understanding of the phenomenon in question. Objective reality can never be fully captured. The combination of approaches adds depth to the analysis, thus contributing to better understanding, which is an essential objective of triangulation when applied as a method of naturalistic enquiry (Denzin 1989).

Process and the format of the thesis

NTNU doctoral study regulations offer the option of submitting a thesis either in the form of a monograph, or as a collection of papers with a synopsis or synthesis accounting for the basis and the whole of the thesis. The decision to write a series of articles rather than a monograph is a strategic decision with impacts on the research process. Reflecting on this choice, I see both benefits and problems resulting from this decision. A doctoral thesis in the form of a monograph is usually difficult to disseminate, while it is possible to reach a wider readership through publication in journals or anthologies. Among the benefits of writing a series of articles is that it is easier to test pieces of your research, to get valuable feedback, first from workshops and international conferences and later from editors and reviewers. This form of feedback has helped me in the research process, through having to sharpen my argument, from critiques, encouragement and good questions asked. Writing, presenting and discussing

conference papers has helped to first identify (potentially) publishable sub-projects and to research and produce them to a publishable standard. It is also a process where it is possible to realise and document results of research as you go along. Further, in a collection of papers it is possible to make some flexible adaptations, but this would tend to add to the length of the process. I also had to try to identify and address different audiences and leave some control of the process to editors and reviewers, who are entrusted to ensure the quality of publications. The five papers had to serve different audiences, and in some places I can see that their writing – in terms of perspective and what was included or omitted in the end – was influenced by factors that are not central to this thesis. I have not been able to avoid the repetition of some phrases, passages, illustrations and maps between the papers. Further, I had to trim down ambitions to document my research and develop thoughts at length (at least while writing the papers), and I had to condense data and analysis to maintain focus and to attain a publishable length. Some specific problems can be mentioned. While developing a paper for publication in the Norwegian Journal of Geography, I had to reduce the level of documentation of the information in *c*50 footnotes that I used to keep track of information while developing the text and that could have been helpful to other researchers. There is no system in that journal for reference to archives. It was not possible to provide detailed reference to a grey literature, which I find is imperative to use because there is so little publication in eastern Africa. These sources had to be referred to as (Author, unpublished data), which is unspecific. There can sometimes be difficulties in finding (identifying) the right channel to publish reasonably well researched papers, and delays in publication. My original plan for the doctoral thesis incorporated the publication of case studies as working papers, which could be a solution to that problem, but since *c*2002 this has been discouraged by the Norwegian system of incentives at my institution. There are also choices as to which audiences to address through publication. I find publication with African academic publishers meaningful, because it improves the impact of an article through more affordable distribution in the region. Like most systems for building an academic track record, the Norwegian system of incentives does not generally give as much weight to publishers in the South, even if it actually is possible to suggest publication channels for approval as well as changes in their standing. One problem in publication is that submitting to book

Studies of the waterscape of Kilimanjaro

projects easily leads to delays and leaves success in publication dependent on the success of your cooperation partners and on a larger and more complex project. At points in a review process it may be necessary to modify objectives, an argument or an emphasis that you would have liked to keep because it is related to the structure of the argument in the thesis. In spite of these issues, I must add that comments from editors and reviewers have been helpful and usually well founded.

A summary of the five papers

The first paper (Tagseth forthcoming) is entitled 'Irrigation amongst the Chagga in Kilimanjaro, Tanzania. The organisation of *mfongo* irrigation'.⁶⁵ This article draws on intensive fieldwork focused on irrigation in one neighbourhood conducted in 1995-96 and during short visits in 2001 and 2002. The local organisation of water use in a neighbourhood is analysed and discussed on the basis of a detailed study of the use of four irrigation schemes. Central aspects of social organisation in the study are scheme tenure, water tenure and access to water, as well as the canal organisation and its relationship to local organisation. A tendency in the literature on the organisation of irrigation to describe irrigation organisation as a static and a-political object is identified as problematic. In this article I pursue a combination of three methodological and theoretical approaches to the problem of the social organisation of water use. At a normative-institutional level, the norms of water use and notions of rights in the irrigation scheme are described. These results can then be compared with reports on everyday practice in water management and with reports on conflict and conflict management. Lastly, these can be compared with statistical data on the results of these processes in terms of access to water for different social groups. The results suggest that access to water is not well predicted by the norms (institutions) of water use alone. A better understanding of the water commons can result from a broader conception of its institutional, normative or ideational aspects, but also from the investigation of how

⁶⁵ This paper was written at the request of Nathalie Gomes and Stephanie Duvail at the French Institute for Research in Africa (IFRA) as a contribution to a proposed anthology, 'Irrigation management in eastern Africa-Building on indigenous knowledge'. The paper was revised following editorial comments on the 1st draft in 2004. An updated version was submitted to a special issue of *IFRA les cahiers d'Afrique de l'Est* on irrigation management in eastern Africa on May 27 and accepted on June 3, 2009. The intention of IFRA is now to publish this paper in cooperation with Hekima College in Nairobi as a book chapter (D. Lebrun, pers. comm., November 4, 2009).

negotiations over water take place and of the outcome of these processes in terms of access to water. The results show that this neighbourhood- and kinship-based type of organisation can work without an elaborate set of bureaucratic rules in catering to access to water for users outside the kin-group, for different socio-economic groups and for women. The irrigation organisations can be seen not so much as a timeless and isolated 'common property resource' but rather as a commons institutionalised through a historical process and embedded with other institutions and social relations.

The second paper (Tagseth 2008a) is entitled 'Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania.'⁶⁶ The paper draws on data from intensive fieldwork on irrigation in one neighbourhood conducted in 1995-96, and knowledge of a larger district expanded during fieldwork in 2001 to 2003. The paper discusses methods to study the development of water use in periods without written records. Past research on the issue is reviewed. It is argued that the development of irrigation schemes in areas of eastern Africa depended on different institutions, such as chieftaincy, age sets or kinship groups. The oral history of these institutions can be exploited as a source. The establishment and management of irrigation schemes in what has been termed the 'Kilimanjaro cluster' (Adams & Anderson 1988) has in most cases depended on patrilineal kinship groups and took place in societies that could be with or without centralised chieftaincies. Examples are given of how this method can be used to date the establishment of a group of irrigation schemes to periods from the 1830s onwards.

The third paper (Tagseth 2008b) is entitled 'The expansion of traditional irrigation in Kilimanjaro, Tanzania'.⁶⁷ This is the substantial contribution to the historical

⁶⁶ A short preliminary version of this paper was published in EDSU working papers i Stockholm (Tagseth 2003). It has been presented at an international workshop hosted by the research network 'People, land and time in Africa' in Arusha in October 17-18 in 2002, for the 3rd international conference of the International Water History Association at Bibliotheca Alexandrina, 11-14 December 2003, and as an invited presentation at a workshop arranged by the British Institute in Eastern Africa at the conference of the Society of Africanist Archaeologists in Bergen, June 26-29, 2004. It was submitted to the Norwegian Journal of Geography on February 8, 2007 and was accepted in October 2007 following peer review.

⁶⁷ This was an invited paper for a workshop on 'Regional interaction and land use in North-Eastern Tanzania' in Usambara, October 13-15 2006, hosted by the University of Stockholm. A revised version was sent to the editors on September 30, 2007, and submitted for a special issue of International Journal

Studies of the waterscape of Kilimanjaro

geography of water use. The paper analyses the development of 'traditional irrigation' at Mt. Kilimanjaro. It is based on fieldwork, secondary sources and archive work conducted in 1995-96 and 2001-2003. The paper draws on oral history, 19th century eyewitness accounts and several studies of irrigation from the 20th century. Two conflicting hypotheses about changes in water use can be identified from the literature. According to the first of these, there has been a decline in traditional irrigation. According to the second hypothesis, there has been an increase in water use as a consequence of population growth in the period after 1961. Neither of these has been adequately tested. On the basis of analysis of data on changes in the number of schemes through the 20th century, the paper puts forward a third, alternative hypothesis: infrastructure for irrigation was fully developed in certain areas by the early 20th century. Changes in the 20th century can be seen as a restructuring, where decline in some of the areas that had been developed early has been balanced by an increase in new areas and in the scale of the schemes. The results weaken or moderate the role of population growth as an explanation of changes in water use. No single driving force can account for the changes on the longer term, but several contributing factors of explanation are identified.

The fourth paper (Tagseth 2006) is entitled 'The "mfongo" irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania.'⁶⁸ In this paper, the question of local knowledge and the relationship between local knowledge systems and science-based knowledge systems is used in the analysis of irrigated agriculture in the catchment of the Himo River. Local knowledge is operationalised to two subjects; the use of resources and the social organisation of irrigation. Changes and practices in land and water use are described, and changes in water use and the number of irrigation schemes quantified. Two modes of irrigation organisation are identified. A general model for the characterisation of 'scientific knowledge systems' and 'indigenous knowledge systems' is presented. This model is then used to develop a specific model for a 'modern water

of African Historical Studies in March 2008, titled 'The political ecology of trade, food production and landscape transformation in Northeast Tanzania 1850-2000'. Following peer review, it was accepted with revisions in October 2008.

⁶⁸ This paper was first presented at the conference of the International Water History Association in Bergen in August 10-12, 2001. It was submitted and accepted for publication as a book chapter by I. B. Tauris following peer review and some changes in 2002-2003.

management system’ and an ‘indigenous water management system’. The meeting between these management systems is characterised by conflict.

The fifth paper (Lein & Tagseth 2009), entitled ‘Models of water resource management: Tanzanian water policies between principles and practical applications,’⁶⁹ is co-authored with Haakon Lein. The paper draws on fieldwork in the water sector in Tanzania in 1995-96 and in 2001-2003. Blaikie’s (1998) categorisation of contemporary theories of development is applied, and it is argued that ideas of improvement in water management can be classified into market-based, state-led and neo-populist. This categorisation is used to analyse the development of water policy at four different scales: discourse and resolutions in global forums, the development of Tanzanian water policy and legislation, and the development of water management for the Pangani River Basin, and its local impact.

Conclusions

In this concluding section, the main findings with reference to the research questions are presented. It first presents conclusions with reference to the detailed research questions related to the two main themes. Following this, general conclusions relating to the organisation of water use and changes in farmer managed irrigation are presented. Finally, the approaches to the Kilimanjaro waterscape in this study are discussed.

The organisation of water use

The first of the two main research questions asked: ‘*How is the use of water for agriculture organised?(1).*’ Four more specific questions are related to this question, relating to the local organisation of water use (1.1) and to water management reform (1.2.1, 1.2.2, 1.2.3).

⁶⁹ This paper was presented at the international conference Hydro Africa in Arusha in November 2003 and in revised form at the international conference of the International Rural Sociology Association in Trondheim in July 2004. The paper was submitted to Water Policy on May 9, 2007 and accepted for publication on June 12, 2007 following peer review.

The local organisation of water use (1.1)

'How do small scale farmers organise themselves in order to operate their own irrigation schemes, especially with regard to maintenance, water distribution and conflict management? (1.1)'

The organisation of water use is in most cases independent of irrigation extension and the water management authorities. Farmer management defines both important strengths and problems in water management in the area. Organisational solutions vary, but can be classified into three main types (Tagseth 2006/paper four). The first type consists of an unnamed informal furrow community under the authority of a hereditary furrow elder. A second type consists of a named group. Here, leadership is often elected, and there are more formal rules of management. The organisation can be integrated with the village organisation or independent of it. In the past a third type was under the jurisdiction of the *mangi*, but many of these have now been abandoned, perhaps because of the decline in highland arable irrigation or because these schemes did not make a successful organisational transition to local government when chiefdoms were abolished in the 1960s. Change in irrigation organisation over time can be seen in a geographical pattern where the old schemes upslope rely on basic models of kinship and neighbourhood (type 1), while schemes built mostly from the late pre-colonial and colonial period in the foothills are somewhat more formal (or bureaucratic) (type 2). In addition to the forms described in this study, there are introduced models of organisation in irrigation development and redevelopment schemes, with related issues of their adaptation and the transfer of irrigation management to user organisations. To some extent, the mode of organisation reflects the age of the schemes. The variation in organisation also corresponds to differences in scale (Tagseth 2002b, Tagseth 2006/paper four).

None of these models should be seen as static. Schemes organised as type two may previously have been under a lineage elder, the chief or a manager appointed by a European settler. Organisation under type 1 appears to have undergone secularisation. There are problems with irrigation being in the male domain when men of working age increasingly seek income beyond the village. For those who want to carry on with irrigation this calls for flexibility. Another topic referred to the concepts of tenure.

Conclusions

Hydraulic tenure can be divided into water tenure and scheme tenure. There appears to be agreement that water, being a 'gift from God' cannot be owned, but when water has been appropriated or produced in a furrow scheme, people can have rights in it. Rights to a share of water belong to 'those who follow it to the source' and can be strengthened through participation in the work of the group of irrigators. Irrigation schemes are usually understood to belong to those who built them, which can refer to initial construction or later investment. When someone is said to own a furrow under type 1 organisation, this does not imply that it is the private property of a person, but rather that a person has management rights. Schemes under type 1 are sometimes said to belong to the group of irrigators, while statements that the scheme belongs to the users or to the community are common under type 2. Water is divided into proportional shares (turns or time; *zamu* in Swahili, see Mehari et al. 2009) rather than into volumes. The most basic way is to use a sequence under type 1, while division of a cycle of distribution into time shares, 'hours of water,' is more common under type 2. Drawing water by bucket for domestic use is not restricted, and such use does not carry the same obligations as the use of water for irrigation.

More detailed investigations were focused on type 1 organisation (Tagseth forthcoming/paper one), which depends on kinship and neighbourhood. The furrow elder (chairman) is appointed by the descendants of the canal founder. The status of the chairman and the norms of proper conduct over water are strengthened through their 'enchantment'. Use rights in water can be achieved by those having access to land in the command area through participation in the work party that maintains an irrigation scheme, a principle that is important in keeping the furrows in repair. In the community case study area, negotiations over water in most cases take place directly between users. The institutionalised general meeting can set up a schedule for water rotation, but this was not practised here. Problems can be resolved in a parley (*baraza* in Swahili) where a neighbourhood elder and the furrow elder are present, or the users can act as a group to sanction behaviour seen as deviant.

Data on access to water by gender, wealth group and lineage affiliation reveal differences in access to water. Some of the results, including ease of access to the

Studies of the waterscape of Kilimanjaro

furrow-owning lineage members, and the ability of women to access water, are contrary to the stated norms of water access. An analysis of the normative system of the water commons alone has a somewhat limited power of explanation, and the analysis is extended to reports about interaction and about the outcome in terms of the ability of different social groups to access water. In terms of wealth rank, the middle group is more frequently able to access water than other groups. Restrictions against female participation in furrow cleaning and especially the repair of intake structures imply that women have difficulties in achieving rights to water, but the analysis of interaction and access to water shows that de facto female headed households are able to access water. Men who are present in the community and able to participate in work on the scheme and are related to the furrow elder have better access. Neighbourhood- and kinship-based organisation can work without an elaborate set of bureaucratic rules in catering to scheme maintenance and access to water for a varied set of users, thus contributing to livelihoods and food security. The strength and endurance of this water commons is not so much related to a strong, isolated, single purpose organisation as it is to the social and cultural embeddedness of water management.

Water management reform and policy issues (1.2)

There are three specific questions related to water management reform and policy issues. Regarding global influences, I asked:

'What are the global influences on water policy in Tanzania and the Pangani River Basin?' (1.2.1)

Three types of policy directions for the improvement of water management have been identified, the 'state-centred', the 'market-based' and the 'community-based'. Each of these are based on different development ideologies and provides different answers to how and by whom limited water resources best could and should be managed. All of these relate to international discourses, but directions in global water policy supported by donors emphasise the 'market-based' solutions of 'demand management,' and also to a limited extent 'community-based' solutions, with objectives of devolution and concessions to participation. These directions can be seen as challenges to the central role of 'state-centred' management in Tanzanian water policy and practice. These

Conclusions

influences have been balanced and compromises made in the development of a new water policy and in a water reform process where Integrated River Basin Management remains an objective (Tagseth 2002a, Lein & Tagseth 2009/paper five).

Regarding the transformation of global influences to water management in the region, I asked:

'How do these influences translate into water management in this region?' (1.2.2)

The establishment of a river basin board and office for the Pangani River Basin (PBWO) followed a national agenda (United Republic of Tanzania 1981) but is also related to the influence of aid donors, including the Norwegian Agency for Development Cooperation (NORAD), which provided advisors in the process in order to protect the viability of the rehabilitated hydropower plant at Pangani Falls. PBWO activities have also received support from the World Bank and the IUCN. In addition to changes in national water policy, donor influences contribute in changing the approach to water management in the region. The strategy of an initiative in water management from the 1990s onwards thus emphasised the river basin as the management unit, a strategy of making a system of administrative water licences issued by the Water Officers under statutory law the only legitimate basis for accessing water, and the introduction of volumetric water fees (See Tagseth 2002a, van Koppen et al. 2007, Lein and Tagseth 2009/paper 5). The latter was seen as a means of increasing efficiency through demand management and to provide a source of funds for management activities. A crash programme was also funded by NORAD to restrict water use in traditional irrigation through the installation of flumes ('control gates') that would make abstractions lockable and measurable. Another objective was to transform varied local irrigation organisations into standardised 'water user associations' which could be held accountable to the water authorities. Collection and organisation of hydrological and water use data was another element. There was little emphasis on participation, and public relations were seen primarily as a problem of 'creation of awareness.'

The initiative in water management for the Pangani River Basin from the 1990s was thus inspired by the 'state-centred' and the 'neo-liberal' prescriptions for water

Studies of the waterscape of Kilimanjaro

management (Lein and Tagseth 2009/paper five). Problems with the initial approach and other factors may have contributed to some attempts to draw on ‘community-based’ inspirations. One of these is the change of rhetoric for public relations from ‘the creation of awareness’ to ‘dialogue.’ Another change is the objective of establishing a ‘catchment forum’ (decentralisation of river basin management functions has been tested in the Rufiji River Basin, see Maganga et al. 2004). The water management initiative was met with ‘weapons of the weak’, widespread resistance and non-cooperation from communities and local government. The problems were acute during the installation of ‘control gates’ by the contracted engineers with minimal consultation. User groups maintained that they already had the right to draw water according to custom and ignored demands that they seek licences from the water office for the use of schemes that are constructed, maintained and managed by users. Furthermore, some user groups saw charging for water as unethical and upheld their own norms of proper water management. This contributed to a very limited success for the strategy of making the statutory licence the only basis for legitimate water use and for volumetric water charging as an incentive. There were also other problems with the implementation as discussed below.

Regarding the impact in this geographically and historically contingent regional setting, I asked:

‘In what ways have the specific and contingent factors impacted on the water reform process?’ (1.2.3)

When the impact of the initiative in water management was limited, this was at least in part because the initiative was based on global water management discourse and national administrative traditions more than it was based on the specific management problems of the region. Past management experience was not taken sufficiently into account in defining water management reform. Further, the initiative failed to take the needs experienced by user groups as a starting point, which would explain a lack of interest in participation. Certain elements of the reform were seen as illegitimate in the region. The initiative failed in taking customary rights to water into account and underestimated the considerable legal and practical problems in establishing statutory

law and the administrative water licence as the only basis for legitimate water use, which had hampered initiatives in water management in the region in the 1950s and 1970s. Volumetric charges for water use for a large number of small rural consumers are uneconomical and impractical due to the cost of travelling, monitoring and billing in this area. This led to the adoption of flat rate fees for small withdrawals and a practice of billing according to installed capacity rather than water consumption. This means that the water fee is undermined as an incentive, while it can function as a tax or cost recovery the water management authorities (Lein & Tagseth 2009/paper five, see also van Koppen et al. 2007). Past experience with interventions in water management, as well as indigenous ideas of water management, provided models and shaped local resistance to the initiative in water management.

Changes in farmer managed irrigation

The second of the main research questions (2) asked: *'What changes have occurred over time in farmer managed irrigation?'* Relating to this, there are further questions about methodology, substance and explanation. The first of these is:

Methodology (2.1)

'How can questions of origins and changes in irrigation best be addressed empirically?'(2.1).

In many cases, local level resource use leaves little record on paper, which led to the adoption of oral history methodology. The social organisation of irrigation in the Kilimanjaro cluster often depends on the patrilineage, and the oral history of this institution can be used as a source. It was found through oral history that the practice of irrigation predates European contact and is older than the written sources. There are indications in oral tradition that *mfongo* were in use in the 17th century in Marangu. The establishment of a cluster of specific schemes could be dated to the 1830s onwards, and appears to represent a phase of expansion of an existing technology. It is thus not necessary to assume that the use of the *mfongo* is an unchanging, timeless tradition. The extent of the system and the early adoption of the technology make it difficult to address

Studies of the waterscape of Kilimanjaro

the question of origin through oral history (Tagseth 2008a/paper two), but oral history could possibly be used to guide archaeological or historical landscape studies that could contribute further knowledge.

Documentation of the extent of irrigation systems could also be identified, thus providing an empirical basis for regional and temporal analysis of change in irrigation. Such documentation can be found in travelogues, past studies of irrigation and in the archives of the wards and in water office records. The travelogues provide some information of the distribution of hill furrows and some information about change at an analytical level. In the case of Mt. Kilimanjaro, it is furthermore possible to compare more recent surveys with documentation of the system earlier in the 20th century. This is a method that has not previously been attempted for the hill furrow in eastern Africa. Some familiarity with the area or fieldwork may be needed in the interpretation of the records (Tagseth 2002b, Tagseth 2006/paper four, Tagseth 2008b/paper three). In addition to the methods I have employed, there are further possibilities for the comparison between historical surveys and targeted re-surveys, as well as specialised archaeological methods (Stump & Tagseth 2009).

Directions and magnitudes of change (2.2)

I also asked about the empirical substance of the change: *'What have been the directions and magnitudes of changes in (the extent of) farmer managed irrigation?'* (2.2)

The present study provides new knowledge of and analysis of change in hill furrow irrigation (Tagseth 2006/paper four, Tagseth 2008a/paper two, Tagseth 2008b/paper three). The analysis from Marangu (Tagseth 2006/paper four, Tagseth 2008a/paper two) shows that canals tend to have been established in different areas during different periods, and it is suggested on the basis of oral tradition that furrows were established first in the mid-slope core area, followed by expansion upslope continuing through the 19th and early 20th century. Many schemes in the foothills were developed during the German and British colonial periods, but there are examples of older and more recent schemes in this zone. This was the first indication of an uneven regional development of

hill furrow schemes and a phasing of irrigation expansion reported in Tagseth (2006/paper four).

Changes in the extent of the furrow infrastructure was analysed for a hydrological region centred on Marangu. Here, the number of schemes declined by 41% in the period 1940 to 1993 under conditions of population growth averaging an estimated 2.1% annually. The decline in the number of schemes, which was most accentuated in areas on the higher slopes, was partly offset by an overall increase in the scale of the schemes. Further studies expanded the regional scale of the analysis to the southern slopes of Mt. Kilimanjaro for paper three (Tagseth 2008b). The paper shows that the existence of hill furrows in most of the major districts on the southern slopes was documented in the last half or the 19th century, and shows that some infrastructure was abandoned while investment continued in other areas, possibly reflecting uneven regional development and insecurity in the wake of an expanding Swahili trade. Despite these instances of abandonment, a considerable overall expansion of hill furrow irrigation at Mt. Kilimanjaro appears to have taken place during the 19th century. The *mfongo* system has a long and dynamic history of change, involving decline as well as growth. It is thus difficult to identify a stable 'traditional' period in irrigation history, and an estimate of the extent of traditional irrigation 'prior to development' based on field survey of all 'live' and 'dead' schemes could be misleading. Changes in the 20th century could be examined in more detail. Figures on the overall number of schemes on the southern slopes of Mt. Kilimanjaro are somewhat uncertain, but are estimated at *c* 1000 schemes in the early 1990s (based on water office data from field survey), as compared to 1000 to 1500 schemes in 1939-40 (extrapolated from a count of 602 from surveys of specific catchments). The overall estimates and the counts from various districts show that hill furrow irrigation infrastructure was extensive in the first half of the 20th century. More reliable data on changes within the three main regions of the southern slopes of Mt. Kilimanjaro show a decline in Marangu (from 251 schemes in the 1930s to 148 schemes in the 1990s), no change in Old Moshi with Mbokomu (from 66 schemes in the 1910s to 65 schemes in the 1990s) and a small increase in a part of Machame (from 72 schemes in the 1930s to 92 schemes in the 1990s). The explanation of an extensive irrigation infrastructure as a result of agricultural intensification driven by population growth

Studies of the waterscape of Kilimanjaro

since independence is thus contradicted. Neither does the competing understanding, that the furrow system is in decline as the technology becomes obsolete with development, fit the data on the overall development of the systems, even if the *mfongo* have declined in some areas. The stability in the number of schemes at these regional levels masks changes in the distribution of schemes within the regions. Twentieth century changes can be described as a restructuring, which involved abandonment of infrastructure in some long established areas upslope, and an increase on the lower slopes and in the plains.

Changes in land and water use upslope in the 20th century included a decline in arable irrigation, especially of finger millet. This change was associated with the adoption of maize as the arable cereal, but more importantly the widespread conversion of arable land to agroforestry groves (*vihamba*) with shading and mulching as important methods of soil water management. Through this process, surplus production upslope changed from millet for local and regional consumption to coffee for the world market. Irrigation was expanded and restructured on the lower slopes in order to cater to the arable cultivation of maize, often assisted by irrigation. This zone has later seen an increase in settlement and conversion of arable to agroforestry groves. In some areas on the lower slopes, bananas and coffee require irrigation. The expansion of irrigation in the plains has been a policy objective since the 1930s, and was seen as the solution to a 'Chagga overpopulation problem' which avoided the subdivision of the settler estates on the lower slopes. Colonial planners saw the estates on the lower slopes as acting with the forest reserve upslope as a vice on the Chagga settlement (Swynnerton 1949). Increase in irrigation infrastructure in the plains did follow, but only at a moderate pace. The Chagga tended not to prefer settlement on the plains as irrigators, and they pursued several alternative strategies. Migration from other districts in the region as well as more distant areas in Tanzania contributed significantly to increased population in the plains, which was to some extent contrary to policy.

Last is the question of explanation:

Explanations of change

'How can the present study contribute towards explanation of such changes?' (2.3).

The initial objectives were directed at improving the understanding of hill furrow irrigation. Ideally, a comprehensive treatment of the explanation of irrigation change or establishment would involve a more concentrated effort following a hypothetical deductive approach, at least if the objective is to provide a sound empirical basis to make the rejection of hypotheses possible. Change can relate to the initial choice to adopt irrigation technology, which is often the focus of historians and archaeologists as the problem of intensive agriculture. The question of change can also relate to later processes affecting investment and technological change in an irrigating society. Within this synthesis is provided a review of approaches to causation in irrigation. Some models of explanation are discussed in paper three (Tagseth 2008b), which weakens the dominant population-based explanations of hill furrow irrigation in Kilimanjaro, and calls for the consideration of several contributing factors.

The historical depth of irrigation at Mt. Kilimanjaro may make it difficult to reach conclusions about the adoption of the technology in the region based on oral history methods, but further research on the beginnings of irrigation in new locations as the system expanded may yield further knowledge. The original adoption of the technology may have been motivated by adaptation, regional specialisation or it could have been part of the development of an economically and socially differentiated local and regional economy. It would be somewhat difficult to explain irrigation as a response to the subsistence needs of the farmers alone, as other options would have been available. It would be difficult to qualify land scarcity as the motivation in the early phases (Tagseth 2008a/paper two). A long history of change in irrigation has been documented, showing phases of expansion as well as decline (Tagseth 2008a/paper two, Tagseth 2008b/paper three).

Two theses about change that have guided policy and interventions in hill furrow irrigation at Mt. Kilimanjaro were tested. According to the first of these, the system is in

Studies of the waterscape of Kilimanjaro

decline, as the furrows become redundant with development and transition to piped water supply. According to the second, conflicting thesis, the post-Independence era has seen an increase in hill furrow technology that is driven by population growth. While each of these can describe change in some localities, they are rejected for the system as a whole on the basis of data on the extent of the furrow system in periods from the 20th century. Instead, changes in the 20th century can be seen as a restructuring of hill furrow irrigation, a where decline in irrigation in the densely settled highland areas was offset by an increase in irrigation in the foothills and lowlands, and by some increase in scale. Increased knowledge about the historical process may make it more difficult to maintain single-factor explanations. The results of the present study question the prevailing emphasis on population-based explanations of hill furrow irrigation at Mt. Kilimanjaro. There was no clear correspondence between population density and the intensity of irrigation at district level in the 20th century. Population growth has been associated with both expansion and decline in different parts of the system (Tagseth 2008b/paper three). Furthermore, the establishment of a considerable hill furrow infrastructure on the slopes of Mt. Kilimanjaro predates the population expansion it has been ascribed to, and cannot be explained by it (Tagseth 2008b/paper three). Population growth and migration have interacted with other factors, such as policy, market and technological factors in restructuring irrigation at Mt. Kilimanjaro (Tagseth 2008b/paper three).

Kimambo (1996) pointed towards adaptation, emphasising how irrigation facilitated the efficient utilisation of the three agro-ecological zones through three seasons. Irrigation made sense in agronomic terms, for instance in allowing the expansion of *mchare* and other valued banana varieties into drier areas, or in the off season cultivation of finger millet in the uplands. Finger millet production appears to have been important as a motivation for scheme establishment, which raises further questions about its economic and social role. The focus on millet, a crop that could be stored and redistributed more easily than the high-yielding banana, point towards 'social production' (Brookfield 1972), or regional specialisation facilitated by trade, rather than towards subsistence. Håkansson (1995, 2003, 2007) emphasises regional specialisation and trade, with the irrigators specialising in grain production in order to barter with groups that were wealthier in livestock. Crops were exchanged for pots, iron, soda and livestock in a

Conclusions

regional network of markets, but documentation of exchange of millet for livestock with Maasai around Mt. Kilimanjaro remains somewhat thin. Exchange of millet did take place between Mt. Kilimanjaro districts, but in patterns that were more complex than an exchange between agricultural economies in the southern districts and a pastoral east as suggested by Håkansson (2007). Despite instances of abandonment related to increased hostilities, the growth in the Swahili trade was associated with an overall expansion of the system over the 19th century. Caravan provisioning may have motivated increased production, but it is reasonable to assume that the much broader economic and political changes also affected irrigation. Oral histories of commoners from Marangu emphasise social production through the importance of millet cultivation in mobilising labour, while it is clear that in the 19th century the chiefs could use millet to retain warriors and increase their power.

Twentieth century changes may involve the needs of an expanding population, but very high and rising population densities in the highlands are associated with stagnation and decline in irrigation and a regional shift towards irrigation in the less populated areas down slope. The decline in the highland irrigation can be related to a trajectory of intensification focused not on the arable, where finger millet was phased out, but on the agroforestry grove where coffee was integrated. This trajectory was reinforced by British policies favouring peasant production in coffee for the world market, and the decision to reallocate confiscated German-owned estate land to new European settlers. British and postcolonial planning pointed towards the lowlands as a Chagga population spillover zone, to be assisted by irrigation. Conflicts of interest between smallholder irrigation and the estate sector and hydropower production and poor access to funding for irrigation development led to a slow increase over the decades. Thus, development planning as well as economic policies and market factors influenced change in irrigation. Grain cultivation in the lowlands was focused on maize, with production increasing in the post-war years, allowing surpluses to enter the national market. Following Independence, Ujamaa may have suppressed maize production through low producer prices. While neoliberal development since 1986 (and declining terms of trade) has affected coffee negatively, it has stimulated food production, especially horticulture and grain production. The latter phase coincides with Japanese assistance

Studies of the waterscape of Kilimanjaro

to intensify rice production through the introduction of new technology, including a high yielding variety. This variety was widely adopted outside the project area, and facilitated intensified market-oriented irrigation in the lowlands, and restructured and intensified irrigation along the Rau River.

General conclusions

The organisation of water use

-How is the use of water for agriculture organised?

Water use for the hill furrows in Kilimanjaro is organised by groups of smallholders, around principles of kinship and neighbourhood under a furrow elder (type 1), or more formal forms of association usually under a board (type 2). The local organisation of water use is often described in terms of its norms, but extending the analysis to interaction and outcome in terms of water access improves the understanding of a socially, culturally and institutionally embedded water commons. Most of the hill furrows operate without subsidy and with few extension services, but contribute to livelihoods and food security. Water use for the hill furrows is governed by local custom, regulating the access to water for varied sets of users, and providing for resistance against outside interests in water resources and in water control.

The initiative in water management for the Pangani River Basin was motivated by concerns about the availability of water for hydropower production at the downstream location at Pangani Falls. Its formulation followed a national agenda of river basin management and increased state control over resources, but was influenced by 'market-based' and 'state-centred' ideas about good practice in water management from global water policy discourse. The more recent intention to establish a 'catchment forum' for the Kikuletwa, where user groups can be given a voice, could be seen as a licence to neo-populist ideas of participation and decentralisation. A water management organisation covering a smaller hydrological region could provide a meeting place between 'traditional' and 'modern' water management systems, or possibly a framework for incorporating 'traditional' irrigation into the state management system. The initiative was defined and implemented with little consultation with user groups,

leading to conflicts during implementation, not only over water as a resource, but also between models of water management described as ‘modern’ and ‘indigenous’. The impact of the initiative, through its measures of implementing the licence from the Water Officer as the only legitimate basis for access to water, the introduction of volumetric water pricing, and the construction of control gates, thus remained limited.

Changes in farmer managed irrigation

-What changes have occurred over time in farmer managed irrigation?

Hill furrow irrigation has a long history in the region and at Mt. Kilimanjaro, with indications of the practice in late 17th century Marangu. It is thus difficult to examine the original adoption of the technology, but change can also relate to later transformations of the practice. The construction of specific schemes has been traced to periods in the early to mid 19th century though oral history, which appears to reflect a phase of overall expansion of the system, some of which was geared to ‘social production’ and the production of tradable surpluses of finger millet. German colonisation brought European settlers and some furrow construction on mission and estate land, mostly in a belt in the foothills. In the British period, surplus production in the highlands shifted from finger millet for consumption in the region to coffee cultivation for the world market by smallholders, initiating a period of stagnation and decline in irrigation in the upslope areas under conditions of population pressure. Increased settlement facilitated by irrigation in the sparsely populated lowland areas was a policy objective from the 1930s onwards. Chagga commuted and intensified maize production in the foothills and lowlands, with maize emerging as a co-staple to that of banana while also yielding tradable surpluses. Settlement was slow due to a combination of factors; a lack of enthusiasm for lowland settlement, lack of funding for the proposed irrigation development projects, and conflicts of interest between the use of water for smallholder irrigation, estates and hydropower. Market-oriented grain production in the lowlands, which may have been suppressed by regulations during *Ujamaa* following independence, has been stimulated during the period of economic liberalisation since 1986. Together with a new rice variety, this has involved an intensification of rice production in recent decades.

Studies of the waterscape of Kilimanjaro

Comparisons from counts from historical field surveys show a stagnation or decline in districts where irrigation was long established, with a decline in the number of furrows in Marangu between 1939-40 and 1992, but stability on water abstraction explained by an increase in scale. Expanding the analysis to districts representing the three main regions of the southern slopes reveals no change in Old Moshi/ Mbokomu (1910s to 1990s), and a small increase in a part of Machame (1930s to 1990s). Irrigation has been restructured over the 20th century, with stagnation and decline in old irrigation districts which had high and rising population densities, followed by an intensification of irrigation at the extensive margin in the foothills and lowlands.

The results weaken population growth as the dominating explanation of change in irrigation. The shifting influences of several factors have to be considered in the explanation of considerable variation in irrigation from a regional and temporal perspective. Change in irrigation is part of an intensification process based on available models and technology and the adoption of new techniques and cultivars. The discussion and review provided evidence of a relationship between water use change and political economy in a broad sense, including not only the production, appropriation and circulation of surplus, regional exchange and changing connections with national and world markets, but also irrigation policy, regional development and macro-policy.

Approaching the Kilimanjaro waterscape

The famous but dwindling snows and ice of Mt. Kilimanjaro have emerged as the foremost icon of climate change from Africa, which adds to the worries about decreasing availability and increasing demand for water among local, national and international actors. These actors experience aridity and water scarcity differently, ascribe it to varying causes and prescribe diverse solutions and courses of action. This involves not only competition over water as a resource, but between different and contested ideas of good practice, and of improvement in water management, all of which have been analysed in this thesis. The approaches to water issues of Kilimanjaro reflected in this study can be explained through a concept of the waterscape that encompasses not only 'sceneries' or visions of water, but also water in a material sense

Conclusions

as a 'resource', and its 'institutional' aspects through the organisation and control over water use.

Varying visions of water have been analysed in terms of ideas of improvement in water management in the global discourse and in national water policy, in terms of a conflict between a 'modern' and an 'indigenous' water management system, and to some extent the local perception of water and irrigation. Water in a material sense has been approached through the study of changing water use, by tracing the establishment of irrigation schemes through oral history and analysing changes in populations of irrigation schemes from a diachronic and regional perspective. The institutional aspects of water were approached through the study at two scales, the first of river basin management, and the second, of the local organisation of water use in the *mfongo* irrigation systems. The combination of these three approaches has allowed a nuanced analysis of central aspects of the water problems of Kilimanjaro.

Reference list

- Aase T. H. (1994). Symbolic space. Representations in geography and anthropology. *Geografiska Annaler*, 76B(1), 51-58.
- Aase, T. H. (1997). Tolkning av kategorier. Observasjon, begrep og kategori. In E. Fossåskaret, O. L. Fuglestad & T. H. Aase (Eds.), *Metodisk feltarbeid. Produksjon og tolkning av kvalitative data* (pp. 143-166). Oslo: Universitetsforlaget.
- Adams, A. M., T. G. Evans, R. Mohammed & J. Farnsworth (1997b). Socioeconomic stratification by wealth ranking: Is it valid? *World Development*, 25(7), 1165-1172.
- Adams, W. M. (1989). Definition and development in African indigenous irrigation. *Azania*, (XXIV), 21-27.
- Adams, W. M. (1990). How beautiful is small? Scale, control and success in Kenyan Irrigation. *World Development*, 18(10), 1309-1323.
- Adams, W. M. (1992). *Wasting the rain. Rivers, people and planning in Africa*. Minneapolis: University of Minnesota Press.
- Adams, W. M. & D. M. Anderson (1988). Irrigation before development: Indigenous and induced change in agricultural water management in East Africa. *African Affairs*, 87, 519-535.
- Adams, W. M., D. Brockington, J. Dyson & B. Vira (2003). Managing Tragedies: Understanding Conflict over Common Pool Resources. *Science*, 302(5652), 1915 - 1916.
- Adams, W. M., E. Watson. & S. K. Mutiso (1997a). Water, rules and gender: Water rights in an indigenous irrigation system, Marakwet, Kenya. *Development and Change*, 28(4), 707-730.
- Anderson, D. (1984). Depression, dust bowl, demography and drought: The colonial state and soil conservation in East Africa during the 1930s. *African Affairs*, 83(332), 321-343.
- Andersson, R., F. Wänseth, M. Cuellar and U. v. Mitzlaff (2006). *Pangani Falls Re-development Project in Tanzania*. SIDA evaluation 06/09. Stockholm: SIDA, Department for Infrastructure and Economic Cooperation.

- Arusha Times (2005). Chagga want chief Meli's skull back from Germany. *Arusha Times*. Nov 5 - 11, 2005, Issue 00394. Arusha: front page. Retrieved November 09, 2005, from http://www.arushatimes.co.tz/front_page_1.htm
- Attems, M. (1967). *Bauernbetriebe in tropischen Höhenlagen Ostafrikas. Die Usambara-Berge im Übergang von der Subsistenz- zur Marktwirtschaft*. München: IFO-Institut für Wirtschaftsforschung.
- Bailey, P. & J. Mumford (1968). The changing economy of the Chagga cultivators of Marangu, Tanzania. *Geography*, (53), 163-169.
- Bakker, K. J. (2000). Privatizing water, producing scarcity: The Yorkshire Drought of 1995. *Economic Geography*, 76(1), 4-27.
- Barnett, T. (1984). Small scale irrigation in sub-Saharan Africa: sparse lessons, big problems, any solutions? *Public Administration and Development*, 4(1), 21-47.
- Baumann, O. (1891). *Usambara und seine Nachbargebiete. Allgemeine Darstellung des nordöstlichen Deutsch-Ostafrika und seiner Bewohner auf Grund einer im Auftrage der Deutsch-ostafrikanischen Gesellschaft im Jahre 1890 ausgeführten Reise*. Berlin, Reimer.
- Beez, J. (2005). *Die Ahnen essen keinen Reis. Vom lokalen Umgang mit einem Bewässerungsprojekt am Fuße des Kilimanjaro in Tansania*. (Bayreuth African Studies Working Papers 2.) University of Bayreuth: Bayreuth. Retrieved October 30, 2007, from <http://opus.ub.uni-bayreuth.de/volltexte/2005/168/>
- Behnke, R. H. J., I. Scoones & C. Kerven (Eds.) (1993). *Range ecology at disequilibrium: New models of natural variability and pastoral adaptation in African savannas*. London: ODI Publications.
- Bender, M. V. (2006). Water brings no harm: Knowledge, power, and practice on Kilimanjaro, Tanzania. Unpublished PhD thesis. Baltimore, Johns Hopkins University.
- Bender, M. V. (2008). 'For more and better water, choose pipes!' Building water and the nation on Kilimanjaro, 1961-1985. *Journal of Southern African Studies*, 34(4), 841-859.
- Bergkamp, G., B. Orlando & I. Burton (2003). *Change. Adaptation of water resources management to climate change*. Gland: IUCN.

Studies of the waterscape of Kilimanjaro

- Bernard, H. R. (1994). *Research methods in anthropology. Qualitative and quantitative approaches*. Thousand Oaks, Calif.: SAGE.
- Blaikie, P. (1985). *The political economy of soil erosion in developing countries*. Singapore, Longman Scientific & Technical.
- Blaikie, P. & H. Brookfield (Eds.) (1987). *Land degradation and society*. London: Methuen & Co.
- Blaikie, P. (1995). Changing environments or changing views. A political ecology for developing countries. *Geography*, 80(3), 203-214.
- Blaikie, P. (1998). Paradigms for environment and development. In L.de Haan & P. Blaikie (Eds.), *Looking at maps in the dark. Directions for geographical research in land management and sustainable development in rural and urban environments of the Third World*, (pp. 9-40). Utrecht: Royal Dutch Geographical Society & Faculty for Environmental Sciences, University of Amsterdam.
- Boelens, R. & B. Doornbos (2001). The battlefield of water rights: rule making amidst conflicting normative frameworks in the Ecuadorian highlands. *Human Organization*, 60(4), 343-356.
- Boelens, R., M. Zwartveen & D. Roth (2005). Legal complexity in the analysis of water rights and water resources management. In D. Roth, R. Boelens & M. Zwartveen (Eds.), *Liquid relations: Contested water rights and legal complexity* (pp. 1-20). New Brunswick, NJ, Rutgers University Press.
- Boesen, J. (1986). *Aiming too high, planning too much and achieving too little. Some lessons from rural water supply development in Tanzania before the international drinking water and sanitation decade*. CDP Project Papers A.86.5. Copenhagen: Centre for Development Research.
- Boesen, J., K. Havnevik, J. Kopponen and R. Odgaard (1986). Introduction. In J. Boesen, K. Havnevik, J. Kopponen and R. Odgaard (Eds.), *Tanzania. Crisis and struggle for survival* (pp. 19-29). Uppsala: Scandinavian Institute of African Studies.
- Börjeson, L. (2004). *A History under siege. Intensive agriculture in the Mbulu Highlands, Tanzania, 19th century to the present*. Stockholm: Acta Universitatis Stockholmiensis.

- Börjeson, L. (2007). Boserup backwards? Agricultural intensification as its own driving force in the Mbulu highlands, Tanzania. *Geografiska Annaler, Series B: Human Geography*, 89(3), 249–267.
- Börjeson, L. (2009). Using a historical map as a baseline in a land-cover change study of northeast Tanzania. *African Journal of Ecology*, 47(Suppl.1), 185-191.
- Boserup, E. (1965). *The conditions of agricultural growth: The economics of agrarian change under population pressure*. London: George Allen & Unwin.
- Boserup, E. (1976). Environment, population and technology in primitive societies. *Population and Development Review*, 2(1), 21-36.
- Boserup, E. (1983). The impact of scarcity and plenty on development. *Journal of Interdisciplinary History*, 14(2), 383-407.
- Bricolage (2009). In *Merriam-Webster Online Dictionary*. Retrieved May 8, 2009, from <http://www.merriam-webster.com/dictionary/bricolage>
- Brockington, D. & K. Homewood (2001). Degradation debates and data deficiencies. The Mkomazi game reserve, Tanzania. *Africa*, 71(3), 449-480.
- Bromley, D. W. (1992). The commons, property, and common-property regimes. D. W. Bromley, D. Feeney, M. A. McKean, P. Peters, J. L. Gilles, R. J. Oakerson, C. F. Runge & J. T. Thomson (Eds.), *Making the commons Work. Theory, practice and policy* (pp. 3-16). San Francisco: ICS Press.
- Brookfield, H. C. (1972). Intensification and disintensification in Pacific agriculture. A theoretical approach. *Pacific Viewpoint*, 13(1), 30-48.
- Brookfield, H. C. (1984). Intensification revisited. *Pacific Viewpoint*, 25(1), 15-44.
- Bruns, B. R. & R. Meinzen-Dick (2000). *Negotiating water rights*. London: ITDG Publishing.
- Burra, R. & K. van den Heuvel (1987). *Traditional irrigation in Tanzania*. Volume 3: Proposal for a District based improvement and conservation programme for the traditional irrigation sector. Dar es Salaam: SNV-TIP.
- Burton, M. A. & C. K. Chiza (1997). Water, conflicts and the environment. M. Kay, T. R. Franks & L. E. D. Smith (Eds.), *Water: Economics, management and demand* (pp. 173-180). London: Spoon Press.

Studies of the waterscape of Kilimanjaro

- Chambers, R. (1977). Men and water: the organisation and operation of irrigation. In B. H. Farmer (Ed.), *Green revolution? Technology and change in rice-growing areas of Tamil Nadu and Sri Lanka* (pp. 340-363). Macmillan: Boulder, Colorado.
- Chambers, R. (1994). The origins and practice of Participatory Rural Appraisal. *World Development*, 22(7), 953-969.
- Clack, T. A. R. (2005). Protective memoryscapes of the Chagga of Kilimanjaro, Northern Tanzania. *Azania*, (XL), 101-107.
- Clack, T. A. R. (2007). *Memory and the mountain: Environmental relations of the Wachagga of Kilimanjaro and implications for landscape archaeology*. Cambridge Monographs in African Archaeology 72 / BAR International Series 1679. Archaeopress, Oxford.
- Clack, T. (2009). Sheltering experience in underground places: thinking through precolonial Chagga Caves on Mount Kilimanjaro. *World Archaeology* 41(2), 321-344.
- Clarke, R. (1991). *Water: The international crisis*. London: Earthscan Publications.
- Cleaver, F. (2000). Moral ecological rationality, institutions and the management of common property resources. *Development and Change*, 31(2), 361-383.
- Cleaver, F. (2002). Reinventing institutions: Bricolage and the social embeddedness of natural resource management. *The European Journal of Development Research*, 14(2), 11-30.
- Cleaver, F. & T. Franks (2005). *How institutions elude design: River basin management and sustainable livelihoods*. BCID Research Paper No. 12. Bradford: Bradford Centre for International Development.
- Cleaver, F. & A. Toner (2006). The evolution of community water governance in Uchira, Tanzania: The implications for equality of access, sustainability and effectiveness. *Natural Resources Forum*, 30(3), 207-218.
- von Clemm, M. F. M. (1964). Agricultural production and sentiment on Kilimanjaro. *Economic Botany*, 18, 99-121.
- Coopey, R. & T. Tvedt (Eds.) (2006). *A history of water. Volume 2: The political economy of water*. London: I. B. Tauris.
- Cosgrove, D. (1990). An elemental division: Water control and engineered landscape. In D. Cosgrove & G. Petts (Eds.), *Water, engineering and landscape: Water*

- control and landscape transformation in the modern period* (pp. 1-11). London: Belhaven Press.
- Coward, E. W. (1979). Principles of social organization in an indigenous irrigation system. *Human Organization*, 38(1), 28-36.
- Coward, E. W. (1991). Planning technical and social change in irrigated areas. In M. M. Cernea (Ed.), *Putting people first: Sociological variables in rural development* (pp. 46-72). New York: Oxford University Press.
- Curry, J. R. (1939). Millet cultivation by the Wachagga on Kilimanjaro. *The East African Agricultural Journal*, 5(1), 386-390.
- Daluti, L. R. (1994). *Report on the agro-socio-economic situation in Pangani River Catchment*. Consultancy for NORPLAN Moshi, United Republic of Tanzania-Zonal Irrigation Office (Kilimanjaro). Moshi: Zonal Irrigation Office.
- Davidson, T. (1997). Playing by the rules: Cooperation, rules and water use in a Chagga irrigation system, Mount Kilimanjaro, Tanzania. Unpublished Cand. Polit. thesis. Dept. of Geography, Norwegian University of Science and Technology.
- Davies, M. (2006). *Outline of an applied archaeology of Pokot and Marakwet agriculture*. Paper presented at the Society for Africanist Archaeologists conference, June 22-26, 2006, Calgary. Retrieved September 20, 2007, from <http://cohesion.rice.edu/CentersAndInst/SAFA/emplibary/Davies,M.Safa2006.pdf>
- Davies, M. I. J. (2008). *Forced moves? Rethinking human-environment relationships among intensive cultivators in Eastern Africa*. Paper presented at the Sixth World Archaeological Congress, 29th June- 4th July, 2008, Dublin. Retrieved August 10, 2009, from http://www.wac6.org/livesite/precirculated/1531_precirculated.pdf
- Davies, M. I. J. (2009). Wittfogel's dilemma: Heterarchy and ethnographic approaches to irrigation management in Eastern Africa and Mesopotamia. *World Archaeology*, 41(1), 16-35.
- Denzin, N. K. (1989). *The research act: A theoretical introduction to sociological methods*. Englewood Cliffs, N.J.: Prentice Hall.
- Denzin, N. K. & Y. S. Lincoln (1994). Introduction. Entering the field of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 1-17). Thousand Oaks, California: Sage.

Studies of the waterscape of Kilimanjaro

- Department of Lands and Surveys (1952). *African population map*. Department of Lands and Surveys: Dar es Salaam.
- Derman, B. & A. Ferguson (2003). Value of water: political ecology of water reform in Southern Africa. *Human Organization*, 63(3), 277–288.
- Devenne, F. (2006). On the ‘mountain of waters’ the furrows are running dry: Rethinking Mount Kilimanjaro's irrigation system. In F. Bart, M. J. Mbonile & F. Devenne (Eds.), *Kilimanjaro. Mountain, memory, modernity* (pp.177-200). Dar es Salaam: Mkuki na Nyota publishers.
- deWalt, B. R. (1994). Using indigenous knowledge to improve agriculture and natural resource management. *Human Organization*, 53(2), 123-131.
- Dundas, C. (1924). *Kilimanjaro and its People. A History of the Wachagga, their Laws, Customs and Legends, together with Some Account of the Highest Mountain in Africa*. London: Frank Cass & Co. LTD.
- Durkheim, É. (1966 [1895]). *The rules of sociological method*. New York: Free Press. [First edition: *Les Regles de la methode sociologique*. Paris: F. Alcan.]
- Ertsen, M. (2006). Colonial irrigation: Myths of emptiness. *Landscape Research*, 31(2), 147-167.
- Ertsen, M. W. & Melosi, M. (2009). Preface. *Physics and Chemistry of the Earth*, 34(3), 107-108.
- Ethnologue report for Chaga (E30) (2005). In R. G. Gordon, R. G. Grimes, B. F. Simons, G. F. Wise, M. Ruth (Eds.), *Ethnologue: Languages of the World*. Dallas, Tex.: SIL Int. Retrieved March 20, 2009, from: http://www.ethnologue.com/14/show_family.asp?subid=2261
- Fairhead, J. & M. Leach (1995). False forest history, complicit social analysis: Rethinking some West African environmental narratives. *World Development* 23(6): 1023-1035.
- Fairhead, J. & M. Leach (1996). *Misreading the African landscape. Society and ecology in a forest-savanna mosaic*. Cambridge: Cambridge University Press.
- Falkenmark, M. (1989). The massive water scarcity now threatening Africa: Why isn't it being addressed? *Ambio*, 18(2), 112-118.

Reference list

- Falkenmark, M. & J. Lundqvist (1995). Looming water crisis: New approaches are inevitable. L. Ohlsson (Ed.), *Hydropolitics: Conflicts over Water as a Development Constraint*. London, Zed Books: 178-212.
- Falkenmark, M. & C. Widstrand (1992). Population and water resources: a delicate balance. *Population Bulletin* 47(3): 1-36.
- Fairhead, J. & M. Leach (2000). Desiccation and domination: Science and struggles over environment and development in colonial Guinea. *Journal of African History*, 41(1), 35-54.
- Feierman, S. (1974). *The Shambaa kingdom: A history*. Madison, Wis.: University of Wisconsin Press.
- Feierman, S. (1990). *Peasant intellectuals. Anthropology and history in Tanzania*. London: The University of Wisconsin Press.
- Firth, R. (1951). *Elements of social organization: Josiah Mason lectures delivered at the University of Birmingham*. London: Watts.
- Fleuret, P. (1978). Farm and market: A study of society and agriculture in Tanzania, Unpublished PhD thesis. University of California, Santa Barbara.
- Fleuret, P. (1985). The social organisation of water control in the Taita Hills, Kenya. *American Ethnologist: A Journal of the American Ethnological Association*, 12(1), 103-118.
- Fosbrooke, H. A. & P. I. Marealle (1952a). The engraved rocks of Kilimanjaro: Part 1. *Man*, 52, 161-162.
- Fosbrooke, H. A. & P. I. Marealle (1952b). The engraved rocks of Kilimanjaro: Part II. *Man* 52, 179-181.
- Fosbrooke, H. A. (1957). Early Iron Age sites in Tanganyika relative to traditional history. In Clark, D. and S. Cole (Eds.) *Proceedings of the third Pan-African Congress on Prehistory* (pp 318-325). London: Chatto and Windus.
- Franks, T. and F. Cleaver (2007). Water governance and poverty: a framework for analysis. *Progress in Development Studies* 7(4): 291-306.
- Færøyvik, F. (1995). Bonus satte fart i Norad-prosjekt. *Teknisk Ukeblad*, 8 (23/2/95), 18-19.
- Geertz, C. (1967). Tihingan: A Balinese village. In Koentjaraningrat (Ed.), *Villages in Indonesia* (pp 210-243). Ithaca: Cornell University Press.

Studies of the waterscape of Kilimanjaro

- Geertz, C. (1972). The wet and the dry: Traditional irrigation in Bali and Morocco. *Human Ecology*, 1(1), 23-29.
- Geertz, C. (1973). The interpretation of cultures. In C. Geertz, *The interpretation of cultures: Selected essays*, (pp. 3-30). New York: Basic Books.
- Geertz, C. (1983). 'From the Native's point of view': On the Nature of Anthropological Understanding. In C. Geertz, *Local knowledge. Further essays in interpretive anthropology*, (pp. 55-70). U.S.A.: Basic Books.
- Geilinger, W. (1936). The retreat of the Kilimanjaro glaciers. *Tanganyika Notes and Records*, 2, 7-20.
- Gelles, P. H. (2000). *Water and power in highland Peru: The cultural politics of irrigation and development*. New Brunswick: Rutgers University Press.
- Gillingham, P. [M. E.](1997). *Indigenous Irrigation on Mount Kilimanjaro, Tanzania. A Report to Kilimanjaro Zonal Irrigation Office and Kilimanjaro Regional Water Office*. Cambridge: P. Gillingham / Dept of Geography, University of Cambridge.
- Gillingham, M. E. (1999). Gaining access to water: Formal and working rules of indigenous irrigation management on Mount Kilimanjaro, Tanzania. *Natural Resources Journal*, 39(3), 419-441.
- Gillman, C. (1932). Some geographical controls in East Africa. *The South African Geographical Journal*, 15, 3-14.
- Gillman, C. (1936). A population map of Tanganyika Territory. *Geographical Review*, 26(3), 353-375.
- Gillson L, M. Sheridan & D. Brockington (2003). Representing environments in flux: Case studies from East Africa, *Area*, 35(4): 371-389.
- Glick, T. F. (1970). *Irrigation and society in medieval Valencia*. Cambridge, Mass.: Harvard University Press.
- Goldsmith, E. & N. Hildyard (1984). The lessons of traditional irrigation agriculture: Learning to live with nature. In E. Goldsmith & N. Hildyard (Eds.), *The social and environmental effects of large dams: Volume 1: Overview* (pp 329-343). Cornwall: Wadebridge Ecological Centre.
- Goldsmith, E. (1998). The lessons of traditional irrigation agriculture: Learning to live with nature. *The Ecologist*, 28(3), 162-170.

- Gomes, N. (2004). Canal Management and Flood control in Jowhar district in Somalia. Workshop on Irrigation Systems Management in Eastern Africa, October 27. 2004, Maison Française, Nairobi.
- Gourou, P. (1966 [1947]). *The Tropical World. Its Social and Economic Conditions and its Future Status*. London: Longman, Green & Co. Ltd. [First published as *Les pays tropicaux. Principes d'une géographie humaine et économique*, Paris: PUF.]
- Gray, R. F. (1963). *The Sonjo of Tanganyika: An Anthropological Study of an Irrigation-based Society*. London: Oxford University Press.
- Griffith, A. W. (1930). Chagga land tenure report Moshi District: Government of Tanganyika. [Document in UDSM East Africana collection: EAF Cory 272]
- Grove, A. (1993). Water use by the Chagga on Kilimanjaro. *African Affairs* 92(368), 431-448.
- Gutmann, B. (1913). Feldbausitten und Wachstumsbräuche der Wadchagga. *Zeitschrift für Ethnologie*, 45, 474-511.
- Gutmann, B. (1926). *Das Recht der Dschagga*. München: Beck.
- Gutmann, B. (1958 [1932]). *The tribal teachings of the Chagga. Volume 1 [Die Stammeslehren der Dschagga*. München: Beck]. New Haven: Human relations Area Files.
- Guttormsen, O. & B. A. S. Luhumbika (1995). *Pangani Basin water management. Quarterly progress report for the period July- September 1995*. Hale: United Republic of Tanzania, MWEM-Pangani Basin Water Office & IVO-NORPLAN.
- Håkansson, T. (1989). Social and political aspects of intensive agriculture in East Africa: some models from Cultural Anthropology. *Azania*, (24), 12-20.
- Håkansson, N. T. (1995). Irrigation, population pressure, and exchange in precolonial Pare, Tanzania. *Research in Economic Anthropology: A Research Annual*, 16, 297-323.
- Håkansson, N. T. (2003). Livestock and the development of indigenous irrigation in East Africa. Second PLATINA workshop, Usa River, 17-19 October 2002. Dahlberg, A, H. Öhberg, S. Trygger, K. Holmgren & P. Lane (Eds.) *Working Paper from the Environment and Development Studies Unit*, (46), 28-30. Stockholm: The University of Stockholm and the British Institute in East Africa.

Studies of the waterscape of Kilimanjaro

- Håkansson, T. (2007). The decentralized landscape. Regional wealth and the expansion of production in Northern Tanzania before the eve of colonialism. In L. Cliggett & C. A. Pool (Eds.), *Economies and the transformation of landscape* (pp. 239-265). Plymouth: Alta Mira Press.
- Håkansson, N. T. (2008). Regional political ecology and intensive cultivation in pre-colonial and colonial South Pare, Tanzania. (In M. Widgren, N. T. Håkansson and L. Börjeson (Eds.), *The political ecology of trade, food production, and landscape transformations in Northeast Tanzania 1850-2000.*) *The International Journal of African Historical Studies*, 41, 3, 433-459.
- Håkansson, N. T. & M. Widgren (2007). Labour and landscapes: the political economy of landesque capital in 19th century Tanganyika. *Geografiska Annaler*, 89B(3), 233–248.
- Håkansson, T., M. Widgren, & L. Börjeson (2008). Historical and regional perspectives on landscape transformations in Northeast Tanzania, 1850-2000. (In M. Widgren, N. T. Håkansson and L. Börjeson (Eds.), *The political ecology of trade, food production, and landscape transformations in Northeast Tanzania 1850-2000.*) *International Journal of African historical Studies*, 41, 3, 455-459.
- Hammersley, M. and P. Atkinson (1995). *Ethnography: Principles in practice*. London: Routledge.
- Hastenrath, S. & L. Greischar (1997). Glacier recession on Kilimanjaro, East Africa, 1912-89. *Journal of Glaciology*, 43(145), 455-459.
- Havnevik, K. J. (1993). *Tanzania : the limits to development from above*. Sweden: Nordiska Afrikainstitutet and Mkuki na Nyota Publishers.
- Hemp, A. (2005). Climate change-driven forest fires marginalize the impact of ice cap wasting on Kilimanjaro. *Global Change Biology*, 11, 1013-1023.
- Herbert, S. (2000). For ethnography. *Progress in Human Geography*, 24(4), 550-568.
- Hoag, H. (2003). Designing the delta: A history of water and development in the Lower Rufiji River Basin. Unpublished PhD thesis. Graduate School of Arts and Sciences. Boston: Boston University.
- Holand, I. S. (1996). More people, more trees. Population growth, the Chagga irrigation system, and the expansion of a sustainable agroforestry system on Mount

- Kilimanjaro. Unpublished Cand. Polit. thesis. Trondheim, Norwegian University of Science and Technology.
- Homewood, K., P. Kristjanson, P. C. Trench (2009). Changing land use, livelihoods and wildlife conservation in Maasailand. In Homewood, K., P. Kristjanson, P. C. Trench (Eds.), *Staying Maasai?: Livelihoods, Conservation and Development in East African Rangelands* (pp. 1-42). New York: Springer.
- Howard, M. T. & A. V. Millard (1997). *Hunger and shame: Poverty and child malnutrition on Mount Kilimanjaro*. New York: Routledge.
- Huijzendveld, F. (2008). Changes in political economy and ecology in West-Usambara, Tanzania: ca. 1850-1950. (In M. Widgren, N. T. Håkanson and L. Börjeson (Eds.), *The political ecology of trade, food production, and landscape transformations in Northeast Tanzania 1850-2000.*) *The International Journal of African Historical Studies*, 41, 3, 383-409.
- Hunt, R. C. & E. Hunt (1976). Canal irrigation and local social organization. *Current Anthropology*, 17(3), 389-398. [Comments, 398-405, Reply, 405-409.]
- Huntingford, G. W. B. (1933). The Azanian civilization of Kenya. *Antiquity*, 7, 133-165.
- International Conference on Water and the Environment (1992). The Dublin statement on water and sustainable development. International Conference on Water and the Environment, Dublin. January 31, 1992. Retrieved October 22, 2007, from <http://un-documents.net/h2o-dub.htm>
- Irrigation (2008). *World Encyclopedia. Oxford Reference Online* [online]. Retrieved April 22, 2009, from <http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t142.e5870>
- IUCN (2003). *Pangani Basin: A situation analysis*. Nairobi: International Union for the Conservation of Nature and Natural Resources-Eastern Africa Programme.
- Johansson, I. (1983). *Nordic Glossary of Hydrology*. Stockholm: Almqvist & Wiksell International.
- Johnson, C. (2004). Uncommon ground: The 'poverty of history' in common property discourse. *Development and Change*, 35(3), 407-434.

Studies of the waterscape of Kilimanjaro

- Johnston, H. H. (1886). *The Kilima-njaro expedition. A record of scientific exploration in eastern equatorial Africa. And a general description of the natural history, languages, and commerce of the Kilima-njaro district*. London: Kegan, Paul Trench and Co.
- Juma, I. H., & Maganga, F. P. (2005). Current reforms and their implications for rural water management in Tanzania. *International workshop on African water laws: Plural legislative frameworks for water management in Africa*. 26-28 January 2005, Johannesburg. Retrieved July 6, 2009, from:
<http://www.nri.org/waterlaw/AWLworkshop/JUMA-IH.pdf>
- Juuti, P. S., T. S. Katko & H. Vuorinen (Eds.) (2007). *Environmental history of water. Global views on community water supply and sanitation*. London: IWA publishing.
- Kaika, M. (2003). Constructing scarcity and sensationalising water politics: 170 days that shook Athens. *Antipode*, 35(5), 919-954.
- Kaika, M. (2006). The political ecology of water scarcity. The 1989-1991 Athenian drought. In E. Swyngedouw, N. Heynen & M. Kaika (Eds.), *In the nature of cities. Urban political ecology and the politics of urban metabolism* (pp 157-172). London, Routledge.
- Kersten, O. (1869). *Baron Carl Claus von der Decken's Reisen in Ost-Afrika in den Jahren 1859 bis 1865*. vol 1. Leipzig and Heidelberg: C.F. Wintersche Verlagshandlung.
- Kimambo, I. (1996). Environmental control and hunger. In G. Maddox, Giblin, J. & Kimambo, I, *Custodians of the land. Ecology and Culture in the history of Tanzania* (pp. 71-95). London: James Currey Ltd.
- Kipepeo Tours (2009). Marangu culture tourism. Retrieved June 29, 2009, from:
http://www.infohub.com/vacation_packages/22803.html
- Kissawike, K. (2008). *Irrigation-based livelihood. Challenges and opportunities. A gendered technography of irrigation development intervention in the Lower Moshi Irrigation Scheme in Tanzania*. PhD thesis. Wageningen: Wageningen Universiteit.
- Kitunga, D. (1989). *The role of women in traditional irrigation*. Dar es Salaam: SNV - Traditional Irrigation Improvement Programme.

- van Koppen, B. (2003). Water reform in Sub-Saharan Africa: What is the difference? *Physics and Chemistry of the Earth*, 28, 1047–1053.
- van Koppen, B., Sokile, C. S., Lankford, B. A., Hatibu, N., Mahoo, H., Yanda, P. Z. (2007). Water Rights and Water Fees in Rural Tanzania. In F. Molle and J. Berkhoff (Eds.), *Irrigation Water Pricing: The Gap Between Theory and Practice* (pp. 143-164). Wallingford: CAB International.
- Krugmann, H. (1996). Water Management, Use, and Conflict in Small-scale Irrigation: The Case of Rombo in the Kenyan Maasailand. In E. Rached, E. Rathgeber & D. B. Brooks (Eds.), *Water management in Africa and the Middle East. Challenges and opportunities* ([no pagination]). Ottawa: IDRC. Retrieved April 7, 2008, from http://www.idrc.ca/en/ev-31162-201-1-DO_TOPIC.html
- Lakoff, G. & M. Johnston (2003). *Metaphors we live by*. 2nd edition. Chicago: The University of Chicago Press.
- Lankford, B. & T. Beale (2007). Equilibrium and non-equilibrium theories of sustainable water resources management: Dynamic river basin and irrigation behaviour in Tanzania. *Global Environmental Change – Human and Policy Dimensions*, 17(2), 168-180.
- Lansing, J. S. (1987). Balinese 'water temples' and the management of irrigation. *American Anthropologist*, 89(2), 326-341.
- Lansing, J. S. (1991). *Priests and programmers: Technologies of power in the engineered landscape of Bali*. Princeton, N.J.: Princeton University Press.
- Lansing, J. S. (2004). Irrigation Societies. N. J. Smelser & P. B. Baltes (Eds.) *International encyclopaedia of the social & behavioral sciences* (pp. 7910-7913). Amsterdam: Elsevier.
- Leach, E. R. (1959). Hydraulic Society in Ceylon. *Past and Present*, (15), 2-26.
- Leach, E. R. (1961). *Pul Eliya. A village in Ceylon*. Cambridge: The syndics of the Cambridge University Press.
- Leach, M. & R. Mearns (1996). Environmental change and policy. Challenging the received wisdom in Africa. In M. Leach & R. Mearns (Eds.), *The lie of the land. Challenging the received wisdom of the African environment* (pp. 1-33). Oxford: James Currey.

Studies of the waterscape of Kilimanjaro

- Leach, M., R. Mearns & I. Scoones (1999). Environmental entitlements: dynamics and institutions in community-based natural resource management. *World Development*, 27(2), 225-247.
- Lee, D. & H. Newby (1983). *The problem of sociology*. London: Unwin Hyman.
- Lein, H. (1998). Traditional versus modern water management systems in Pangani river basin, Tanzania. In L. de Haan & P. Blaikie (Eds.), *Looking at maps in the dark. Directions for geographical research in land management and sustainable development in rural and urban environments of the Third World* (pp. 52-64). (Netherlands Geographical Studies 240) Utrecht: Royal Dutch Geographical Society & Faculty for Environmental Sciences, University of Amsterdam.
- Lein, H. (2004). Managing the water of Kilimanjaro: Water, peasants, and hydropower development. *GeoJournal*, 61(2), 155-162.
- Lein, H. & M. Tagseth (2009) Tanzanian water policy reforms – between principles and practical applications. *Water Policy*, 11(02), 203-220.
- Lerise, F. S. (2005). *Politics in land and water use management: Study in Kilimanjaro, Tanzania*. New Dehli: Mkuki na Nyota Publishers.
- Lévi-Strauss, C. (1966). *The savage mind*. Chicago: University of Chicago Press.
- Lightfoot, D. R. (2000). The origin and diffusion of Quans in Arabia: New evidence from the northern and southern peninsula. *The Geographical Journal*, 166(3), 215-226.
- Lindberg, C., V.-M. Loiske, C. Mung'ong'o & W. Östberg (1993). Handle with care! : Rapid studies and the poor. *Working paper from the Environment and Development Studies Unit*, 24. Stockholm, School of Geography - Stockholm University.
- Loftus, A. (2006). Reification and the dictatorship of the water meter. *Antipode*, 38(5), 1023–1045.
- Loftus, A. & F. Lumsden (2008). Reworking hegemony in the urban waterscape. *Transactions of the Institute of British Geographers*, 33(1), 109–126.
- Lund, C. (2001). Seeking certainty and aggravating ambiguity: On property, paper and authority in Niger, *IDS Bulletin* 32(4): 47-53.
- McCall, J. C. (1995). Rethinking ancestors in Africa. *Africa*, 65(2), 256-270.

- McGregor, S. (2008). Tanzania: Poverty reduction slow despite economic growth. *IPS (Inter Press Service News Agency)*. December 4. Dar es Salaam: IPS.
- Maganga, F. P. (2002). The interplay between formal and informal systems of managing resource conflicts: Some evidence from South-Western Tanzania. *The European Journal of Development Research*, 14(2), 51-70.
- Maganga, F. P., H. L. Kiwasila, I. H. Juma & J. A. Butterworth (2004). Implications of customary norms and laws for implementing IWRM: Findings from Pangani and Rufiji basins, Tanzania. *Physics and Chemistry of the Earth*, 29, 1335-1342.
- Maghimbi, S. (2007). Recent changes in crop patterns in the Kilimanjaro region of Tanzania: The decline of coffee and the rise of maize and rice. *African Study Monographs*, Suppl.35, 73-83.
- Marealle, P. I. (1947). *Maisha ya Mchagga hapa duniani na ahera. (The life of a Mchagga on Earth and after Death)*. Nairobi: The English press.
- Maro, P. S. (1974). Population and land resources in Northern Tanzania: The dynamics of change, 1920-1970. Unpublished PhD thesis. Minneapolis: University of Minnesota.
- Maro, P. S. (1988). Agricultural land management under population pressure: The Kilimanjaro Experience, Tanzania. *Mountain research and development*, 8(4), 273-282.
- Marx, K. (1979 [1853]). The British rule in India. In *Marx and Engels: Collected works*. V. 12 (pp 125-134). London: Lawrence & Wishart. [First published as The British rule in India. *New York Daily Tribune*, June 25, 1853].
- Marx, K. (1973 [1939]). *Grundrisse: Foundations of the critique of political economy*. New York: Vintage Books. [First published as *Grundrisse der Kritik der Politischen Ökonomie*. Moscow: Rohentwurf].
- Masao, F. T. (1974). The Irrigation system in Uchagga: an ethno-historical approach. *Tanzania Notes and Records*, (75), 1-8.
- Mascarenhas, A., J. Ngana & M. Yoshida (1985). *Opportunities for irrigation development in Tanzania*. Tokyo: Institute of Developing Economies.
- Masty, S. M. & C. J. Komba (2001). Tanzanian privatisation song. Retrieved October 25, 2007, from

Studies of the waterscape of Kilimanjaro

<http://rru.worldbank.org/Themes/PromotingReform/Communications/TanzaniaSinging/CaptainJohnLyrics.aspx>

- Mbonile, M. J. (2005). Migration and intensification of water conflicts in the Pangani River Basin, Tanzania. *Habitat International*, 29(1), 41-67.
- Mehari, A., B. V. Koppen, M. McCartney, B. Lankford (2009). Uncharted innovation? Local reforms of national formal water management in the Mkoji sub-catchment, Tanzania. *Physics and Chemistry of the Earth, Parts A/B/C*, 34(4-5), 299-308.
- Mehta, L. (2001). The manufacture of popular perceptions of scarcity: Dams and water-related narratives in Gujarat, India. *World Development*, 29(12), 2025-2041.
- Mehta, L. (2007). Whose scarcity? Whose property? The case of water in western India. *Land Use Policy*, 24(4), 654-663.
- Mehta, L., M. Leach, P. Newell, I. Scoones, K. Sivaramakrishnan & S-A. Way (1999). *Exploring Understandings of Institutions and Uncertainty: New Directions in Natural Resource Management*. IDS Discussion Paper 372. Brighton: Institute for Development Studies.
- Mehta, L., M. Leach & I. Scoones. (2001). Environmental governance in an uncertain world. *IDS Bulletin*, (32), 1-9.
- Meinzen-Dick, R. & B. R. Bruns (2000). Introduction. In B. R. Bruns & R. Meinzen-Dick (Eds.), *Negotiating Water Rights* (pp. 23-55). London: ITDG Publishing.
- Meinzen-Dick, R. & L. Nkonya (2005). Understanding legal pluralism in water rights: lessons from Africa and Asia. In Van Koppen, B., J. Butterworth & I. Juma (Eds.), *African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa. An International Workshop* (Chapter 8). Johannesburg: Natural Resources Institute. Retrieved June 11, 2008, from <http://www.nri.org/projects/waterlaw/AWLworkshop/MEINZEN-DICK-R.pdf>
- Mels, T. (2005). Political landscapes as pleasant places - The low countries around 1600. In T. Peil & M. Jones (Eds.), *Landscape, law and justice* (pp. 41-48). Oslo: Novus Forlag.
- Meyer, H. (1890). *Ostafrikanische Gletscherfahrten: Forschungsreisen im Kilimandscharo-Gebiet*. Duncker & Humblot: Leipzig.

Reference list

- Miles, M. B. & A. M. Huberman (1984). *Qualitative data analysis. A sourcebook on new methods*. New Dehli: Sage publications.
- Mölg, T., N. J. Cullen, D. R. Hardy, G. Kaser & L. Klok (2008). Mass balance of a slope glacier on Kilimanjaro and its sensitivity to climate. *International Journal of Climatology* 28, 881-892.
- Moore, S. F. (1973). Law and social change. The semi-autonomous social field as an appropriate subject of study. *Law and Society Review*, 7, 719-746.
- Moore, S. F. (1986). *Social facts and fabrications. 'Customary' law on Kilimanjaro 1880-1980*. Cambridge: Cambridge University Press.
- Morgan, G. (2006). *Images of organization*. Updated edition. Thousand Oaks, Calif.: Sage.
- Mosgrove, D. L. (1998). Watering African moons: Culture and history of irrigation design on Kilimanjaro and beyond. Unpublished PhD thesis. Cornell: Cornell University.
- Mosha, R. S. (2000). *The heartbeat of indigenous Africa : A study of the Chagga educational system*. New York: Garland Publishing.
- Mosse, D. (1997). The symbolic making of a common property resource: History, ecology and locality in a tank-irrigated landscape in South India. *Development and Change* 28(3): 467-504.
- Mosse, D. (2003). *The rule of water. Statecraft, ecology and collective action in South India*. Oxford: Oxford University Press.
- Mote, P. W. & G. Kaser (2007). The shrinking glaciers of Kilimanjaro: Can global warming be blamed? *American Scientist*, 95(4), 308-316.
- Mshana, R. R. (1992). *Insisting upon people's knowledge to resist developmentalism. - Peasant communities as producers of knowledge for social transformation in Tanzania*. Frankfurt: Verlag für Interkulturelle Kommunikation.
- Mujwahuzi, M. R. (2001). Water use conflicts in the Pangani Basin, an overview. In J. O. Ngana (Ed.), *Water resources management in the Pangani River Basin. Challenges and opportunities* (pp. 128-137). Dar es Salaam: Dar es Salaam University Press.

Studies of the waterscape of Kilimanjaro

- Mujwahuzi, M. R. (2002). *Drawers of water II. 30 years of change in domestic water use & environmental health in East Africa. Tanzania country study*. London: IIED.
- Mung'ong'o, C. (1997). Pangani dam versus the people. In A. D. Usher (Ed.), *Dams as aid. A political anatomy of Nordic development thinking* (pp. 105-118). London: Routledge.
- Mung'ong'o, C. G. (2009). Political ecology: a synthesis and search for relevance to today's ecosystems conservation and development. *African Journal of Ecology*, 47(s1), 192 - 197.
- National Environmental Secretariat (1992). *An introduction to participatory rural appraisal for natural resources management*. Nairobi: National Environmental Secretariat, Ministry of Environment and Natural Resources.
- Netting, R. M. (1974). The system nobody knows: Village irrigation in the Swiss Alps. In T. Downing and M. Gibson (Eds.), *Irrigation's impact on society* (pp. 67-75). Tucson: University of Arizona Press.
- Ngana, J. O. (2002a). Diminishing water resources and increasing water demands. Strategies for sustainable water resources management. The case of Pangani River Basin in Tanzania. In J. O. Ngana (Ed.), *Water resources management. The case of Pangani River Basin. Issues and approaches* (pp. 90-100). Dar es Salaam: Dar es Salaam University Press.
- Ngana, J. O. (Ed.) (2002b). *Water resources management . The case of Pangani River Basin. Issues and approaches*. Dar es Salaam: Dar es Salaam University Press.
- Niemeijer, D. (1996). The dynamics of African agricultural history: Is it time for a new development paradigm? *Development and Change*, 27(1), 87-110.
- ODI Water Policy Programme (2002). The 'water crisis': Faultlines in global debates. *Water Policy Brief*, (1), 1-4.
- Odnor, K. (1971). A preliminary report on an archaeological survey on the slopes of Kilimanjaro. *Azania*, (6), 131-49.
- Odnor, K. (2000). *Tradition and transmission. Bantu, Indo-european and Circumpolar great traditions*. Bergen: Norse Publications.
- OECD (1996). Development cooperation review series - Norway. n.14. Paris: OECD Development Assistance Committee.

- Öhman, M.-B. (2007). *Taming exotic beauties: Swedish hydro power constructions in Tanzania in the era of development assistance, 1960s - 1990s*. Doctoral Thesis. Stockholm: Royal Institute of Technology (KTH).
- Olwig, K. R. (1996). Recovering the substantive nature of landscape. *Annals of the Association of American Geographers*, 86(4), 630-653.
- Olwig, K. R. (2001). 'Time out of mind'-'mind out of time'. Custom and tradition in environmental heritage research and interpretation. *International Journal of Heritage Studies*, 7, 339-354.
- Östberg, W. (2004). The expansion of Marakwet hill-furrow irrigation in the Kerio Valley of Kenya. In M. Widgren & J. E. G. Sutton.(Eds.), *Islands of intensive agriculture in eastern Africa* (pp. 19-48). Irthlingborough: James Currey Ltd.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.
- Ostrom, E. (1992a). *Crafting institutions for self-governing irrigation systems*. San Francisco: ICS Press.
- Ostrom, E. (1992b). The rudiments of a theory of the origins, survival and performance of common-property institutions. D. W. Bromley, D. Feeney, M. A. McKean, P. Peters, J. L. Gilles, R. J. Oakerson, C. F. Runge & J. T. Thomson (Eds.), *Making the commons work. Theory, practice and policy* (pp. 293-318). San Francisco: ICS Press.
- Pálsson, G. (1990). Introduction. In G. Pálsson (Ed.), *From water to world-making* (pp. 7-21). Uppsala: Nordiska Afrikainstitutet.
- Parker, P. M. (2008). *Webster's Vunjo-English thesaurus dictionary*. Fontainebleau: INSEAD.
- Philippson, G. and M.-L. Montlahuc (2003). Kilimanjaro Bantu (E60 and E74). In D. Nurse and G. Philippson (Eds.), *The Bantu languages* (pp. 475-500). Great Britain: Routledge.
- Philippson, G. & M.-L. Montlahuc (2006). Before Coffee, a Pre-Colonial Agricultural Glossary. In F. Bart, M. J. Mbonile & F. Devenne (Eds.), *Kilimanjaro. Mountain, memory, modernity* (pp. 59-70). Dar es Salaam: Mkuki na Nyota publishers.

Studies of the waterscape of Kilimanjaro

- Porter, P. W. & N. J. W. Thrower (1966). Annals map supplement. Number six: East Africa-population distribution. *Annals of the Association of American Geographers* 56(1), 180.
- Postel, S. (1992). *The last oasis*. London: Earthscan Publications Limited.
- Radcliffe-Brown, A. R. (1935). On the concept of function in social science. *American Anthropologist*, 37(3), 394-402.
- Radcliffe-Brown, A. R. (1952). *Structure and Function in Primitive Society: Essays and Addresses*. London: Cohen & West.
- Raum, O. F. (1940). *Chaga childhood: A description of indigenous education in an East African tribe*. London: Oxford University Press.
- Reed-Erichsen, M. (2003). Negotiations over rights to water. The process of determining allocation of water between farmers and estates, in the context of coffee-producing estates in Kilimanjaro region-Tanzania. Unpublished Cand. Polit. Thesis. Department of Geography, Norwegian University of Science and Technology.
- Rice, X. (2008, July 28). Biwater fails in Tanzanian damages claim. *The Guardian*. [online], no pagination. Retrieved April 16, 2009, from <http://www.guardian.co.uk/business/2008/jul/28/utilities.tanzania>
- Roe, E. M. (1991). Development narratives, or making the best of blueprint development. *World Development*, 19, 287-300.
- Røhr, P. C., Å. Killingtveit, G. M. Nderingo & P. E. Kigadye (2001). Water and environmental conflicts in the Pangani River Basin - Hydropower or irrigation? Hydropower in the new millennium, Bergen, June 20th-22nd 2001.
- Røhr, P. C. (2003). *A hydrological study concerning the southern slopes of Mt Kilimanjaro, Tanzania*. Dr. Ing. thesis. Doctoral thesis 239/2003. Trondheim: Norwegian University of Technology and Science. Retrieved June 19, 2008, from <http://urn.uu.se/resolve?urn=urn:nbn:no:ntnu:diva-239>
- Rudberg, T. (1994). Spilt vann kan koste Tanzania norsk støtte for 400 mill. *NTB*. 29.06.1994. Oslo: NTB.
- Sabatier, P. A. (1992). Review: Governing the commons: The evolution of institutions for collective action by Elinor Ostrom. *The American Political Science Review*, 86(1), 248-249.

- Sandström, K. (1995). *Forests and Water - Friends or Foes? : Hydrological Implications of Deforestation and Land Degradation in Semi-arid Tanzania*. Linköping studies in arts and science 120. Linköping: University of Linköping.
- Scoones, I. (1999). New ecology and the social sciences: What prospects for a fruitful engagement? *Annual Review of Anthropology*, 28, 479-507.
- Scott, J. C. (1976). *The Moral Economy of the peasant: Rebellion and Subsistence in Southeast Asia*. New Haven: Yale University Press.
- Scott, J. C. (1985). *Weapons of the weak: Everyday forms of peasant resistance*. New Haven, Conn.: Yale University Press.
- Scott, J. C. (1998). *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven: Yale University Press.
- Sen, A. (1980). Famines. *World Development*, 8(9), 613-621.
- Selvik, I. (1996). Cooperatives in Tanzania - From Government control to liberalisation. Response and attitudes among coffee producing smallholders in the Kilimanjaro Region. M. Phil thesis. Department of Human Geography, University of Oslo.
- Sevaldsen, K. (1997). Competing interests and growing demand for water: Irrigation in the lowlands of Kilimanjaro: The case of Makuyuni Ward. Cand. polit. thesis. Department of Geography, Norwegian University of Science and Technology. Trondheim: K. Sevaldsen.
- Sheridan, M. J. (2001). Cooling the land: Politics, ecology, and culture in the North Pare Mountains of Tanzania. Unpublished PhD thesis. Boston: Boston University.
- Sheridan, M. J. (2002). An irrigation intake is like a uterus: Culture and agriculture in precolonial North Pare, Tanzania. *American Anthropologist*, 104(1), 79-92.
- Sheridan, M. (2008). Tanzanian ritual perimetrics and the African landscapes: The case of *dracaena*. *International Journal of African Historical Studies*, 41(3), 491-521.
- Sokile, C. S., W. Mwaruvanda & B. van Koppen (2005). Integrated water resource management in Tanzania: Interface between formal and informal institutions. In Van Koppen, B., J. Butterworth & I. Juma (Eds.), *African water laws: Plural legislative frameworks for rural water management in Africa. An international workshop*. Johannesburg: Natural Resources Institute: 28.1-28.13. Retrieved June 11, 2008, from <http://www.nri.org/projects/waterlaw/AWLworkshop/SOKILE-C.pdf>

Studies of the waterscape of Kilimanjaro

- Soper, R. (1983). A survey of the irrigation systems of the Marakwet. In B. E. Kipkorir, R. C. Soper & J. W. Ssenyonga (Eds.), *Kerio Valley. Past, present, future. Proceedings of a seminar held in Nairobi at the Institute of African Studies, University of Nairobi. May 21-22, 1981* (pp. 75-95). Nairobi: Institute of African Studies.
- Southall, A. W. (1961). Population movements in East Africa. In K. M. Barbour & R. M. Prothero (Eds.), *Essays on African Population* (pp 157-192). London: Routledge & Kegan Paul.
- Spear, T. (1993). Being 'Maasai', but not 'people of cattle. In T. Spear and R. Waller (Eds.), *Being Maasai: Ethnicity and identity in East Africa* (pp 120-136). London: James Currey.
- Spear, T. (1997). *Mountain farmers: Moral economies of land & agricultural development in Arusha & Meru*. Oxford, James Currey.
- Spear, T & D. Nurse (1992). Maasai farmers: The evolution of Arusha agriculture. *The International Journal of African Historical Studies*, 25(3), 481-503.
- Stahl, K. (1964). *History of the Chagga people of Kilimanjaro*. London: Mouton & Co.
- Stahl, K. M. (1965). Outline of Chagga history. *Tanganyika Notes and Records*, (64), 35-49.
- Stump, D. (2006a). The development and expansion of the field and irrigation systems at Engaruka, Tanzania. *Azania*, (XLI), 69-74.
- Stump, D. (2006b). Towards an applied archaeology of east African intensive agricultural systems. Unpublished PhD thesis. The Institute of Archaeology, London University College. London: London University College.
- Stump, D. & M. Tagseth (2009). The history of precolonial and early colonial agriculture on Kilimanjaro: A review. In T. Clack (Ed.) *Culture, History and Identity: Landscapes of Inhabitation in the Mount Kilimanjaro Area, Tanzania. Essays in Honour of Paramount Chief Thomas Lenana Mlangi Marealle II (1915-2007)* (pp. 89-105). (BAR International Series 1966). Oxford: Archaeopress.
- Sutton, J. E. G. (1984). Irrigation and soil-conservation in African agricultural history with a reconsideration of the Inyanga terracing (Zimbabwe) and Engaruka irrigation works (Tanzania). *The Journal of African History*, 25(1), 25-41.
- Sutton, J. E. G. (1989). Towards a history of cultivating the fields. *Azania*, (24), 98-112.

- Sutton, J. E. G. (2004). Engaruka. In M. Widgren & J. E. G. Sutton (Eds.), *Islands of intensive agriculture in eastern Africa* (pp. 114-132) Irthlingborough: James Currey Ltd.
- Swift, J. (1996). Desertification. Narratives, winners & losers. In M. Leach & R. Mearns (Eds.), *The lie of the land. Challenging the received wisdom of the African environment* (pp. 73-90) Oxford: James Currey.
- Swyngedouw, E. (1999). Modernity and hybridity: Nature, regeneracionismo, and the production of the Spanish waterscape 1890-1930. *Annals of the Association of American Geographers*, 89(3), 443-465.
- Swyngedouw, E. (2004). *Social power and the urbanization of water. Flows of power*. Oxford: Oxford University Press.
- Swynnerton, R. J. M. (1949). Some problems of the Chagga on Kilimanjaro. *East African Agricultural Journal (Amani)*, 15 (January), 117-32.
- Tagseth, M. (2000a). Knowledge and development in mifongo irrigation systems. Three case studies from Mt. Kilimanjaro, Tanzania. Cand. Polit. thesis, Norwegian University of Science and Technology. Trondheim: M. Tagseth.
- Tagseth, M. (2000b). Geographical studies. In M. Tagseth (Ed.), *Water management in the Pangani River Basin, Tanzania. A report on an ongoing multidisciplinary research co-operation, based on a workshop in Trondheim 13 April 2000* (pp. 24-32). Trondheim: Development studies and Co-operation Initiative, Norwegian University of Science and Technology.
- Tagseth, M. (2000c) (Ed.). *Water management in the Pangani River Basin, Tanzania. A report on an ongoing multidisciplinary research co-operation, based on a workshop in Trondheim 13 April 2000*. Trondheim: Development Studies and Co-operation Initiative, Norwegian University of Science and Technology.
- Tagseth, M. (2002a). Contested waters. Issues in water management for the Pangani Basin. In G. Setten & S. Rudsar (Eds.) *Geographical Methods. Power and morality in geography. Proceedings of the annual conference of the Norwegian Geographical Society. Acta Geographica. Series A, No. 2*. Trondheim: Department of Geography, Norwegian University of Science and Technology: 227-235.

Studies of the waterscape of Kilimanjaro

- Tagseth, M. (2002b) Local practices and changes in farmer managed irrigation in the Himo Catchment, Mt. Kilimanjaro. In J. O. Ngana (Ed.), *Water resources management. The case of Pangani River Basin. Issues and approaches* (pp. 48-63). Dar es Salaam: Dar es Salaam University Press.
- Tagseth (2003) Genealogy as a source to the establishment of water furrows. Examples from Mt. Kilimanjaro, Tanzania. In A. Dahlberg, H. Öhberg, S. Trygger, K. Holmgren, & P. Lane (Eds.) Second PLATINA workshop 17-19 October 2002 Usa River, Arusha, Tanzania. *Working Paper from the Environment and Development Studies Unit 46*, 36-37. Stockholm: The University of Stockholm and the British Institute in East Africa.
- Tagseth, M. (2004). Three approaches to landscape and environmental history in Africa. Unpublished paper presented at the workshop 'Landscape: scenery and practice' in Lund, 24.09.04 - 26.09.04.
- Tagseth, M. (2006). The 'mfongo' irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania. In T. Tvedt & E. Jakobsson (Eds.), *A history of water. Volume 1: Water control and river biographies* (pp. 488-506). I. B. Tauris: London.
- Tagseth, M. (2008a). Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania. *Norwegian Journal of Geography*, 62(1), 9-22.
- Tagseth, M. (2008b). The expansion of traditional irrigation in Kilimanjaro, Tanzania. (In M. Widgren, T. Håkansson & L. Börjeson (Eds.), *Northeast Tanzania 1850-2000: The Political Ecology of Trade Networks, Food Production, and Land Cover Change.*) *The International Journal of African Historical Studies*, 41(3), 461-490.
- Tagseth, M (2009). Social and cultural dimensions of irrigation management in Kilimanjaro. In T. Clack (Ed.) *Culture, History and Identity: Landscapes of Inhabitation in the Mount Kilimanjaro Area, Tanzania. Essays in Honour of Paramount Chief Thomas Lenana Mlangi Marealle II (1915-2007)* (pp. 89-105). (BAR International Series 1966). Oxford: Archaeopress.
- Tagseth, M. (forthcoming). Irrigation amongst the Chagga in Kilimanjaro, Tanzania. The organisation of 'mfongo' irrigation. (In *Shared water, shared opportunities*). Nairobi: IFRA in cooperation with Hekima College.

- Tagseth, M (in press). Indigenous agriculture. In B. Warf (Ed.) *Encyclopaedia of Geography*. Thousand Oaks, Calif.: SAGE.
- Teale, E. O. & C. Gillman (1935). *Report on the Investigation of the Proper Control of Water and the Re-organisation of Water Boards in the Northern Province of Tanganyika Territory November- December 1934*. Morogoro: [The Government Printer].
- Therkildsen, O. (1986). State, donors and villagers in rural water management. In J. Boesen, K. J. Havnevik, J. Kopponen & R. Odegaard (Eds.), *Tanzania. Crisis and struggle for survival* (pp. 293-308). Uppsala: Scandinavian Institute of African Studies.
- Therkildsen, O. (1988). *Watering white elephants? Lessons from donor funded planning and implementation of rural water supplies in Tanzania*. Uppsala: Scandinavian Institute of African Studies.
- Thompson, L. G., E. Mosley-Thompson, M. E. Davis, K. A. Henderson, H. H. Brecher, V. S. Zagorodnov, T. A. Mashiotta, P. N. Lin, V. N. Mikhaleiko, D. R. Hardy & J. Beer. (2002). Kilimanjaro Ice Core Records: Evidence of Holocene Climate Change in Tropical Africa. *Science*, 298(5593), 589-593.
- Tiffen, M., M. Mortimore & F. Gichuki. (1994). *More people, less erosion: Environmental recovery in Kenya*. Chichester: J. Wiley.
- Troll, C. (1963). Qanat-Bewässerung in der Alten und Neuen Welt. *Mitteilungen der Oesterreichischen Geographischen Gesellschaft*, 105, 3, 314-330.
- Tvedt, T. (1992). Etterord. In R. Clarke. *Vann. -Den egentlige krisen*. Oslo: Aschehoug: 121-137.
- Tvedt, T. (1997). *En reise i vannets historie: Fra regnkysten til Muscat*. Oslo: Cappelen.
- Tvedt, T. (2007). *En reise i vannets fremtid*. Oslo: Kagge.
- Tvedt, T. & E. Jakobsson (Eds.) (2006a). *A history of water. Volume 1: Water control and river biographies*. London: I. B. Tauris
- Tvedt, T. & E. Jakobsson (2006b). Introduction: Water history is world history. In T. Tvedt & E. Jakobsson (Eds.). *A history of water. Volume 1: Water control and river biographies* (pp. ix-xxiii). London: I. B. Tauris.
- Tvedt, T. & T. Oestigaard, Eds. (2006). *A history of water. Volume 3: The world of water*. London: I. B. Tauris.

Studies of the waterscape of Kilimanjaro

- UNDP (1995) (United Nations Development Programme). *Human development report 1995. Gender and human development*. New York: Oxford University Press.
- UNDP (2007). *Human development report 2007/2008. Fighting climate change. Human solidarity in a divided world*. New York: Palgrave Macmillan.
- UNESCO (United Nations Educational, Scientific and Cultural Organization) (2003). *Water for people, water for life: The United Nations world water development report : A joint report by the twenty-three UN agencies concerned with freshwater*. Barcelona: UNESCO.
- UNESCO (2006). *Water - A shared responsibility*. Paris: UNESCO.
- United Nations Conference on Environment and Development 1992 (1992a). *Report of the United Nations Conference on Environment and Development: Rio de Janeiro, 3-14 June 1992*. Rio de Janeiro, United Nations.
- United Nations Conference on Environment and Development 1992 (1992b). *Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources. Agenda 21 (18.1-18.90)*. Rio de Janeiro: United Nations.
- United Nations Water Conference (1977). *Report of the United Nations Water Conference*, Mar del Plata: United Nations.
- United Republic of Tanzania (1981). *Water utilization (control and regulation)(amendment) act, 1981. Gazette 10/1981*.
- United Republic of Tanzania (1994). *Report on the meeting on water utilisation and shortage in the Pangani River Basin*. Moshi: United Republic of Tanzania, Ministry of Water, Energy and Minerals.
- United Republic of Tanzania (2002). *National water policy*. Dar es Salaam: Ministry of Water.
- United Republic of Tanzania (2004a). *National water sector strategy (Circulation draft)*. Dar es Salaam, Ministry of Water & Livestock Development.
- United Republic of Tanzania (2004b). *Proposed draft bill for the Water Resources Management Act, 2004*. Consultancy services on reviewing water resources legislation water supply and sewerage and rural water supply & sanitation by Mawenzi Advocate's Chambers. Dar es Salaam: United Republic of Tanzania.

Reference list

- United Republic of Tanzania (2008). Household budget survey 2007. Analytical report. Dar es Salaam: United Republic of Tanzania. National Bureau of Statistics.
- United Republic of Tanzania (2009) 6-2009, The water resources management act, 2009. Retrieved June 8, 2009, from http://www.parliament.go.tz/POLIS/BTS/general/GENERAL_FR.asp?fpkey=6-2009
- University of Dar es Salaam (1996). Applied research proposal on water management in the Pangani River Basin Tanzania. Unpublished project document. Institute of Resource Assessment, University of Dar es Salaam.
- Usher, A. D. (1997). Pangani power struggle. Nordic dam builders on a Tanzanian river. A. D. Usher (Ed.), *Dams as aid. A political anatomy of Nordic development thinking* (pp. 119-132). London: Routledge.
- Vansina, J. (1985). *Oral tradition as history*. London: James Currey.
- Vavrus, F. K. (2003). 'A shadow of the real thing.' Furrow societies, water user associations, and democratic practices in the Kilimanjaro Region, Tanzania. *The Journal of African American History*, 88, 393-412.
- Vidal, J. (2005). Flagship water privatization fails in Tanzania. UK firm's contract cancelled amid row over supply. *The Guardian*. May 25th. London. Retrieved May 8, 2009, from <http://www.guardian.co.uk/hearafrica05/story/0,15756,1491600,00.html>
- Volkens, G. (1897). *Der Kilimandjaro. Darstellung der allgemeinen Ergebnisse eines fünfzehnmonatigen Aufenthaltes im Dschaggalande*. Dietrich Reimer. Berlin.
- Wade, R. (1995). The ecological basis of irrigation institutions: East and South Asia. *World Development* 23(12): 2041-2049.
- Wadel, C. (1991). *Feltarbeid i egen kultur: En innføring i kvalitativt orientert samfunnsforskning*. Flekkefjord: SEEK.
- Wästerberg, L.-O. (2003). The ancient land use system at Engaruka: Environmental aspects of its rise and fall. Second PLATINA workshop, Usa River, Arusha, 17-19 October 2002. *EDSU Working Papers* 46, 15-16. Stockholm: Stockholm University & British Institute in Eastern Africa.

Studies of the waterscape of Kilimanjaro

- Waterschap (2007). In P. G. J. van Sterkenburg (Ed.), *Van Dale Hedendaags Nederlands Onlinewoordenboek*. Retrieved December 2, 2007, from <http://www.vandale.nl/opzoeken/woordenboek/?zoekwoord=waterschap>
- Waterscape (1989). In N. Webster (Ed.), *Webster's Encyclopedic Unabridged Dictionary of the English Language* (p. 1613). Gramercy Books: New York.
- Widenmann, A. 1899 *Die Kilimandscharo-Bevölkerung. Anthropologisches und Ethnographisches aus dem Dschaggalande*. Petermanns Mitteilungen, Ergänzungsheft 129. Gotha: Justus Perthes.
- Widgren, M. (2004a). Towards a historical geography of intensive farming in eastern Africa. In M. Widgren & J. E. G. Sutton (Eds.), *Islands of intensive agriculture in eastern Africa* (pp. 1-18). Irthlingborough: James Currey Ltd..
- Widgren, M. (2004b). Can landscapes be read? H. Palang, H. Sooväli, M. Antrop & G. Setten. (Eds.), *European rural landscapes: Persistence and change in a globalising environment* (pp. 455-466). Dordrecht: Kluwer Academic Publishers.
- Willis, J. (2002). *Potent brews. A social history of alcohol in East Africa 1850-1999*. Oxford: James Currey.
- Wilson, G. E. H. (1932). The ancient civilization of the Rift Valley. *Man*, 32, 250-257.
- Wimmelbücker, L. (2002). *Kilimanjaro - A regional history. Vol. 1 - Production and living conditions: c. 1800-1920*. Münster: LIT Verlag.
- Winter, J. C. (1979). *Bruno Gutmann 1876-1966: A German approach to social anthropology*. Oxford: Clarendon Press.
- Wittfogel, C. (1957). *Oriental despotism. A comparative study of total power*. New Haven: Yale University Press.
- Worster, D. (1985). *Rivers of empire. Water, aridity and the growth of the American West*. Oxford: Oxford University Press.
- Zimmerer, K. S. (1994). Human geography and the 'new ecology': The prospect and promise of integration. *Annals of the Association of American Geographers*, 84(1), 108-125.
- Zwarteveen, M. (2008). Men, masculinities and water powers in irrigation. *Water Alternatives*, 1(1), 111-130.

Paper 1:

Irrigation amongst the Chagga in Kilimanjaro, Tanzania:

The organisation of *mfongo* irrigation⁷⁰

Introduction

The southern slopes of Mt. Kilimanjaro, the world's largest free-standing mountain and rising to 5985 m in north-east Tanzania, constitute a green and moist oasis surrounded by a semi-arid low plain. From the early Iron Age⁷¹ onwards, the mountain provided refuge from drought and vectors of disease, opportunities of fertile soils and water as well as new challenges such as cold and cloud cover to groups of people that came to settle and cultivate there. Over the last several centuries the groups that are now known collectively as the Chagga were formed. Most of these settlers appear to have been Bantu-speakers from the surrounding mountains and plains, but there have been influxes from other groups. The management practices developed or adopted here to suit the conditions on the mountain slope are now a part of the cultural and technological heritage of the Mt. Kilimanjaro region. While experiencing challenges of modernisation and increasing pressure on resources, smallholders continue to rely on the *mfongo*,⁷² which is a gravity-fed canal system, and on the *kihamba*, a local form of agroforestry in combination with other pursuits.

Gravity-based canal irrigation is a long-standing tradition on the southern slopes of Mt. Kilimanjaro, and an extensive network of irrigation canals remains in use. This region saw rapid social and economic change during the 20th century, with associated changes in water use and social organisation. Technical and organisational development in indigenous irrigation has followed, but *mfongo* irrigation has escaped

⁷⁰ Tagseth, M. (forthcoming). In *Shared water, shared opportunities*. Book edited by IFRA in cooperation with Hekima College in Nairobi.

⁷¹ Early Iron Age in the region is c.100-1000 AD (Mturi 1998:118).

⁷² The *mfongo* (Kichagga) denotes a ditch or furrow. It is related to other hill furrow systems in north-eastern Tanzania such as the *mvongo* of the Wagweno, the *sasi* of the Vvasu and the *mtalo* of Kisambaa speakers in Usambara.

Appendix 1

previous attempts at incorporation in the national schemes for water management, and instead irrigation extension has been focused on a small number of lowland schemes and the Lower Moshi Irrigation Scheme. An extensive irrigation infrastructure on the southern slopes of Mt. Kilimanjaro is documented by contemporary 19th century reports. Today, this area probably has the largest cluster of ‘hill furrows’ in eastern Africa. Farmer managed hill furrow systems with some similarity in organisation and technology are found for instance along the Rift valley⁷³ in Tanzania and Kenya, in nearby mountain areas as well as some locations in the plains surrounding Mt. Kilimanjaro.⁷⁴ These were grouped by Adams (1988) into the Kerio, the Sonjo and the Kilimanjaro clusters.

Several aspects of ‘indigenous irrigation’ (Adams 1989) are of interest for current research. The expansion of ‘hill furrow’ irrigation in Kilimanjaro has been addressed elsewhere (Tagseth 2003, Tagseth 2008a, Tagseth 2008b). The meeting of modern river basin planning with traditional models of water management from the 1990s led to conflict and a breakdown in communication, which is still a central challenge in the management of the Pangani River Basin. In this situation there is a need for increased knowledge of practices of water use and water management in order to guide sensible intervention in local water management (Tagseth 2006). The farmer-managed irrigation sector is much larger in size than the engineered sector of irrigation and the commercial estate sector combined. Tanzania is a country troubled by poverty, inadequate food security and a declining level of human development (UNDP 2005: 226). Irrigation development has been devised as one remedy for these problems, and is on the political agenda (Kikwete 2005). The development of new and capital-intensive irrigation schemes on a larger scale is seen as problematic, due to high costs in relation to the benefits and competition over water for other economic uses, among other factors. The redevelopment of the whole ‘traditional irrigation’ sector, viewed by actors in irrigation extension as deficient both in terms of technology and organisation, has thus been devised as central to the strategy to improve food security by the Ministry of Agriculture (JICA 2002). The strategy of traditional irrigation rehabilitation is

⁷³ Sonjo, Marakwet, Pokot, Konso, among other areas.

⁷⁴ The Taita hills, the Pare Mountains, the Usambaras, Mt. Meru among other areas. Plains oases around Mt. Kilimanjaro are documented by Beez (2005).

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

developed out of criteria of ‘water use efficiency’, and the perception that these are imperfect irrigation schemes which can be upgraded to a higher ‘irrigation development level’ through technology transfer at a comparatively lower cost (JICA 2002). With 1189 schemes and more than 500,000 ha, representing 77% of the irrigated acreage according to the inventory of the Ministry of Agriculture and Food Security (JICA 2002: 211), traditional irrigation represents both a substantial production and a potential for improvement. Some caution is warranted, however, since the assessment is not based on an evaluation of the actual experience of traditional irrigation rehabilitation which has taken place from the early 1980s onwards. This strategy of rapid redevelopment aims to replace both the technical infrastructure and the established organisation of the schemes, and renders improved knowledge of the organisation, operation and sustainability of farmer managed irrigation in Tanzania an urgent matter.

Theory of irrigation systems management has been dominated by organic metaphors, reflecting a functionalist influence, as exemplified by the influential models where the sustainability of an irrigation scheme is assessed through the analysis of how its ‘functional needs’ are served (Hunt and Hunt 1976, Coward 1991). Normative aspects are also emphasised in the theme of governance from Common Property Resources theory, which seeks to analyse and evaluate the commons through the properties of their institutions and especially in terms of their formal and operational rules (Ostrom 1990, Davidsen 1997, Gillingham 1999). Diachronic studies of environmental change (i.a. Tiffen et. al. 1994), but also a critique of applications of equilibrium theory have been important in challenging hegemonic misconceptions of the African environment and in resource management (Fairhead and Leach 1996, Gillson et. al 2003). While useful in addressing questions of social control, theories commonly used in the analysis of irrigation organisation can also constrain analysis due to the inherent tendency to describe organisations as static and apolitical objects (cf. Mehta et. al. 1999). There is thus a rationale to look for supplementing modes of analysis, for instance in order to understand change or conflict in irrigation systems and water management. According to Vincent (1995) the third main approach in the literature on the management of canal systems focuses on hydraulic tenure. Some alternatives can be found in studies focusing on the social organisation of water use

Appendix 1

drawing on processual anthropology (Fleuret 1985). Furthermore, studies of negotiation (conflict, conflict resolution) over water (Bruns and Meinzen-Dick 2000) and other resources (Moore 1986) which draw on concepts of legal pluralism are likely to give results differing from those starting with the problems of control. The debate on land tenure in African studies is an important and much more developed parallel to that of water tenure. Land tenure institutions involve complex bundles of rights, subject to change, and the arenas of land allocation are only partially isolated from other arenas.

The objective of this article is to describe and analyse the social organisation of *mfongo* irrigation on the slopes of Mt. Kilimanjaro on the basis of a case study. The focus is on some aspects of the social organisation of irrigation: firstly, on scheme tenure, water tenure and access to water, and secondly, on the canal organisation and its relationship to local organisation. This article relies on the principles of methodological triangulation (Denzin 1989). The analysis of irrigation organisation will be done through the comparison of a normative (institutional, symbolic) level with reports on the social practice of water management at scheme level, and with the result of this process in terms of water access for different groups, while drawing on quantitative and qualitative data.

Mt. Kilimanjaro is a diverse region, and a research strategy focusing on the central District of Moshi Rural on the southern slopes was chosen. In this article I draw on the results of fieldwork conducted in the period 1995–1996, supplemented during visits in 2000–2002, in a region within this district, and also on data from one mountain village selected for a more intensive study. The catchment of Himo River was selected as a regional study area (Fig. A1:1). Centrally located in this hydrological region is the district of Marangu, which literally translates as ‘*a lot of water*’. Water use by the Chagga of Kilimanjaro and some dimensions of variation within that system will be introduced, before proceeding with a description of upland canal structures, based on a case study of irrigation in an upland village. The case study draws on a series of interviews in all the 65 households which have physical access to four irrigation schemes, field conversations, depth interviews and observation. The establishment and use of the system is discussed before moving on to the institutions, norms and symbolism surrounding the system, some data on differences in access to water between

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

social groups before presenting reports on negotiations and, finally, the concluding remarks.

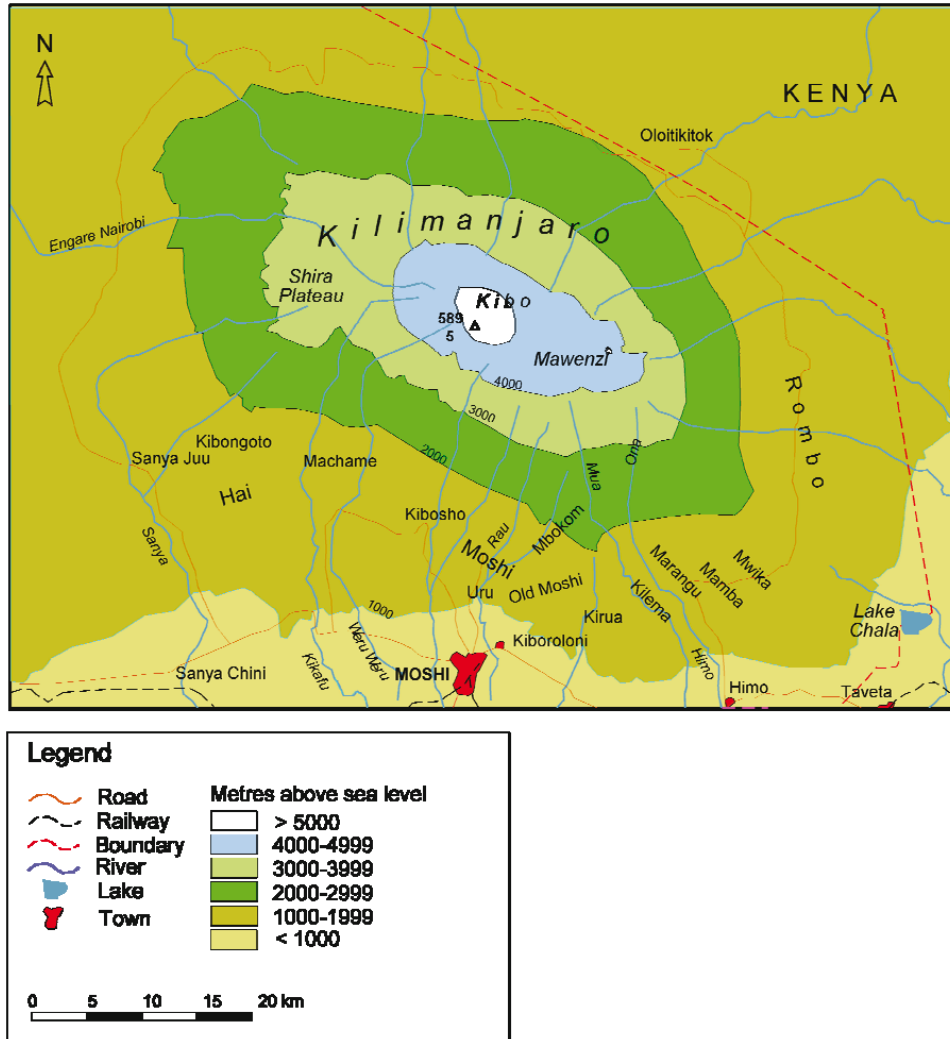


Fig. A1:1. Locations at Mt. Kilimanjaro, Tanzania

Water and the Chagga of Mt. Kilimanjaro

The extensive network of small-scale irrigation canals on the southern slopes of Mt. Kilimanjaro was marvelled upon by the early European visitors who first reported on them in the 19th century (Rebmann 1860, Kersten 1869, New 1873, Johnston 1886).

Appendix 1

Oral history and written accounts from the study area record that hydraulic control was well established prior to contacts with Europe. It is clear that the area has a long history of agriculture. While continuity of settlement is less certain, the theory forwarded on the basis of archaeological survey is that sites were first settled by farming and iron-using communities in the first millennium (Odner 1971). The irrigation technology in Marangu can be traced back to the first half of the 19th century for specific schemes while about three and a half centuries are indicated in more general oral traditions (Tagseth 2008a). This is as far as oral history can be expected to take us, while systematic historical landscape studies and archaeology might yield more knowledge. Moshi and the neighbouring Hai Districts have *c.* 1000 irrigation schemes of varying size, with an average throughput of 18.7 litres per second.⁷⁵ Some of these systems have main canals serving several hundred farms 6–10 km from the source, while most are less than 2 km in length and serve from 10 to 30 farms. In addition to the local traditions of water use by *mfongo*, the combination of the banana-based agroforestry grove (*kihamba*) and the arable (*shamba, pata*) cultivation remains an important feature of the farming system.

In the 19th century, the mountain was divided between chiefdoms or counties that had changing alliances (Stahl 1964), and were competing for control over the Swahili trade (Wimmelbücker 2002). Each more-or-less sovereign chiefdom (*nchi*) was organised into several districts (*mitaa*) under a headman (*mchili*). Patrilineal kinship and a preference for virilocal settlement led to the development of the localised patrilineage as an important arena and group with a territorial interest (Moore 1986). There are no compact village settlements, but a densely settled landscape where each small homestead farm borders on the next (Fig. A1:2), and where there is a high likelihood that your neighbour is also your agnate. The *mangi* (Prince) could be involved in the construction of a scheme (cf. Rebmann 1860) and water management (Gutmann 1926), but most furrows would have been started by prominent members of smaller local communities. In the early 20th century, Gutmann (1926) distinguished between several types of canal tenure. Some schemes were started by specialists (Stahl 1964), and some schemes were under the management of the *mangi*, as a part of the

⁷⁵ The estimate of the number of schemes is based on Pangani River Basin Water Office records. The average water throughput is calculated for the catchment of the Himo River.

family estate or for other reasons, but the majority were under the control of lineage elders.

A preoccupation with water and its integration into Chagga culture is reflected in beliefs, proverbs, riddles and sayings, such as the blessing '*may you sleep below a furrow*', which is still heard. The value of irrigation in food security is communicated in riddles, as shown in an example by Mosha (2000: 61), structured with a question, '*My father has left me a bowl from which I have been eating ever since*', and an appropriate answer, '*The irrigation canal*'. Aspects of a gendered symbolism of irrigation (cf. Sheridan 2002) is seen in the current prohibitions against women going to the intake of the furrow or working on the canal, and in reports of how in the past pregnant women could not cross the furrows (cf. Fréon 2004, Tagseth 2009). Scheme 'ownership' often lies with the descendants of the initiator of a scheme, and it carries the right to manage it. In some areas, people say that a man who starts a new furrow will benefit, but that he will not reach a high age. Some furrow schemes are regarded as enchanted, which serves to strengthen norms of behaviour, tenure and rights of use in a water commons. Arguments that a goat should be paid for and slaughtered in order to restore the flow of water and by way of compensation have appeared both in conflicts over tenure related to rehabilitation and in conflicts with the government officers over access to the intake, especially during a campaign to strengthen the statutory water management system from the early 1990s.

Dimensions of variation

The topography of the area is dominated by the slope of the huge volcanic cone, which is intersected by alternating ridges and river valleys. Important differences in the resource base are determined by the variations in climate, from the cool sub-humid highlands to the hot semi-arid foot-lands. The vertical linkages and the river valleys as barriers to horizontal communication are important in the spatial structure. Data from the catchment of the Himo River (Tagseth 2002) suggest that the *mfongo* canals have been established in different periods in different areas. The mid-slope core area has the longest history of settlement, and the some of the older schemes are to be found here. Further up, the establishment of some schemes can be dated through genealogies to the

Appendix 1

first half of the 19th century. Some schemes in the lowlands are also pre-colonial, but furrow development continued here in the German colonial and early British periods. Scheme establishment continued with migration throughout the 20th century, and settler schemes have been revitalised with migration to lowland areas since the period following villagisation and nationalisation of estate land in the 1970s. Thus, there has been an apparent association between the establishment of *mfongo* schemes and settlement history over a long time period.

The methods of irrigation are predominantly extensive. Supplementary and protective irrigation makes food production less vulnerable to drought. Permanent crops are irrigated in locations that are marginal for rain-fed banana and coffee cultivation. The irrigation of arable crops remains important. In the higher areas, maize is cultivated in the relatively dry period following the main rains, whereas further down slope, irrigation enables a second cultivation period during the period of short rains. In the foot-lands, arable cultivation is somewhat marginal even during the main rains, and is safeguarded by supplementary irrigation. The need to irrigate finger millet (*mbege*) was important in the establishment of many canals. This motivation can be attributed to a past phase of the expansion of irrigation, predating the expansion of coffee cultivation and an associated transformation of *kihamba* agroforestry practices, which took place in the first half of the 20th century. In the moist higher areas, millet cultivation took place in the period following the main rains (*masika*). This crop has been uncommon for more than 60 years, as arable fields were converted into *kihamba* groves, while the remaining arable was turned into maize fields. Millet could provide high yields,⁷⁶ but required more labour to produce than maize. The exploitation of the pre-existing water supply for new purposes slowed down rate of decline in the technology. Horticulture on a commercial scale has been increasing in recent decades. Current water use differs according to purpose and season along the slope. In good years, the demand for irrigation is limited during the rainy seasons in the uplands, while these periods are important for arable cultivation safeguarded by supplementary irrigation in the plains and the foothills. The different timing of the peak water demand between three zones along the slope reduces the regional competition for water somewhat. Farmers who

⁷⁶ Griffith (1930:45) estimated that millet yields ranged from 2.3 to 3.4 tons per ha under irrigation and approximately half that amount under rain-fed conditions.

cultivate below lowland furrows are more likely to report irrigation than those in the upland area. The main purposes of irrigation also differ, and water use is more intensive in the communities on the lower slope. There is a significant awareness of the varying natural conditions along the slope, the possibilities and restrictions that they pose. There is also variation in the history and institutional arrangements between different areas, and from one commons to the next. Correspondingly, people do not expect the same norms and regulations of irrigation to apply everywhere. When irrigators in a lowland case study area learned that I was researching simultaneously in an upland area, they were curious to know whether goats were still sacrificed there. In the upland area, irrigators contrasted their irrigation practices with those ‘*in the porini*’ (lowland bush), where they have to bribe water distributors or bring their bush-knives in order to ensure water allocations. Irrigation has been practised for generations in the lowland areas too, but these areas are marginal in the pre-colonial Chagga sphere of influence. In the uplands these areas were spoken of as having no tradition of irrigation. I have previously (Tagseth 2002) offered a categorisation of farmer-managed irrigation organisation into two main modes:

1) Furrow organisations of the first type are centred on unnamed and informal groups of users. The authority over the scheme rests with a furrow chairman⁷⁷, and depends on his relationship to the canal founder. The canal rites and the mystical ideas surrounding the schemes have been weakened as a consequence of school attendance and conversion to Christianity among other things, but they remain an influence on irrigation management. The furrow chairman is appointed by his patrilineage or ‘clan’, and usually holds his office for life. The furrow chairman is often said to own the canal, but the resulting clan control over the water is limited. The main responsibility of the furrow elder is to organise the maintenance of the scheme, and to call out work parties when necessary. Certain canal rights are defined by kinship, but membership in the group of furrow users is defined by territory (i.e. command area) and contribution to scheme maintenance rather than by kinship. The canal organisation is an unnamed and informal social group with members (households), who at least in local theory invest

⁷⁷ The furrow headman is referred to as *mwenyekiti* or ‘chairman’ in Kiswahili by the local administration, but normally this position is termed *meku o mfongo*; furrow headman or elder in Kichagga.

Appendix 1

labour in the scheme and have more or less equal claims to water. Group membership is regulated by the ability to access land⁷⁸ in the command area and participation in the work party. The furrow elder controls changes in scheme layout and the composition of the work party. The water itself is understood to be '*a gift from god*', and cannot be claimed as property by anyone. To demand payment for water is thus regarded as '*a sin*'. The access to water depends on the use of the canal, and this is governed by principles of contribution to the scheme: '*The water belongs to those who follow it to the source*' it is said. A schedule of rotation could be agreed upon at a general meeting in case of drought, and this appears to be the regular practice in some areas. Under normal conditions, however, the allocation of water in upland Marangu was a matter of direct negotiation between co-users.

2) The second type of furrow organisation has a higher degree of formal regulation and the leadership is in the form of an elected or appointed board and canal leader. While the rules governing contribution to the scheme and the allocation of water are more formal, the details vary significantly from scheme to scheme. Under this mode of organisation, the allocation of water is commonly divided into fixed time units per user, whereas this is less usual under the first mode. The rotation between secondary branches or geographical areas is also common. In this second mode of irrigation organisation, membership fees, fines for the violation of the norms of irrigation and – according some users – bribes are used in the regulation of access to the scheme and its water. A connection between cash and water is less problematic here. The group of users can be formalised as part of the village organisation where the scheme does not transcend the village, or separately, for instance in the form of a co-operative. There is a stronger precedence for statutory water rights. This is, firstly, because this mode of organisation is often found on land nationalised or purchased from the former estates, and, secondly, due to some influence through government assistance to these irrigation schemes.

⁷⁸ The agnates should be offered to purchase any plots of land which have been acquired through inheritance prior to any sale to a non-agnate. The use of *pata* plots for arable cultivation can be borrowed or rented for cash or an agreed amount of the harvest, while *kihamba* land now appears to be exclusively controlled through inheritance (and marriage). Details from interviews on land tenure history indicate that some land for *kihamba* groves was allocated by the *mangi* during British rule, and that some few plots were transferred through purchase.

The first mode of organisation predominates in the upland schemes, which are older and usually smaller than the schemes further down the mountain slope. The mid-slope situation is varied, in contrast to the foot-lands where organisation according to the second mode of furrow organisation dominates. The background and scale of the schemes also vary. There are different problems of water management associated with these two modes, though it is apparent that management according to both principles can be relatively successful at scheme level. A common trait of the farmer-managed irrigation in the area is that the institutions of irrigation are well integrated with other local institutions. Universal user rights based on access to land in a command area subject to contribution to the scheme are acknowledged. The definitions of rights thus serve to improve the sustainability of the labour-intensive schemes.

In the schemes described in the following sections, the use and management of water under the first (or lineage) mode, is described using the case of an upland village⁷⁹ in Marangu. The village stretches out from the upper fringe to the core area of the Chagga settlement, and lies within the highest ecological zone.

Upland canal structures

There are differences in the density of schemes and how these have survived within short distances of each other. In areas closer to the main road and the central place in Marangu there are a lot of abandoned schemes, while other areas (including the village selected as a case study area) have a high density of active irrigation canals. All the active and derelict schemes have probably never operated simultaneously. The springs, natural waterways and canals in this study area are so densely located, that it can be difficult to find anywhere where the sound of trickling of running water cannot be heard. The area has two sources of furrow water, the Ruwa stream and its tributary Kizuru stream. Both streams are spring fed, and supply a number of furrows. When I climbed the waterways of this small sub-system, I identified 36 individually named furrows. One-third of them took their water from the Kizuru stream. Of these, some 17 furrows deliver water to different parts of the case study village⁸⁰ (Fig 2).

⁷⁹ Komalyangoe, Marangu West Ward, Moshi Rural District in Kilimanjaro Region

⁸⁰ Field inspection October 1995 and lists provided by Komalyangoe Village and Marangu West Ward.

Appendix 1

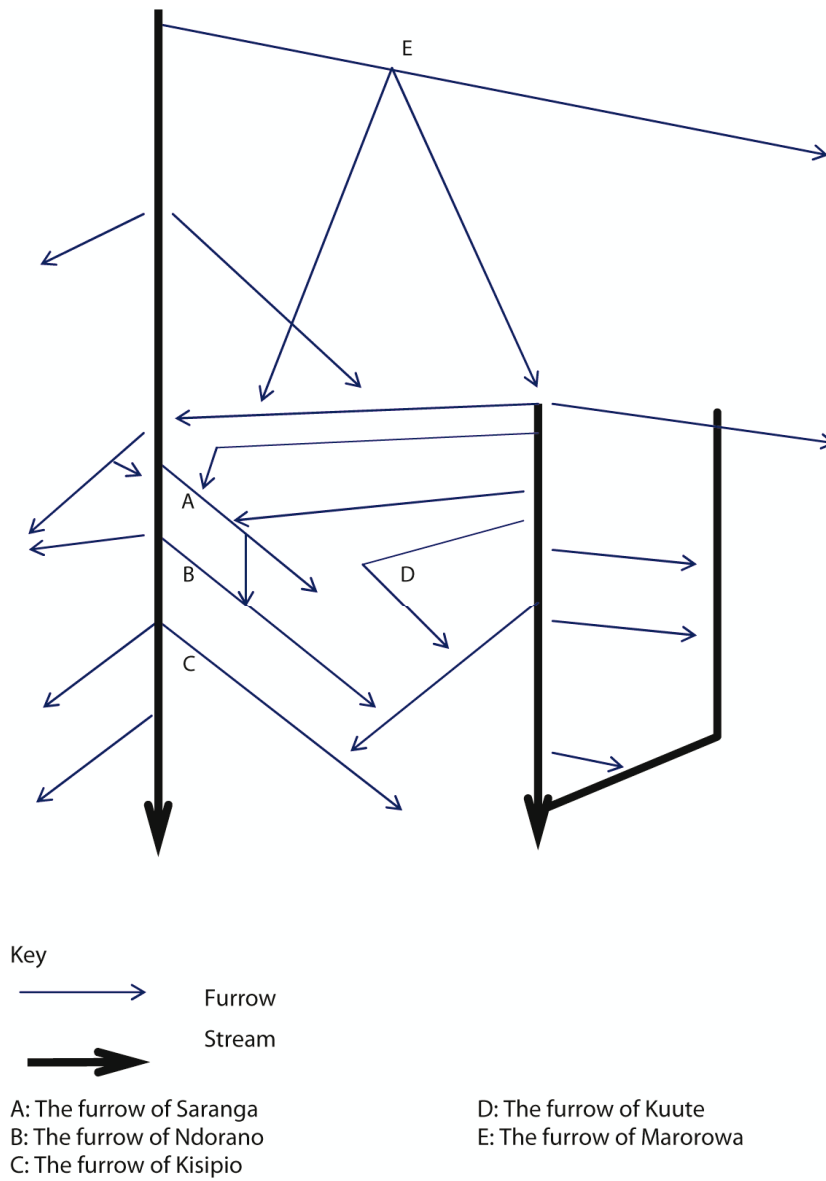


Fig. A1:2. Hydrology and canals in Komalyangoe, Marangu (Schematic).

The furrow network is extensive, and it has a high connectivity. There are approximately 30 households for each furrow scheme, as compared to 50 households for each public standpipe. The schemes are comparatively small, with actual discharges ranging from 8 to 42 litres per second⁸¹.

The stream water is checked, either by a small permeable dam or by a stonewall protruding into the streambed, in order to create some hydraulic head. This dam is constructed with boulders, stones, twigs, and mud. The intake is often constructed where the water flows more smoothly, and where the stream divides naturally or at a pond. Permeable structures and overflow structures are useful, as the stream flow is variable. Both high flow and low flow make repairs or modifications of the check structure necessary from time to time. In many cases, a furrow will divert most of the available water during the dry parts of the year. However, some water is always available for the next furrow below, since water is either lost or returned close to the abstraction point, and because stream flow is augmented by the seepage of groundwater infiltrated on higher ground. The technology, with the use of permeable dams, limits the maximum water acquisition at a single abstraction point.

A canal usually starts from a source area in a gorge or depression and also collects water on its way to the farms on the ridge. Simple spillway- or overflow structures are incorporated close to the intake in order to avoid breakdown of the canal banks at times of high flow. In the river valleys, the water is carried on a gentle gradient in a canal running along an embankment, in places several metres high, towards the higher ground on the ridge. Regular abstraction points in the earth banks of the canal can be seen from the small packs of grass and mud used to block them. Upon reaching the main settlement on the ridge, the furrows divide. The proportional weir is used, as permanently flowing water is wanted in the secondary canals, which serve the homestead compound farms (Fig. A1:3). This is different from areas with less water, where water is rotated according to a sequence agreed upon at a general meeting following the communal work session, or divided proportionally into a schedule of time-units. The distribution of water is manipulated by placing and adjusting a small pack of mud, twigs and grass on either branch. The canals divide to provide running

⁸¹ Measurement by J.J. Temu, Pangani Basin Water Office in March 1996.

Appendix 1

KISU AREA
Komalyangoe village,
Moshi rural district

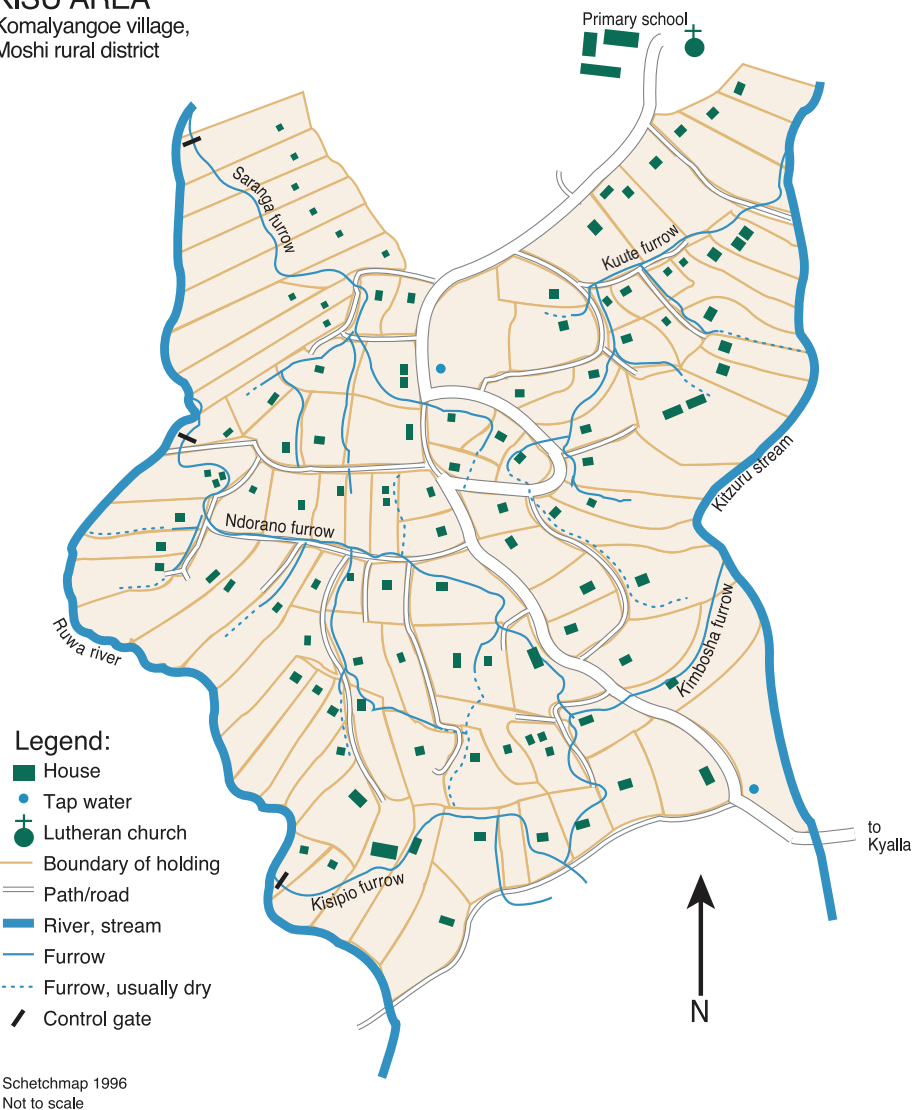


Fig. A1:3. Furrows, paths and farms in lower Komalyangoe

water close to most homesteads and fields. Other secondary canals are dry. The terrain on the ridge is sloping, and it is sometimes necessary to bring the water down rapidly, which requires a controlled release of potential energy. The simple drop structure used in order to achieve this also provides a convenient tapping place for domestic water. Stone lining is another method of energy control, which is used to prevent scouring.

The horizontal footpaths tend to run alongside the canals in the river valleys and on the ridge. The co-localisation of paths and canals has the advantage of facilitating the monitoring of the canal and the flow of water. The situation of turning points on the public paths rather than in private groves further facilitates the monitoring of water flow. The control of runoff is more important than the drainage of irrigation water in the sloping and naturally well-drained terrain. Surface water is drained into the river through the irrigation canals and separate drainage canals.

The establishment of the upland furrows

The oral history of the *mfongo* schemes in the upland case study area suggests that the establishment of the schemes was associated with the immigration and subsequent expansion of the furrow-controlling lineages in the area, more than with development from subsequent intensification of agriculture. Scheme establishment in this village is estimated to have taken place in the period from between the 1830s and 1920s, when the margin towards the forest reserve was reached. Even though ‘*no one would remember how to survey a furrow today*’ (Informant B), existing schemes in this area continue to be maintained and used. The first simple structures were made with digging sticks. They were later expanded to include more farms, and improved by subsequent generations. Oral tradition (Schanz 1913) suggest that there were two centres in Marangu prior to the arrival of the ancestors of the lineage of the chiefs (Ngowi/Lyimo/Marealle). Engraved stones related to the boys’ initiation (*ngasi*) ritual are reported at two locations in Marangu (Fosbrooke and Marealle 1952), one of which is located near the hamlet of *Kisu* (the knife). This, and a place-name which might be associated to ritual sites imply that the area is long established cultural space. Lack of indications in archaeological survey by Odner (1971), interview data and the village name of *Komalyangoe* (where the poles grow) do not suggest that this particular area was among the early agricultural settlements within the wider upland area. In this regard, the history of the schemes of one lineage can serve as an example (see Tagseth, 2003 and Tagseth 2008a, fig. 5, showing a tabulation of the lineage and its furrows).

The furrow of Ndorano was the first of a series of small furrows built by the members of this family as they grew in numbers. The history of this family in the area

Appendix 1

started with a settler who migrated here due to conflicts over pasture between two clans, and the first furrow was initiated by his son (no. 2). It is named after a former furrow chairman. The furrow chairman explained: *'The name changes for each generation, it is the grandfather furrow'*. The furrow was constructed *'because it was too far to go to the river to fetch water for irrigation and domestic purposes'* (Informant E). In the third generation, the resident lineage continued through sons no. 3 and no. 6. The last born son (no. 6) took over his father's homestead, while his older brother (no. 3) had other plots in the area. In the fourth generation, the son (no.7) of no. 3, built the second furrow in order to provide water for irrigation of finger millet, maize, beans and banana in an area above the original furrow, and he set up a homestead there. Water was also used for domestic purposes and for fire protection. This second furrow is called *the furrow of Saranga*, after a former chairman. According to the current chairman (Informant D), *'There was no involvement from the mangi. The people of the area used to organise themselves to do it. All the people who were going to use the water took part.'* Also, in the fourth generation, the son (no. 10) of the last born (no. 6) constructed the third and last furrow, the smallish furrow of *Kisipio*. The scheme improved the water supply to the former tail-end users of the first furrow, as new farms were established. According to the current furrow chairman (Informant E), who is the great grandson of the furrow initiator, it was constructed for *'irrigation of finger millet. There is too little land for that now; we mainly irrigate vegetables and beans'*. The detailed genealogy shows that the establishment of the schemes was related to the expansion of the resident lineage. Control over the furrow has been inherited by the direct descendants of the canal founders, despite the inclusion of non-kin in the group of users through land acquisition and migration. There is a correspondence between the three segments of the lineage and control over the three schemes, but there is no apparent correspondence between membership in a lineage segment and the use of a scheme under the control of that particular segment. The family history describes a process, where three canals are a physical result of the past expansion of a lineage. The addition of the second furrow (*Saranga*) increased the command area of furrows and the volume of water under the control of the family, but may also have served to provide independent access for an emerging lineage segment. The third scheme (*Kisipio*) may

have eased the supply for areas which it was difficult to acquire water for due to competition with upstream users.

Springs understood to be controlled by ancestors who died or 'disappeared' there are common on Mt. Kilimanjaro and nearby areas. One interpretation of the sacred springs and rain shrines that are common in the mountain landscapes of north-east Tanzania is that they are markers of a symbolic political geography, involved in the definition of groups of people, tenure, and political regions or domains. The clan of the Prince of Marangu is associated with a central hilltop shrine, the 'ancestor hill' where the ancestral mother of the Marealle, Ngowi and Lyimo clans stayed and died following the migration from *Ukambani* to the north of Mt. Kilimanjaro. In times of famine and drought, '*they went to the Fumwu Iya Meku hill above and slaughtered a bull and a male goat. It used to start raining the same day*' (Informant M). Tradition holds that a named child and later a man were killed at a spring in the upland part of the case study area, and this is still respected as a sacred place (Informants H, I and P). It is said that at the time of scheme construction, and in later times of crisis, a goat or a bull was sacrificed there in order to make the water flow smoothly (Informants G and B). In the former case, it was made to the supreme god (Ruwa), while in the latter case it was to the ancestors. One furrow chairman reported that he offered libations of milk and *mbege* beer for the same purpose. Libations in connection with the furrows have declined, and are done discretely. Elders complain that the discharge of the springs and the rivers has diminished, which can be related to physical processes and discourses of climate change, deforestation and land use changes which lead to less infiltration of water, but also to a local discourse of moral decay. Common to the furrow intake, the sacred spring and the hilltop shrine is that they all have to be manipulated by the 'proper' groups of people and procedure, which is important in their use as vehicles for the establishment of political control at different levels through devices of 'enchantment'. Conflicts involving references to the symbolism of an irrigation scheme or a water source can thus relate not only to the control over water as a resource or the 'mystification' of hydraulic tenure, but also to local discourses of power (cf. Feierman 1990, Sheridan 2001).

Appendix 1

Water use

The importance of irrigation has declined with changes in the upland agricultural system, primarily the extension of the area under permanent crops: *'In the past, there were open areas, where people could plant more seasonal crops. These needed irrigation. These days, there are a lot of permanent crops covering almost all the open area. ... People are not as interested as they used to be, but we still regard irrigation as important'* (Informant K). Coffee is processed on the farms by the wet method, which requires access to water. The cherries are pulped in running water (reported by 83% n=65), before the beans are fermented in basins, and then washed and dried for sale in parchment. This method ensures the high quality of the acidic *Arabica* coffee from Kilimanjaro. The farmers struggle to keep the mole rats (*mfuko*) away from crops, and flooding their tunnels was reported by 26% of the farmers. Livestock, mainly zebu, are fed with succulent banana stems and rarely need to be given water (8%). Domestic use includes water for drinking (25%), cooking (60%) and washing (94%).

Irrigation was reported by 60% of the households with land in the command area, and can be described as supplementary for most crops. For some crops the access to water acts mainly as a safeguard against crop failure. Irrigation is used in order to extend the cultivation period into parts of the year when there is a higher risk of drought. Maize and beans are watered in September and October. Some farmers also water the coffee trees at this time or in the dry spell in January, together with other *kihamba* crops⁸². For crops such as sweet taro, sugar cane and watercress, there is a continuous need for water outside the rainy seasons. The average yields of coffee, beans and maize are higher in households where irrigation is practised ($p > 0.95$, independent samples T-test). The incidence of vegetable cultivation is also affected by irrigation practice ($p > 0.95$, chi-square test).

Households with land in the command area were differentiated by key informants, in three independent sessions by wealth rank and into three broad socio-economic groups. The data sets were evaluated through rank correlation and reduced to a trichotomous variable. Variation in water use between social groups can be shown

⁸² In trials at Lyamungo, adding 51mm of water per month increased the output of coffee by 27%, while irrigation with mulching increased output by 107% (Wallace et. al. 1953).

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

when irrigation activities are further differentiated into three broad categories: arable, agroforestry and horticulture (Table A1:1). The middle group has a higher frequency of reported irrigation, especially for arable crops (dry season maize). Vegetable cultivation is on a small scale, for household consumption and the local market. Horticulture and bananas are the main source of cash for women.

Table A1:1. Reported irrigation by wealth rank.

Type of irrigation	Well-off	Middle	Poor	All groups
	27% (17)	48% (30)	25% (16)	100% (63)
Arable	29.4% (5)	46.7% (14)	25.0% (4)	36.5% (23)
Agroforestry	23.4% (4)	6.7% (2)	18.8% (3)	14.3% (9)
Horticulture	52.9% (9)	40.0% (12)	37.5% (6)	42.9% (27)
All purposes	58.8% (10)	63.3% (19)	56.3% (9)	60.3% (38)

Local arenas, groups and leadership

Processes of social control, conflict and co-operation in resource use take place in a local arena. The village organisation, the churches and the coffee co-operative can be understood as formalised and 'modern' organisations. Other groups, organisational units and sets of statuses can, for the sake of convenience, be labelled 'traditional'. The latter are important in the organisation of agriculture and irrigation.

The smaller neighbourhood convenes from time to time in order to discuss common problems. Small parleys are conducted in conflict resolution; where the complainant, the 10-cell leader (below) and an elder from the neighbourhood are present. The co-users of a furrow are also neighbours and relatives. They exchange surplus crops and favours, and borrow the use of auxiliary plots from each other. Neighbours and relatives have obligations of reciprocity. These networks are crucial in times of crisis and for resource mobilisation, and community members monitor each other closely. Interdependency also provides a means for sanctioning. Loss of standing could influence the future allocation of a vacant lineage plot, the lending of a cow, or the willingness to contribute towards the cost of a marriage or medical treatment. Violence does occasionally occur, but the ultimate sanction is to be ostracised: to be

Appendix 1

expelled from the community (Howard & Millard 1997, Moore 1986), deprived of the means of subsistence and cut-off from the web of mutual assistance.

Every Chagga belongs to one of the more than 400 major patrilineages of the mountain, each named after a founder. The precise relationship to the founder is unknown, so these *ukoo* can be defined as clans.⁸³ This clan is exogamous, and it can share food prohibitions but it has no joint assets and it does not act as a body. The active group is the smaller virilocal lineage segment, the *localised patrilineage* (Moore 1986). This is a group of men with a common ancestor and history in the area, together with their dependants. At times enforced by neighbours, the kin groups appear as tiers or segments, as the beer-drinking group (lineage members and neighbours), the cattle-slaughtering group (approximately 20 married men) and the goat-slaughtering group (an elder and his married sons). The localised patrilineage is a resilient organisational unit, which remains important in the management of the furrows, and matters of mutual assistance, marriage and land.

Modern institutions of governance were introduced into the area after independence, as part of the experiment with *ujamaa* or African socialism, replacing the 'native authority', of indirect rule which was disposed of as a colonial creation. The villagisation programmes of the mid-1970s involved movement of people on a grand scale and the creation of new settlement patterns in most parts of Tanzania. In the established communities on the slopes of Mt Kilimanjaro, however, old territorial units were reshuffled into new agglomerates and realities changed less (Moore 1986, p. 139). A village is headed by a council, which elects a chairman and establishes a series of village committees. Some village administrations are involved in the matters of the furrows through the village committee of production. The next tier in the structure is the hamlet (*kitingoji, mtaa*), headed by a chairman. These chairmen are more frequently involved in matters of conflict resolution. In the case of Komalyangoe Kisu, the roles of hamlet chairman, head of a lineage and chairman for one of the furrows were combined in one person. A system of a cell leader (*balози*) for 10 households was introduced on Mt. Kilimanjaro in the mid-1960s (Moore & Puritt 1977, p. 20).

⁸³ A precisely known relationship to the founder of the resident patrilineage is often claimed, and the description of this kin group as a clan can be questioned on the basis of usage in anthropology (cf. Keesing 1981:227).

Interviews in four village offices yielded no information on involvement in matters of the furrow system. In this respect, the uplands are different from lowland areas where the second mode of scheme management prevails.

Institutions, norms and symbolism

The *organisation of irrigation* follows a relatively standardised model within this upland area. A slightly different organisation was reported for some of the larger derelict schemes. The leadership lies with a furrow elder or headman. This headman is said to own the furrow, and he is seldom elected. As described in the section on the construction of the furrows above, the furrows had originators or founders. The latter made the first cut in the bank of the stream and performed the necessary sacrifices to *Ruwa* (God), and thus established furrow rights (Informant M). These initial rights have been retained within the lineages of the founders, but the furrow is also said to belong to those who cultivate below it. The furrow chairman acquires his position through inheritance. The family usually decides succession on the conclusion of the funeral (*matanga*) of a deceased chairman. He should perhaps be seen as the representative of his lineage, as he is usually appointed by its members. The position is nevertheless often inherited down a direct line of descent, since elder or junior sons can be appointed. If libations to appease the ancestors are found to be necessary in order to make the water flow steadily and smoothly, the furrow chairman is the one to perform it. This follows from his relationship to the founder. Furrow matters, in common with some other agricultural matters, have undergone a process of secularisation and disenchantment, but this remains an ultimate source for the (moral) authority of the furrow chairman, and strengthens his management rights. The aspect of mysticism surrounding irrigation is related to the ancestral cult, which has been transformed and subordinated rather than replaced by near universal adoption of Christianity. Libations for the furrow are not frequent, but few would declare that they intend to discontinue them: *'My father was the last to sacrifice. I am responsible to do it, but I have not done it yet. ... I must perform a sacrifice at the intake because the ancestors were able to get water from that intake. It is thanking God for giving us blessings'* (Informant H, furrow chairman).

Appendix 1

The furrow chairman is the only person who has the power to call users to work on the furrow. This is adhered to even in cases when the chairman is too old to work and not even a furrow user. The organisation of maintenance is thus a core task of this office. Work on the furrow is not performed on the weekday of self-help activities, when the village organises road maintenance work among other things. Any household using the water is under obligation to send one man when requested to do so by the chairman. The chairman, who is also an expert on this technology; monitors the condition of the furrow and makes the decisions when work is deemed necessary, and also has authority over scheme layout. He has a limited control over water utilisation: *'The furrow chairman makes the decisions on cleaning. ... I make my own decisions about irrigation'* (Informant N). Indirectly, the furrow chairmen control access to the scheme, since they call out the work parties, and also have some power to prohibit the digging of new sub-branches, and to seal leaks. These decisions can be understood as technical, but they do have an effect on access to water. An accomplished furrow chairman earns respect and invitations to beer. Formal tribute or gifts (*mashiro ha mfongo*) to the furrow elder or the group for entrance were not reported as current in the upland study area, though this had been the practice in other areas in the past. The chairman's own use of the water cannot easily be challenged, however. Some schemes have a second designated role in the furrow organisation, the overseer of the canal intake.

The people with rights to land in the command area of a furrow constitute an unnamed social group, the *mfongo* water community. This water community is an informal organisation. There is no clearly defined membership, but membership status can be attributed either to households or to male household heads, which have an equal status as participants in the scheme. Attendance in communal work strengthens the claim to irrigation water. The water community is a territorially defined unit, as clans other than that of the founding lineage for the scheme are usually represented in the command area. Command areas do not correspond closely to patrilineal clusters nor to the political boundaries of hamlet and village. The degree of correspondence varies. For one of the furrows in Kisu, most users have a shared clan allegiance different from that of the canal elder and the founder. This situation is due to immigration facilitated

by a redistribution of land classified as underutilised by the Prince during British rule, and probably to land purchase in the past. Political processes beyond the hamlet thus led to a situation where most landholders in the command area of a furrow share clan name, even if their geographical and genealogical origin was actually quite distant. The creation of this new clan cluster could be interpreted as an expression of an ideology that clansmen should form compact neighbourhoods. The chance that the owner of a plot in Kisu hamlet shares clan with the canal elder of that area is 0.24. A comparison of the network of furrows and the political boundaries based on sketch-mapping of the village in 1995 shows that furrows are more likely to cross village (39%) than internal hamlet (11%) boundaries. This strengthens the interpretation that the hamlet is a basic and older unit, over which the village is superimposed.

The individual schemes are often said to belong to the furrow chairman or to his family group: *'It is our furrow. Ndorano's furrow and the one below belong to my brothers and me'* (Informant O). Chairmanship includes a free use of water, invitations to beer parties and respect, but scheme tenure does not confer tenure over water. On the contrary, water is regarded as a gift from God. The apparent interpretation is that this is a description of communal tenure. That, *'It is the water from God, and it does not belong to any particular person'* (Informant P), may be taken as equivalent to *'Everybody has got the right to use the furrow. Each and everybody needs to use it, for example for washing coffee'* (Informant N). The right to furrow water is seen as a part of the general right to subsistence, and the peasant ideology seeks to protect these entitlements. Thus, the statements relate to a morality of water use. The furrow chairman (Informant G) expressed the norms thus: *'All water is a gift from God. It is a sin to pay for water. A sin against God'*. Not to demand money for water is therefore a central norm in *mfongo* irrigation management; to mix payment and water allocation is immoral and subject to sanction. If the exchange of beer or livestock (*mashiro ha mfongo*) for access to furrow use or group membership was legitimate, this could be explained through Barth's (1967) concept of economic sphere, but no informant in this particular area has chosen to report any such transactions to me. According to Johnsen (1969), payment for irrigation water was understood to be subject to supernatural sanctions, and it has been a controversial issue in irrigation settlement schemes since the

Appendix 1

1950s, when it explained some of the reluctance to take part (Allan 1965, Johnsen 1969, Molohan 1960). The insistence that the withdrawal of water without a licence from the Water Officer was illegal, the installation of flumes designed to limit the maximum abstraction of the schemes with minimum consultation with the user groups and the introduction of volumetric water fees were among the central issues in a conflict which explains the limited results of an attempt to reform water management for the Pangani Basin in the 1990s (Cf. Mung'ong'o 1997, Usher 1997, Gillingham 1999).

The distribution of water is guided by a set of norms for water use. At the normative level, water use is free; everybody is entitled to reasonable use of water as a part of the right to subsistence. Some base their argument on need: *'[we] depend on furrow water'* (Informant Q). The schemes have to be kept in order, and contribution to the upkeep of the scheme is associated with access to water for irrigation. According to one of the furrow chairmen, *'Most of the time, those who attend communal work will get water'* (Informant G). Contribution to the scheme is required: *'we have the right because we maintain the furrow'* (Informant R). There is an obligation to share the common water, and no single user is supposed to divert all the water at any given time. Many users emphasised the need to *'take consideration of the other users'* (Informant Q). All matters of the furrows are rather firmly fixed in the male domain, and more strictly so than other matters in the public sphere (Informant S and others). Irrigation thus has gendered connotations. A taboo or prohibition excludes women from communal work on the furrows. According to community norms, it is also unseemly for women to turn the direction of the water or to manipulate the furrow. Further, they should not go to the intake or clean canals. Rather, it is held that they should act through male representatives in these matters. Male labour migration constitutes a challenge to these ideas.

Negotiations over water

In conditions where water is scarce, access to water in the case study village is the result of a continuous process of negotiation, in which normative arguments are involved. These norms do not dictate the outcome, in terms of distribution of water, which also depends on other factors, such as power, standing, and the ability to alter or break the

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

rules or to build alliances. The increasing number of female-headed households provides a test case. According to the norms of irrigation, access to water depends on contribution to the scheme, and female participation in maintenance is prohibited. Thus, according to the normative rules, it could be expected that female-headed households are unable to irrigate. The outcome of the allocation process is shown in Table A1:2. The results show only a weak tendency for a higher incidence of reported irrigation in male-headed households, and the distribution shows no significant relationship. Access to water may be more difficult for female-headed households, but the distribution of reported irrigation by gender of household head is less skewed than expected on the basis of the norms alone. This can be attributed to flexibility in the application of rules. Female-household heads can be excused for non-participation, and some are able to break the rules.

Table A1:2. Reported irrigation by gender of household head.

	Non-irrigator	Irrigator	Total
Male head	36% (16)	64% (28)	100% (44)
Female head	50% (10)	50% (10)	100% (20)
Total	41% (26)	59% (38)	100% (64)

(Phi=-0.13, p>0.30)

Similarly, wealth (socioeconomic group) is not found to have a significant effect on reported irrigation (Phi=0.06, p>0.11). Two other factors are found to vary systematically with the incidence of irrigation. The first factor is affinity. Membership in the furrow-founding patrilineage (table A1:3) does increase the likelihood of reported irrigation (Phi=-0.30, p>0.95). Contribution to the scheme is another significant factor, in accordance with the norms of irrigation. Participation in scheme maintenance is almost universal among those who irrigate permanent and field crops, but somewhat less usual among those who only water kitchen gardens with vegetables (Table A1:4).

Appendix 1

Table A1:3. Reported irrigation by membership in furrow owning lineage.

	Non-irrigator	Irrigator	Total
Same clan	31% (15)	69% (33)	100% (48)
Other clan	65% (11)	35% (6)	100% (17)
Total	40% (26)	60% (39)	100% (65)

Phi=-0.30, $p > 0.95$, chi-square test: $p > 0.95$

Table A1:4. Reported irrigation by attendance in work party in the previous year.

	Non-irrigator	Irrigator	Total
Not attended	60% (12)	31% (11)	41% (23)
Attended	40% (8)	69% (25)	59% (33)
Total	100% (20)	100% (36)	100% (56)
Not valid	6	3	9

Phi= 0.29, $p > 0.95$, chi-square test: $p > 0.9$

A specific right to a water allocation does not follow automatically from the general right, and actual performance deviates from the patterns that might be inferred from the norms and rules. The distribution of water takes place through a process which is negotiated ad hoc between users, with reference to norms and reasonability. No one is barred from drawing water by bucket. At the simplest level, the prospective irrigator simply diverts a proportion of the water flowing in the main furrow above their homestead. This is often the case outside the peak irrigation seasons. When the amount of water in the main furrow is insufficient, the prospective irrigator has to '*go to the intake*', i.e. they have to follow the canal upwards and close or reduce any competing abstractions on the way to the intake, and also stop leaks and adjust the intake structure if necessary. If the demand for water is high, the water could be gone again by the time the irrigator returns to their farm, due to the actions of a competing user. Two or more users take turns in depriving each other of water, and what one female-household head and irrigator described as a '*game of hide and seek*' (Informant T) often results. In her experience, '*those who are near the source get more [water]*'.

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

According to Informant U: *'The timing [of water application] depends on the circulation between the users. ... There is no schedule, but I will go to turn the direction of the water. Then I get water for an hour or so, and someone turns it again. There is a lot of running [laughs and shakes his head]. I irrigate when I can get some water. If not, I try the next day. ... You have to get up early in the morning'*. He takes part in the irrigation of maize and beans in September, when the water supply is insufficient and competition for water more intense. The next step for the irrigator in need of water is to give notice to the upstream users, claim the water and close their abstractions. Conflicts are handled within the neighbourhood or the hamlet: *'The balozi, the furrow chairmen and the users are responsible. People from other areas are not concerned'*, said Informant I, a retired village official. The level of conflict over water use is usually not very problematic, since water is not so scarce in relation to demand: *'Co-operation is good, because there is more water here. It is not like in Himo and Makuyuni [lowland], where there is a scarcity'* (Informant V). According to informant W, *'Getting water from the Saranga [upland] furrow is no problem in comparison with the (...) [lowland] furrow. In Makuyuni, there are bribes for water, and people feed their cattle on their neighbour's farm. There are no problems here'*. Conditions at home are thus contrasted with *'the other place'* down slope. The cropping pattern gives peaks of water demand for irrigation in the dry periods of August and January, and irrigators complain about difficult access to water during these periods. Conflicts frequently relate to water distribution in the peak seasons, the construction of new sub-furrows, the protection of water quality and the priority of water use for crops and other purposes. Conflicts over water use are usually resolved between the users themselves: *'no person regulates water use. But if someone blocks the furrow, people take action and they approach him'* (Informant X). A 'sanctioning party' composed of co-users makes a visit and usually gives the culprit a scolding, or seizes their property. A female-household head who lived at the head end of a scheme and who had been subject to this method reported: *'I am not allowed to divert water by sub-furrow. ... I am not allowed to make one even during the dry season. My neighbours would take action. Those from further down would come and shout a lot. I tried it. ... Men are not pestered when they make a sub-furrow. ... I was instructed to clean a section of the furrow'* (Informant Y).

Appendix 1

There are conflicts of interest between the need for water for domestic use, which requires some permanent flow in all branches, and irrigation, which requires sufficient flow to be directed to one point. The furrow chairmen are able to use their authority over technical issues to stop abstractions for water-demanding crops. In other cases, elders from the area and the 10-cell leaders are mobilised and a small parley organised, often including the furrow chairman. A hamlet chairman (Informant F) reported that he had been involved in closing down a new and contested sub-furrow higher up on the canal. He went to the area together with the furrow chairman (Informants E, R and an elder from that area), and issued a warning. A few participants in the surveyed schemes reported having complained to either a *balozi*, furrow chairman or hamlet chairman. The tail-ender who had been enraged by this new branch (Informant R) provided another example. When he observed that another user was polluting the water by washing his coffee in the furrow, he went to see the furrow chairman and his 10-cell leader. '*The furrow does not belong to me, but to the other people. They do not involve me in furrow work*', said informant Z. Informant Z was an elderly widow who had had to discontinue her irrigation of watercress and close the new branch, and her inability to participate in scheme maintenance was used as an argument to exclude her. It is likely that that her weak position in the community made it difficult for her to draw much from the common resource.

Concluding remarks

Irrigation by stream diversion and spring-fed canals, locally termed *mfongo*, is a long-standing tradition on the slopes of Mt. Kilimanjaro, which has the largest cluster of 'hill furrows' in eastern Africa. The analysis of irrigation organisation has been dominated by organic metaphors and the theme of social control. Questions of process in indigenous irrigation have thus been left unaddressed, with implications on the understanding of irrigation development, scheme sustainability and access to water. The analysis of tenure and access to water provides an entry point. When the micro-politics of the canal in terms of claims argued and fulfilled and the political-economy problems of 'who gets what where, how, when and why' in terms of water (Chambers 1977) have received little attention, this is also because hydraulic tenure tends to be fluid and difficult to grasp.

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

This article has explored the canal organisation, according to a lineage mode, the first of the two main modes identified. The analysis has proceeded along three lines. The institutional-normative level has touched upon norms, institutions, statuses, arenas, and symbolism. The analysis of interaction has drawn on qualitative data about negotiations and how users access water. The investigation of performance or outcome has relied on quantitative analysis of reported access to water for different social groups.

At an institutional level, the canal organisation relies on the status of the furrow chairman, who is given 'ownership' in a process controlled by the family of the canal founder, which, in turn confers management rights. The status of the chairman is strengthened through devices drawn from indigenous religious ideas. The 'enchantment' of the norms serves to strengthen authority and to boost the norms of proper conduct in relation to water. Conflict resolution and technical control over work or on the scheme are more central to the chairman's position and influence, however. The scheme is associated with an unnamed and informal social group, the *mfongo* water community. Group membership is not exclusive to the kin, but depends on access to land in the command area and participation in work. The link between contribution (investment) in the scheme and the right to a share of the water is crucial in the sustainability of schemes. Agreement at a normative level can be found over leadership, the access of non-kin, not mixing money with the management of the commons, on the requirement of participation in work, and on norms that exclude women. Normative arguments are involved in the interaction, where access to water is negotiated in a continuous process, but these norms do not dictate the outcome, which also depends on factors such as power, standing, and the ability to alter or break the rules or to build alliances.

Some normative principles could be tested against reports on the practice of irrigation. When wealth rank has no effect on access to water, this is in agreement with ideas of equal opportunity to achieve rights to water. Rights can be achieved through investment in the scheme through participation in the work party, which has a moderate and significant effect on water use. Kinship, however, does have an effect on irrigation, which is contrary to these norms. No significant association could be found between the gender of the household head and the ability to irrigate, despite rules of operation which should exclude them from full participation and the acquisition of claims to water. These interesting discrepancies can be better explained if access to water is

Appendix 1

viewed as an outcome of the negotiated social process illustrated by the more detailed reports on water acquisition and conflict. The analysis of the ability to irrigate for different social groups suggests that the outcome in terms of access to water is not well predicted from an analysis of the norms and ideology of irrigation. This is interesting, because concerns about equity related to lineage ownership and a lack of female participation are central among the problem descriptions which have been used to validate interventions in local organisation of irrigation in Kilimanjaro Region, in addition to concerns about environmental sustainability and inadequate technology. The perception that local irrigation organisation is inferior to irrigation organisation designed by outsiders, and in urgent need of reform due to issues of equitability, or because traditional authority is eroded beyond repair may have to be moderated. Important strengths in local irrigation organisation lie in flexible principles of resource mobilisation linked to scheme tenure and the established usufruct rights and obligations. Like Fleuret (1985:115) found for Taita, irrigation management can depend as much on multi-purpose organisations (lineage, neighbourhood and hamlet) drawing on indigenous models of organisation as on a strong single-purpose organisation (the *mfongo* water community). Neighbourhood- and kinship- based organisation can work without an elaborate set of bureaucratic rules in catering for scheme maintenance and access to water for a varied set of users, thus contributing to livelihoods and food security. The *mfongo* irrigation system has already been developed to serve new purposes, and it has been spread by Chagga migrants who replicated it, for instance in Babati. However, the argument that lessons from local knowledge in irrigation organisation can be extracted and replicated elsewhere by actors in development, is somewhat weakened by the observation that strengths in local organisation are related to factors such as the link between investment in the scheme and rights to water, and the way hydraulic institutions are embedded in other institutions and normative systems. Nevertheless, knowledge of practice in the local organisation of irrigation can be important in the negotiation of irrigation redevelopment projects as well as water management reform processes. It may also provide some alternative models, for instance in the general meeting where access is linked to the contribution to the scheme, or in the proportional principle in water allocation, reflected in the use of time schedules

and sequences, which can have advantages over volumetric principles in being easier to implement and in accommodating variable flows.

Reference list

- Adams, W. M. (1988). 'Irrigation before development: Indigenous and induced change in agricultural water management in East Africa.' *African Affairs*, 87, 519-535.
- Adams, W. M. (1989). 'Definition and Development in African Indigenous Irrigation.' *Azania*, (XXIV): 21-27.
- Allan, W. (1965). *The African Husbandman*. Edinburgh: Oliver & Boyd.
- Barth, F. (1967). 'Economic spheres in Darfur.' In R. Firth (Ed.), *Themes in economic anthropology* (pp. 149-174). London: Tacistock.
- Beez, J. (2005). *Die Ahnen essen keinen Reis. Vom lokalen Umgang mit einem Bewässerungsprojekt am Fuße des Kilimanjaro in Tansania*. Bayreuth African Studies Working Papers no. 2. Bayreuth: Universität Bayreuth.
- Bruns, B. R. and R. Meinzen-Dick (2000). *Negotiating water rights*. London: ITDG publishing.
- Chambers, R. (1977). 'Men and Water: the Organisation and Operation of Irrigation.' *Technology and change in rice-growing areas of Tamil Nadu and Sri Lanka*. B. H. Farmer. Boulder, Colorado: 340-363.
- Coward, E. W. (1991). 'Planning technical and social change in irrigated areas.' In M. M. Cernea (Ed.), *Putting people first: Sociological variables in rural development* (pp. 46-72). New York: Oxford University Press, for World Bank.
- Davidson, T. (1997). 'Playing by the rules : cooperation, rules and water use in a Chagga irrigation system, Mount Kilimanjaro, Tanzania.' Unpublished M.Phil thesis. Dept. of Geography, Norwegian University of Science and Technology.
- Denzin, N. K. (1989). *The Research Act: A Theoretical Introduction to Sociological Methods*. Englewood Cliffs, N.J.: Prentice Hall.
- Fairhead, J. and M. Leach (1996). *Misreading the African landscape. Society and ecology in a forest-savanna mosaic*. Cambridge: Cambridge University Press.
- Feierman, S. (1990). *Peasant intellectuals. Anthropology and History in Tanzania*. London: The University of Wisconsin Press.
- Fleuret, P. (1985). 'The social organisation of water control in the Taita Hills, Kenya.'

Appendix 1

- American ethnologist : A journal of the American Ethnological Association*, 12, 103-118.
- Fosbrooke, H. A. and P. I. Marealle (1952). 'The engraved rocks of Kilimanjaro: Part 1.' *Man*, (52), 161-162.
- Fréon, M. (2004). 'L'irrigation traditionnelle á Uru Mashariki, versant sud du volcan Kilimandjaro: un témoin de l'identité Chagga.' *IFRA Les cahiers d'Afrique de l'Est* (26), 49-73.
- Gillingham, M. E. (1999). 'Gaining access to water: Formal and working rules of Indigenous Irrigation Management on Mount Kilimanjaro, Tanzania.' *Natural Resources Journal*, 39(3), 419-441.
- Gillson L., M. J. Sheridan and D. Brockington (2003). 'Representing environments in flux: case studies from East Africa.' *Area*, 35(4), 371-389.
- Griffith, A. W. (1930). *Chagga Land Tenure Report*. Moshi. Document in the East Africana collection of the UDSM library [EAF CORY 272].
- Gutmann, B. (1926). 'Das Wasserrecht. Dargestellt nach dem Bewässerungssystem der Wamotsi und Wambokomu' In B. Gutmann, *Das Recht der Dschagga. Mit einem Nachwort des Herausgebers* (pp. 413-421). München: Beck.
- Howard, M. T. & A. V. Millard (1997). *Hunger and Shame: Poverty and Child Malnutrition on Mount Kilimanjaro*. New York: Routledge.
- Hunt, R. C. and E. Hunt (1976). 'Canal Irrigation and Local Social Organization.' *Current Anthropology*, 17(3), 389-398.
- JICA (Japanese International Cooperation Agency) (2002). *The Study on the National Irrigation Master Plan in the United Republic of Tanzania*. Dar es Salaam: The Ministry of Agriculture and Food Security.
- Johnsen, T. R. (1969). *Wachagga: Kaffepriser og jordbruksknapphet. Problemer i et øst-afrikansk småbrukersamfunn*. Unpublished Thesis for the Mag. Art. degree in Social Anthropology. University of Bergen.
- Johnston, H. H. (1886). *The Kilima-njaro Expedition. A Record of Scientific Exploration in Eastern Equatorial Africa. And a General Description of the Natural History, Languages, and Commerce of the Kilima-njaro District*. London: Kegan Paul, Trench and Co.
- Keesing R. M. (1981) *Cultural Anthropology. A Contemporary Perspective*. Fort

Worth: Holt, Rinehart and Winston Inc.

- Kersten, O. (1869) [1978]. *Baron Carl Claus von der Decken's Reisen in Ost-Afrika in den Jahren 1859 bis 1865. Erster band. Erzählender Theil.* 1st. Ed Leipzig 1869. [New edition Graz 1978. Akademische Druck und Verlagsanstalt.]
- Kikwete, J. K. (2005) 'Speech by the President of the United Republic of Tanzania, his excellency Jakaya Mrisho Kikwete, on inaugurating the fourth phase parliament of the United Republic of Tanzania.' Parliament buildings, Dodoma, 30 December 2005 Available from: http://www.tanzania.go.tz/hotuba1/hotuba/051230_bunge_eng.htm [Accessed 18.01.2006].
- Mehta, L., M. Leach, P. Newell, I. Scoones, K. Sivaramakrishan and S. Way (1999). 'Exploring understandings of institutions and uncertainty : new directions in natural resource management'. *IDS Discussion Paper 372*. Brighton, Institute for Development Studies.
- Molohan, M. J. B. (1960). *Annual reports of the Provincial Commissioners for the year 1959. Northern Province.* Dar es Salaam: Government printer.
- Moore, S. F. & P. Puritt (1977). *The Chagga and Meru of Tanzania.* (Ethnographic survey of Africa. East Central Africa, 18). London: International African Institute.
- Moore, S. F. (1986). *Social Facts and Fabrications. 'Customary' Law on Kilimanjaro 1880-1980.* Cambridge: Cambridge University Press.
- Mosha, R. S. (2000). *The heartbeat of indigenous Africa: A study of the Chagga educational system.* New York: Garland Publishing.
- Mung'ong'o, C. (1997). 'Pangani Dam Versus The People.' In A. D. Usher (Ed.), *Dams as Aid. A political anatomy of Nordic development thinking* (pp. 105.118). London: Routledge.
- Mturi, A. A. *Archaeology of Tanzania.* Dar es Salaam: The Open University of Tanzania, Faculty of arts and social sciences.
- New, C. (1873) [1971]. *Life, wanderings and labours in Eastern Africa. With an account of the first successful ascent of the equatorial snow mountain, Kilima Njaro and remarks upon East African Slavery.* London. Frank Cass & co. Ltd. [3rd edition. 1971]

Appendix 1

- Odner, K. (1971). 'A preliminary report on an archaeological survey on the slopes of Kilimanjaro.' *Azania*, (6), 131–149.
- Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action*. Cambridge, Cambridge University Press.
- Rebmann, J. (1860). 'Journey to Jagga.' In J. L. Krapf (Ed.), *Travels, Researches, and Missionary Labours During an Eighteen Years' Residence in Eastern Africa. Together with Journeys to Jagga, Usambara, Ukambani, Shoa, Abessinia, and Khartum; and a Coasting Voyage from Mombaz to Cape Delgado*. (...) (pp. 230-265). London: Trübner and Co..
- Schanz, J. (1913). *Mitteilungen über die Besiedlung des Kilimandscharo durch die Dschagga und deren Geschichte*. Baessler-Archiv. Beiträge zur Volkerkunde, beiheft 4., Leipzig: Teubner.
- Sheridan, M. J. (2001) 'Cooling the Land: Politics, Ecology, and Culture in the North Pare Mountains of Tanzania.' Unpublished PhD thesis. Boston University, Graduate School of Arts and Sciences.
- Sheridan, M. J. (2002). 'An irrigation intake is like a uterus: culture and agriculture in precolonial North Pare, Tanzania.' *American Anthropologist*, 104 (1), 79–92.
- Stahl, K. (1964). *History of the Chagga People of Kilimanjaro*. London: Mouton & Co.
- Tagseth, M. (2002). 'Local practices and changes in farmer managed irrigation in the Himo Catchment, Mt. Kilimanjaro.' In J. O. Ngana (Ed.), *Water Resources Management. The Case of Pangani River Basin. Issues and Approaches* (pp 48-63). Dar es Salaam: Dar es Salaam University Press.
- Tagseth, M. (2003). 'Genealogy as a source to the establishment of water furrows. Examples from Mt. Kilimanjaro, Tanzania.' In Dahlberg, A., Öberg, H., Trygger, S., Holmgren, K. & Lane, P. (Eds.) *Second PLATINA workshop 17-19 October 2002. Usa River, Arusha, Tanzania*. (Working Paper from the Environment and Development Studies Unit 46.) pp. 36–37. Stockholm. The University of Stockholm and the British Institute in East Africa. [Available from: http://130.237.186.140/Platina/content/files/Platina%20report%20Tz/report2_www.pdf]

Irrigation amongst the Chagga in Kilimanjaro, Tanzania

- Tagseth, M. (2006). 'The "mfongo" irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania'. T. Tvedt, R. Coopey, E. Jakobsson & T. Ostigaard (Eds.). *A History of Water. Volume 1: Water Control and River Biographies* (pp. 488–506). London: I.B. Tauris.
- Tagseth, M. (2008a). 'Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania.' *Norwegian Journal of Geography*, 62(1), 9 – 22.
- Tagseth (2008b). 'The expansion of traditional irrigation in Kilimanjaro, Tanzania' (In M. Widgren, N. T. Håkansson, and L. Börjeson (Eds.), *The Political Ecology of Trade, Food Production, and Landscape Transformations in Northeast Tanzania: 1850–2000*). *The International Journal of African Historical Studies*, 41(3), 461–490.
- Tagseth (2009). 'Social and Cultural dimensions of irrigation management in Kilimanjaro'. In T. A. R. Clack (Ed.), *Culture, history and identity: Human-Environmental Relations in the Mount Kilimanjaro Area, Tanzania* (pp. 89-105). Oxford: Archaeopress.
- Tiffen, M., M. Mortimore and F. Gichuki. (1994). *More people, less erosion: environmental recovery in Kenya*. Chichester: J. Wiley.
- UNDP (2005) '*Human Development Report 2005. International Cooperation at a Crossroads. Aid, Trade and Security in an Unequal World.*' New York: United Nations Development Programme.
- Usher, A. D. (1997). 'Pangani power struggle. Nordic dam builders on a Tanzanian river.' In A. D. Usher (Ed), *Dams as Aid. A political anatomy of Nordic development thinking* (pp 119-132). London: Routledge.
- Vincent, L. (1995). *Hill irrigation: water and development in mountain agriculture*. London: Intermediate Technology Publications on behalf of the Overseas Development Institute.

Appendix 1

- Wallace, G. B. and M. Wallace (1953). 'Magonjwa ya Mtama.' *Tanganyika. Department of agriculture. Pamphlet no. 55, 32.* Dar es Salaam. Government Printer. [UDSM East Africana collection: EAF per s357.a35.no3 irrigation.]
- Wimmelbücker, L. (2002). *Kilimanjaro - A Regional History. Vol 1 - Production and Living Conditions: c. 1800-1920.* Münster: LIT Verlag.

Paper 2:

Oral history and the development of indigenous irrigation.

Methods and examples from Kilimanjaro, Tanzania⁸⁴

Abstract: The article discusses methods to approach events and processes in indigenous irrigation prior to recorded history or from sparsely documented history. Kilimanjaro in Tanzania remains the largest centre of traditional hill furrows in eastern Africa. A considerable infrastructure was developed before the 20th century, supporting relatively dense population concentrations. It is argued that the establishment and management of the canal infrastructure depended on institutions which could contribute to knowledge of the development of irrigated agriculture. The method uses oral history to study two patrilineages and their relationship to the canals in their neighbourhood on Mt. Kilimanjaro. The development of the local irrigation traditions is central to the history of settlement and livelihoods the region, and of relevance to the history of intensive agriculture.

Introduction

On the fertile volcanic slopes of Mt. Kilimanjaro in northeastern Tanzania (Fig. A2:1), the Chagga people continue to rely on an extensive infrastructure of irrigation, based on a local technology of 'hill furrows'. These are stream diversion irrigation systems, which lead water out of the stream valleys and onto the densely settled ridges, where water is used for irrigation of arable crops and agroforestry groves and as a part of the general water supply. The furrows are built using locally available materials and technology, and associated customs, practices and institutions ensure water distribution and maintenance.

⁸⁴ This manuscript was published as: Tagseth, M. 2008. Oral history and the development of indigenous irrigation. Methods and examples from Kilimanjaro, Tanzania. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography* 62, 9-22.

Appendix 2

The Chagga people of Kilimanjaro, like several other groups in the highlands of north-eastern Tanzania (e.g. Shambaa, Pare, Gweno, Meru), have developed specialized and intensive ways to manage and utilise the zone where plantains (savory bananas) thrive in combination with other upland and lowland resources. The slopes of Mt. Kilimanjaro have some of the highest rural population densities in eastern Africa and people there have attempted to deal with the challenges of relatively intense pressure on their resources for some time. Observers described the area as being severely overpopulated more than 75 years ago (Griffith 1930). However, farmers have been able to intensify production and accommodate substantial growth since then. Local knowledge together with innovation have made continued growth possible. Hydraulic control, zero grazing, terracing, and the *kihamba* system of agroforestry based on plantains and coffee in combination with other crops under shade-providing trees are lessons of survival from this area.

Farmer-managed irrigation in eastern Africa has received attention during the last two decades. Over a long period of time the hill furrow systems of Mt. Kilimanjaro variously have been hailed as ingenious or scorned as wasteful by observers. From the perspective of water management, concerns have been voiced about the availability of water downstream due to an assumed recent growth in water use in traditional irrigation on Mt. Kilimanjaro, and also what is perceived as wasteful use of water (Daluti 1994; United Republic of Tanzania - Ministry of Water Energy and Minerals 1994). These 'traditional' irrigation systems contribute not only to the subsistence of dense population concentrations but also to the Chagga identity as part of the cultural heritage. However, empirical knowledge of the adoption of the technology and the subsequent expansion of the irrigation systems of Kilimanjaro has been lacking, despite an attempt by Masao (1974) to draw attention to the question. In turn, this has made it difficult to address adequately questions of the dynamics and spread of irrigated agriculture, and its causes. The hill furrow systems in eastern Africa are seen as an important part of the history of sustainable intensive agriculture in the region (Widgren 2004), and they are presented as an example of indigenous knowledge (Adams 1992).

Water control on the slopes of Mt. Kilimanjaro can be described as a part of a complex, the 'East African hill furrow', which is found in locations along the rift valley systems. Adams (1988) identified three main clusters of indigenous hill furrow

Oral history and the development of indigenous irrigation

irrigation: Kerio Valley in Kenya, Sonjo with Engaruka and Pagasi (c.40 km to the north of Sonjo), and Kilimanjaro. Today, the highest density of schemes is found in the 'Kilimanjaro cluster', which includes the highland areas of Machakos, Taveta and Taita in Kenya, the slopes of Mt. Meru, the Pare Mountains, and the Usambaras. There has been further research in the past two decades into indigenous land and water resources management in sub-Saharan Africa, especially into indigenous irrigation systems and water harvesting (Adams & Watson 2003). Descriptions of irrigation in the Kilimanjaro cluster have been made by Grove (1993), Holand (1996), Mosgrove (1998), Gillingham (1999), Tagseth (2002), and Devenne (2006) for Mt. Kilimanjaro, Beez (2005) for the Kilimanjaro lowlands, Fleuret (1985) for the Taita hills, Mascarenhas et al. (1985) and Hakansson (1995) for the South Pare Mountains, and Sheridan (2002) for the North Pare Mountains.

Widgren (2004) has questioned why some areas have continued to sustain high numbers of people pursuing intensive agriculture, and has sought to explain the location and development of 'islands of intensive farming'. Östberg (2004) discussed the emergence and expansion of hill furrows at Marakwet, Kenya, in relation to several explanations distilled from the literature. The first of these explanations is based on evolution, where society progresses from less advanced to more advanced stages. The second explanation is based on population growth, including the Boserupian explanation whereby population growth forces agricultural intensification (Boserup 1965). The third explanation relates to markets and exchange, where intensification or growth in irrigation is related to exchange with groups pursuing pastoralist or other alternative livelihood strategies, or to the provisioning of the caravan trade. The fourth is political centralisation, including Wittfogel's (1957) thesis that the development of hydraulic control presupposes political centralisation. The fifth explanation is politics and the hypothesis of siege, which presupposes that intensification relates to localised high population densities that have developed out of security needs. Sixth are explanations based on ethnicity, which include the discredited notion that 'more advanced' people had introduced the technology in the past. Östberg argues against single-factor explanations. Adams (1989) questioned whether indigenous irrigation should necessarily be seen primarily as an intensive form of agriculture,

Appendix 2

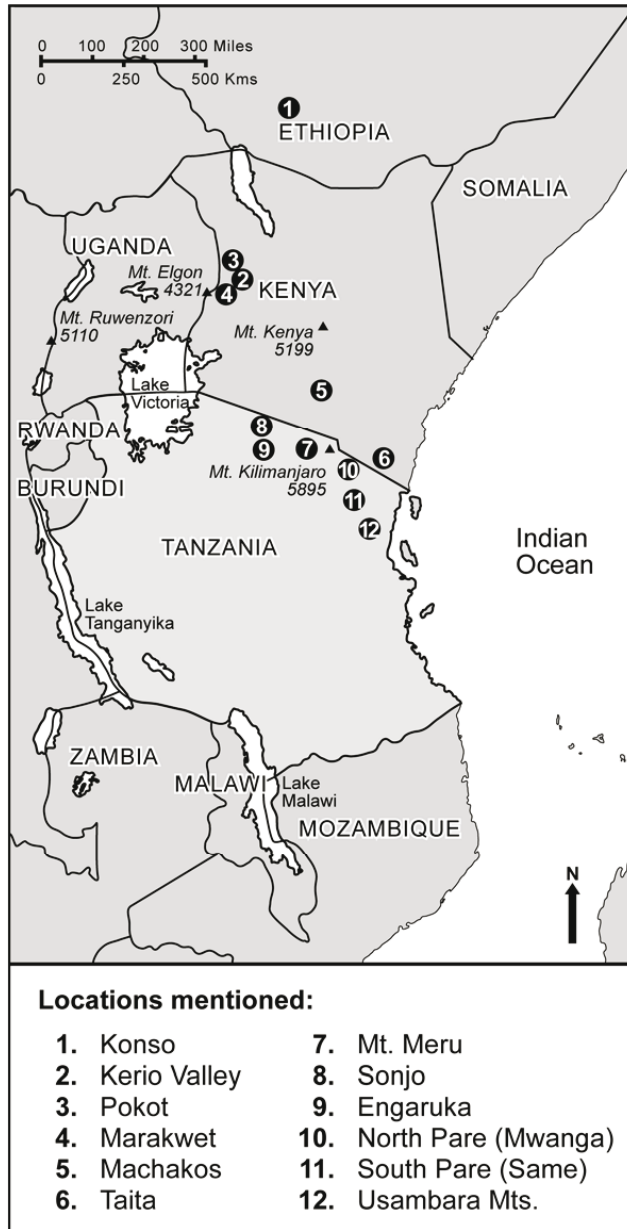


Fig. A2:1. Location of Mt. Kilimanjaro in Tanzania

or whether it could be explained in terms of adaptation to localised resources or in terms of risk management. Sutton (1984) suggests that some of the claimed instances of intensive agricultural systems are better understood as specialised.

Increasingly, it is acknowledged that claims about changes in resource use or the environment need to be grounded in empirical and diachronic studies of such changes (Niemeijer 1996). This basic notion and associated methodological innovations underlie studies which challenge established ideas about processes and directions of environmental change in Africa (Tiffen et al. 1994; Fairhead & Leach 1996). Alternative methods are needed to investigate past use of the environment in order to assess changes in the environment and livelihoods, and to overcome the notion of a static, pre-development past. Local practices of resource use, such as farmer-managed irrigation, often remain inadequately documented, even for historical periods. The objective of this article is to explore oral history as a method to access the history of resource use, with irrigation furrows established in a phase prior to colonial impact as an example. It is argued that the history of water use can be sought in the oral history of the institutions involved in the management of the irrigation schemes. On the slopes of Mt. Kilimanjaro, in most cases this is the sedentary patrilineage or 'clan'.

This article explores the utilisation of place- and community-specific knowledge in the reconstruction of early furrow development. Following the introduction and background to the irrigation practice, methods from research on the development of hill furrow systems in eastern Africa are reviewed. Some oral history of the irrigation, water and settlement is reviewed before the case study of irrigation in an upland settlement in Mt. Kilimanjaro is presented.

Historical background

The irrigation tradition on the southern slopes of Mt. Kilimanjaro can be called *mfongo* irrigation, from the term denoting an irrigation ditch in the local vernacular (Kichagga). The *mfongo* technology has been described in sources starting with 19th century European travellers, who documented the technology as characteristic of resource use in locations around Mt. Kilimanjaro. Rebmann (1860, 242) reported the construction of canals by the clients of *mangi* (Kichagga: prince, chief) Masaki and the practice of zero

Appendix 2

grazing following a visit to Kilema in 1848. More detailed incidental reports from subsequent decades show that irrigation infrastructure was developed in locations across the southern slope of Mt. Kilimanjaro (von der Decken 1869; Johnston 1886; New 1971 [1873]).

More detailed sources on the technology and its extent date from throughout the 20th century. The extensive hill furrow irrigation in the uplands was in conflict with the needs of European planters settling downstream on the lower slopes of Mt. Kilimanjaro from the beginning of the century. Changing colonial and post-colonial governments have aimed to bring water use in indigenous irrigation under their control since at least 1908 (Government of Tanganyika 1956). The record left as a result of past concerns with water management can be exploited for new purposes. In the first systematic study of indigenous irrigation in Kilimanjaro, Gutmann (1926, 371) estimated that there were more than 1000 furrows on Mt. Kilimanjaro probably preceding the advent of World War I. He found 66 canals in the districts of Old Moshi and Mbokom alone (Gutmann 1926, 374), within an area served by 65 schemes today (Sarmett et al. 1997; I.J. Matcha, Regional Hydrologist-Kilimanjaro, unpublished data). Irrigation engineer Buckland (1939, 1940) found 602 furrows in a partial survey of the southern slopes in the period 1939-1940. Water warden Pike supervised a mountain-wide survey of furrows in 1959. Pike (1965) may have considered his survey number of 726 furrows (Molohan 1960) to be incomplete as the figure did not appear in his article, where he wrote: '(T)here are now so many furrows, most houses on Kilimanjaro are within a very short distance of one' (Pike 1965, 96). The results suggest a decline in the furrow technology during the intervening 20-year period. The thesis of a decline in the furrow technology in the highlands received support from Burra & van den Heuvel (1987), who relied on the Water Master Plan figures in estimating that the number of schemes had declined from 1000 to 500 between 1960 and 1986. A more comprehensive survey was made in the mid-1990s, when 1388 'traditional furrows' were registered in the administrative Kilimanjaro Region (Pangani River Basin Water Office, unpublished data).

Data compiled on changes in water use in one catchment on the south-eastern slope of Mt. Kilimanjaro (the Himo River) in the period 1940-1992 showed a 41% decline in the number of furrows, but stability in dry season water abstraction (Tagseth

Oral history and the development of indigenous irrigation

2002, 55). The abandonment of small furrow schemes was accompanied by an increase in the average size of the surviving schemes. The dry season throughput per scheme increased from 11 litres per second to 19 l/s during the same time period. Schemes in this area were established during different periods in different altitude zones on the slope (Tagseth 2002, 62; J.M. Kobalyenda, Principal Water Officer, unpublished data). The available information documents the early development of a substantial infrastructure of water conveyance, and relative stability in the abstraction of water throughout the 20th century. Hidden behind this stability lie important changes, such as a declining reliance on furrows in the old irrigation districts upslope and the development of new schemes and uses of irrigation in other areas, primarily downstream (Tagseth 2006, 496). Devenne (2006) mapped the development of schemes in Mbokom at Kilimanjaro from aerial photos in combination with interview data. He indicated that the existing nine schemes were all present in the 19th century, and that while canals have been extended, no schemes have been added or abandoned in the area. While the utility of recreational GPS for detailed mapping was limited by selective availability in the 1990s, the current accuracy permits mapping at the scale of c.1:50,000. This has been exploited by M.I.J. Davies (unpublished data), who has mapped and classified the infrastructure in an area in Pokot (Kenya) as belonging to broad time periods on the basis of interview data. In this way he was able to show a dynamic where new schemes were added in an upslope expansion of the system, while some of the old infrastructure was abandoned. In the present study registration of scheme layout and the irrigation network are limited to participatory sketch mapping and the recording of sequences of schemes belonging to the left and right banks of streams.

A methodological review

Masao (1974), an archaeologist from Kilimanjaro, raised the issue of the antiquity and the dating of furrow irrigation in an article in *Tanzania Notes and Records* intended to provoke further research on the issue. He complained that mention of the *mfongo* system in the literature was usually brief and often inaccurate. Masao has provided original contributions to the ethnography of irrigation and oral traditions in the landscape of Uru, but he relies heavily on Kathleen Stahl's (1964) political history of

Appendix 2

Kilimanjaro. Masao (1974) found that the technology of the *mfongo* water furrows and the *nduwa* (collection ponds used for short-term water storage) is as old as the Chagga people. This resonates well with current oral traditions, which claim that irrigation has been practised since ‘time immemorial’. Masao correlated the history of irrigation with the history of settlement. *Mangi* Marealle’s (1952) assessment that the Chagga settlement is as young as 300-400 years was accepted. However, this dating, which is based on the history of the royal family, is contradicted by other sources available to Masao (e.g. Stahl 1964), and by archaeological findings which identify Marealle’s home village as an Early Iron Age agricultural site (Odner 1971) which had previously been identified as an old habitation site through oral tradition (Schanz 1913). The archaeology strengthens oral history claims that the area was settled by other lineages prior to the advent of the ancestors of the Marealle from Ukamba. The implied thesis of a relationship between settlement and canal development is an interesting issue, but it should be substantiated. In this section, I will review some methods for dating furrow schemes.

In his analysis, Masao (1974) introduced two methods for dating. The first relies on the history of settlement to establish the date of furrow construction. It also suggests reliance on the naming of schemes to explain how and why a place was settled. The Masale furrow in Mbokom is a comparatively large scheme which carries 60 l/s (Pangani Basin Water Office, unpublished data). It was identified as one of the oldest furrows by Masao (1974) on the basis of its unusual name, which does not derive from a person. The name refers to *masale* plants (Kichagga: *dracaena* ssp.), which are present along the head reaches of the furrow (personal observation, November 2002). The *masale* are symbolically important and sacred. Uprooting them without due precaution is understood as dangerous. The plant can serve as a cultural marker because of its use on grave sites and boundaries, where it often remains. Etymologically, the Masale furrow could thus be taken to be the ‘furrow of peace’, or ‘the ancestral furrow’. In this case, however, the inference from the name is in conflict with the local explanation. The name was said to derive from *masale* plants claimed to be growing wild at the furrow (interview November 2002, in Mbokom, Moshi Rural District). The proposition is methodologically interesting; place names have been exploited more systematically as a source for identifying prehistoric settlements in other places. Other place names which

Oral history and the development of indigenous irrigation

might refer to irrigation could be investigated; for example, Nduweni and Ndiveni (in Marangu, Moshi Rural District and Lembeni, Mwanga District respectively) refer to ponds which could be artificial. Furrows at Sasseni (literally 'at the furrows') in Same district are documented from a place name in the 19th century (Baumann 1891).

The second method involves dating from oral tradition by correlating the initiation of furrows with the better-known succession of 'chiefs' and from major contemporaneous events. In doing this, Masao relied on the record of political history, the chiefs and heroes of the past, which was Stahl's (1964) main concern. In this way, the initiation of the Teshena furrow in Mbokom, ascribed to the agency of a Mrecha clansman, could be dated to the period 1830-1845, when Masha Mrema became the first ruler of Mbokom. However, by that time members of the same family, in the same district, already controlled the Mrambo furrow. This older furrow situated next to the Masale furrow could not be dated with this methodology, as there was no record of 'chiefs' to compare with. The Mrambo furrow, possibly initiated before the 19th century, still serves the Korini area in Mbokom (personal observation, November 2002), and it carries 30 l/s from the Mrusunga River (Pangani Basin Water Office, unpublished data).

Thus, one limitation of the method suggested by Masao is that it is of limited use for periods preceding political centralisation. Another problem is the reliance on a link between furrow creation and chieftaincy, which is weaker than historians from the period of indirect rule tended to assume (Dundas 1924; Stahl 1964). Masao's observation that the establishment of furrows in Mbokom district preceded the advent of the chiefs there is supported by similar stories, for instance the tradition on the advent of the ancestor of the chiefly lineage of the Marangu district (Schanz 1913; N. Mtui, unpublished data).ⁱ The reliance of irrigation on political centralisation has also been denied for other clusters of early irrigation, in the Pare Mountains (Kimambo 1996), the Usambara Mountains (Feierman 1990), and in the nearby Taita hills in Kenya (Fleuret 1985). Throughout this area, irrigation development depended on a more basic unit of social organisation, the sedentary patrilineage. Communities along the Rift Valley with less political centralisation have also been able to develop irrigation traditions (Östberg 2004).

Appendix 2

The hill furrow technology of highland peoples in north-eastern Tanzania is not altogether dissimilar to the irrigation technology known from places along the Rift Valley, for instance, Konso, Marakwet, Engaruka, and Sonjo. Soper (1983), who surveyed the irrigation systems of the Marakwet, Kenya, was also interested in dating the systems. Here, the organisation of irrigation depends on the age set. In age-set systems, young people (men) are grouped together into a named corporate unit. As they become older they remain together in the same group, and rise together in seniority within a hierarchy of such sets (Keesing 1981, 275). The dating of construction through correlation with the social organisation in age sets appeared to be a sensible proposition, but it failed because informants could not provide the necessary supporting data. Soper (1983, 78) was disappointed that '(h)istorical traditions among the Marakwet appear to be poorly developed, or at least have not been collected and studied to give any sort of coherent picture'. There were inconsistencies or lack of agreement even in the naming of the schemes. However, it was consistently claimed in oral tradition that the first furrows were already existing when the forefathers of the Marakwet arrived from the north and met signs of old occupation and one old man living high up on the escarpment.

Soper's second proposition was to use radiocarbon dating. This seemed initially tenable, since Marakwet people tend to use a lot of wood in their furrow construction. However, the prospects for dating the canals directly by archaeological means were judged as poor, 'given the constant maintenance and replacement of wooden structural components which might be dated by the radiocarbon method' (Soper 1983, 78). Direct dating of an irrigation system, for instance through analysis of charcoal found in deposits (Francaviglia 2000), has since been achieved elsewhere, and should be possible in eastern Africa through specialised archaeological methods. Further knowledge is likely to follow when archaeological excavations in the areas with long established and active traditions of irrigation commence (D. Stump, personal communication 2007). Radiocarbon dating of forest glades (Pomel 1999) shows that anthropogenic change in the environment has a history of 5000 years on the higher slopes of Mt. Kilimanjaro. Odnor (1971) identified evidence of Iron Age Bantu agriculturalists from the late first and early second millennium AD from charcoal found in association with pottery. However, there would be problems of validity in applying indirect indicators from

settlements or fields to the history of irrigation at Mt. Kilimanjaro. Another possibility mentioned by Soper (1983) was to rely on core samples from the sycamore fig trees along the canals as sources of carbon for analysis, on the assumption that these could not have established themselves prior to the construction of the canal because they depend on seepage from it. The main problem appears to be the decomposition of the trees' cores and the number of samples needed in order to establish the oldest tree. Vegetation influenced by seepage from an irrigation system is common in other locations. Dendrochronology in eastern Africa has advanced over the past decades (Martin & Moss 1997; Maingi 2006). The sycamore fig has been judged a poor candidate (Maingi 2006), and inferences from the number of rings observed on the stump of an old fig on top of an irrigation structure would be unreliable (personal observation, Ugweno Division, Mwanga District, 2003). Tree rings can serve as proxies for precipitation because moisture is the main restriction on growth (Therrell et al. 2006). In the Mediterranean region it has been shown that remains of olive trees hold a record of the effects of past irrigation (Terral & Durand 2006). It is possible that seepage from a canal has effects on tree growth which can be analysed, but the use of vegetation as an indicator remains unexplored.

Soper had more faith in his third proposition, which was to rely on the stratigraphy of the network of canals to establish the succession of establishment. Thus, 'in the Embobobut system a relative sequence of construction can be postulated on the basis of superposition, on the assumption that where furrows cross, the upper one was built later' (Soper 1983, 78). The main problem with this methodology for establishing a sequence of construction is that it depends on the use of aqueducts, which is less common in other furrow systems. In some cases, for instance where a more recent furrow has cut off an older furrow, it is possible to make inferences about sequence from the morphology of the canal network. Through excavations at the abandoned Late Iron Age site at Engaruka, Stump (2006) has shown that processes and sequences in the development of the system of terraced fields and furrows can be defined by examining the stratigraphy of the site through excavation. The *mfongo* canal schemes are seldom built once and for all, and it may be difficult to find carbon for dating since there is little use of wood in the construction of canals in Kilimanjaro. Wood was used in the past for the *ilalo* (Kichagga: aqueduct), but this construction method was not widely used.

Appendix 2

Wooden pegs were used in the initial constructions of canals, but these may not have been durable. Wooden boards are used in the outlet of the collection ponds, but these are periodically replaced (personal observation of the construction of canals and the reconstruction of a collection pond in Ugweno and Lembeni Divisions, Mwanga District, 2002). Collection ponds (Kichagga: *nduwa*; Kigweno & Chasu: *ndiva*) for short-term storage of furrow water or spring discharge are not as common on the slopes of Mt. Kilimanjaro as they are in the Pare Mountains, and there appears to have been a decline in their use. Some *ndiva* in Ugweno in the North Pare Mountains have large fig trees standing on the very crest of the dam. These indicate old age and could be subject to further analysis. An important institution in the management of irrigation was the meeting that followed completion of maintenance work. At least from the late 19th century onwards, the work party would meet at a certain dam under the shade of a fig tree and drink together a brew of cane juice (Chasu: *dengeluo*) fermented in a pot rested between its roots when the distribution of water was to be agreed upon and libations offered to ensure success in irrigation. While an old fig straddling the crest of a dam can serve as evidence based on stratigraphic principles, it can also feature in oral history because of institutions associated with it (fieldwork, Ugweno Division, Mwanga District 2003).

In approaching the problem of irrigation history, my training directed me towards the use of the interview, in combination with observation and the landscape. My methodological proposition, generalised from suggestions by Masao (1974) and Soper (1983), is that dates and sequences in resource management can be found through *correlation with central social institutions* involved in the phenomenon. This type of oral history depends on the identification of people with *specialist knowledge*, and of the relevant *institutions*. A central objective is to find a sufficient density of sources to make it possible to compare them. Stahl (1964) and Masao (1974) correlated canal construction with the succession of *wamangi* (Kichagga: princes, chiefs), since these were taken to be important agents. Soper (1983) attempted to correlate furrow establishment with the age set mobilised in the construction effort. In the highlands of Kilimanjaro Region, irrigation management has usually depended on groups defined by kinship and residence. A promising option which has not yet been fully explored is to rely on the close relationship that informants have to their home area and to their family,

Oral history and the development of indigenous irrigation

and on the specialist knowledge of the furrow elders and their families. For the study area, my proposition is to rely on the history of *sedentary patrilineages* which have an acknowledged relationship to specific *mfongo* canals and *ndiva* ponds. This method permits the establishment of dates or sequences through genealogical dating, and yields data for the reconstruction of *place- and group-specific environmental history*.

There are several difficulties in the use of the oral history of resource use. It is generally acknowledged that oral history in relation to contested resources such as land and water is influenced by discursive strategies (Fortmann 1995). This can partially be accounted for by seeking to understand conflicts within the community and between the community and outside actors, which requires fieldwork (Fairhead & Leach 1996). In the case of an irrigation furrow in lower Marangu, the leaders elected by members of an upstream village were challenged by the heir of the scheme who claimed that the furrow could not work well because it had been taken from his father without compensation, and was affected by a conditional curse which had to be lifted. A response from those leaders was to claim that the scheme was not the same following realignment during rehabilitation. In my presence, as a student from Europe who might have contacts interested in sponsoring further rehabilitation, they argued that such claims and problems were now void. Walking with other informants, I was not able to identify the old alignment in the field. The story of the realignment could thus be interpreted as a mythical construct, or alternatively as one of several histories of a contested scheme. In addition to seeking out different sides of the story, it is possible to add cases where conflicts are different, or to use historical material as a control for the effect of current struggles over resources. Lawi (2003) has argued that oral traditions should be used in combination with other sources. While historical sources on local level resource use can be scarce or imprecise, even for recent periods, the landscape can act as a control. Method triangulation can be achieved by investigating more cases, recruiting informants in different positions, or by drawing on other studies. Feedback from national and global environmental discourse and a desire to please (Fairhead & Leach 1996, 72-73) and the objective of claiming good ecological stewardship to outsiders (Fortmann 1995) can lead to problems of acquiescence in the oral history of resource use. This can be countered through extended fieldwork and building relationships. Börjeson (2004) was able to reinterpret changes in agriculture in Mbulu on the basis of detailed mapping

Appendix 2

combined with interviews undertaken in the actual fields, among other methods. I argue that oral histories specific to locations (fields, irrigation schemes) and actors are more reliable than statements on general conditions. The present study pursues the history of water use in the biographies of specific schemes and groups of people.

Early irrigation development in the light of oral history

The analysis of interviews with scheme managers on the establishment and management of 16 furrows along a transect across the slope of Mt. Kilimanjaro at Himo-Marangu (Fig. A2:2) indicates that schemes have been established during different periods on different sections of the slope (agro-ecological zones). Factors such as scale and the date of scheme establishment are influential in current irrigation organisation, which can be classified into three main types. A first type of irrigation management has no named irrigation union. Management relies on direct negotiation between members of the group of furrow users, under the authority of a furrow elder. A second main type is described as formal. It has a named group of users, elected leadership, and integration with the village government is common. In addition to these, a few large schemes were under the jurisdiction of chiefs. The abandoned, long Furrow of Blood (Kichagga: Mfongo o Samu), named after violent clashes over water between users from Marangu and neighbouring Mamba in the first 30 years or so of the 20th century, is one example. Another example is the precolonial (Lent 1896) Ufongo lo Mwika, a large multipurpose water delivery system for the Mwika district, which was abandoned in the 1950s after a pipe scheme was constructed. Most of the large schemes under the jurisdiction of the chiefs were abandoned in the 20th century.

Oral history and the development of indigenous irrigation

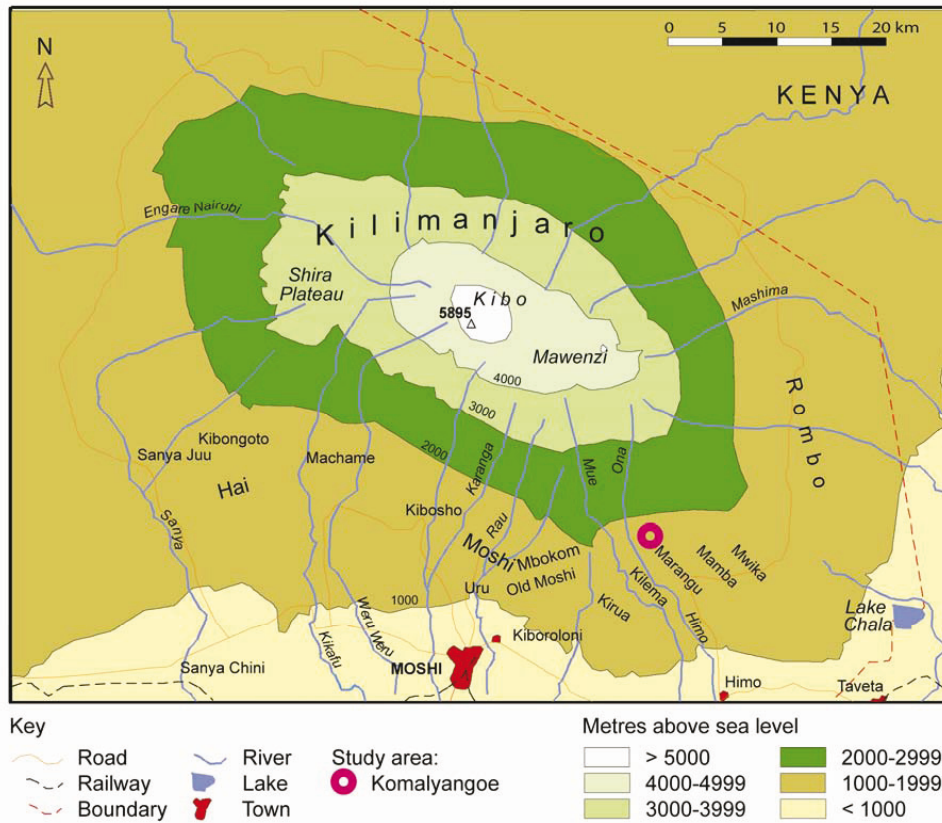


Fig. A2:2. Mt. Kilimanjaro and the location of the case study area.

At a very general level, it appears reasonable to assume early settlement of some prime locations. It is possible to identify some of these locations from oral traditions and through their place names. Settlements are often named after early settlers and sometimes by ecological characteristics. Hypotheses of early settlement could be developed on the basis of traditions of settlement, and the analysis of landscape elements such as the location of shrines, old markets, political centres, roads, place names, and patrilineage clusters. Moore (1986) suggests that new settlements could have been added first in a process of lateral expansion preceding upwards expansion. The settlement of the lower slope appears to be more recent. Regional processes of development, settlement and intensification in different sections of the slope are interrelated with the dynamics of furrow development. The period of scheme

Appendix 2

establishment correlates with irrigation organisation, and there is systematic variation along the slope.

Irrigation is integrated with culture and social organisation. It is rich in meaning, and idioms are taken from this realm in order to explain other facts of life. The furrow is a source of fertility. In North Pare, it has been shown that the irrigation scheme is associated with a gendered symbolism (Sheridan 2002). At Mt. Kilimanjaro, a similar symbolism is seen in prohibitions on female participation in matters of the furrow, and in the past practice when pregnant women did not cross furrows. Rainmaking was a source of political power in the 18th and 19th century, when such abilities could bring a *mangi* to power (N. Mtui, unpublished data). The political significance of rainmaking is more fully researched for the Shambaa people at Usambara Mts. (Feierman 1990), one of the sources of migrants to Mt. Kilimanjaro. Irrigation at Mt. Kilimanjaro has been secularised, but the authority of a furrow elder is still enforced by his ritual power and his relationship to the founder of the furrow. Furrow rites may have become less common and more discrete, but few furrow elders declared that they intended to discontinue libations for the furrow: 'My father was the last to sacrifice. I am responsible for doing it, but I have not done it yet... I must perform a sacrifice at the intake because the ancestors were able to get water from that intake. It is thanking God for giving us blessings.' (informant H, furrow chairman).

A tradition in Old Moshi attributes the start of irrigated grain cultivation there to a curse in c.1850 that *mangi* Salia would die before the harvest of finger millet. Salia tried to delay the sowing, but since he was blown up along with 39 others while drying his gunpowder, millet has been cultivated in the dry season when irrigation is required (Dundas 1924, 54-55). In Mbokom (fieldwork June 2002) (Masao 1974) and in Uru (I.S. Holand, personal communication 1997) there are traditions that the furrow surveyors were guided by red ants on the march. However, there is no commonly told story of an original adoption of the irrigation technology. This could be taken as an indication of an incremental development of irrigation from modest beginnings in a distant past. However, seemingly incidental information on furrows is not uncommon in oral traditions. A local historian, Nathaniel Mtui (unpublished data), recorded the legend of the arrival of the chiefly lineage in Marangu in a manuscript that was utilised by Stahl (1964). This document suggests that the Mboro family in the vicinity of the

Oral history and the development of indigenous irrigation

chief's place had autochthon rights (i.e. as originators) to their irrigation furrows, since these were established before *mangi* Lyimo arrived and established his chiefdom. This family no longer lives in the area (fieldwork November 2002). Likewise, it is mentioned that the son of *mangi* Lyimo was tricked to come to a furrow intake from the river Moonjo close to the Manyangwe stream in Marangu and killed there (N. Mtui, unpublished data). The version of this tradition reported by Schanz (1913) mentions two centres in modern Marangu which were conquered by *mangi* Lyimo, not far from sites identified in Odner's (1971) archaeological survey (the Marangu market site is broadly associated with a western centre and the Marangu TTC site is broadly associated with an eastern centre where the primary court is still located). A third site mentioned by Mtui (N. Mtui, unpublished data) is Fumwu Lya Meku (ancestor hill), a hilltop above the forest, which was the first base of Marealle's ancestors when they arrived from Kamba, and which is now a grave site and a shrine. If this legend could be relied upon as fact, a record would exist of several furrows in the central banana belt, established five or six generations before 1800. However, it is difficult to ascertain whether incidental information or the historical figure has been added to a core myth. Death or disappearance at a water source is a recurrent theme in the local lore of water in Moshi, Ugweno and Meru. This lore is involved in the definition of relationships between land and water resources and groups of people, and in the definition of political domains.

It can be argued that the link, both in fact and in memory, between farming and the politics of the chiefs is weak, and that early furrow development in some locations preceded the centralisation into proto-states. Moore (1986) has drawn attention to the neighbourhood and the patrilineage with its land (*ukoo*) as basic and resilient institutions in Chagga society. My proposition is to use the stability of these communities, and to develop methods to solicit community members' knowledge of their own home area, their families, and of the past micro-politics of survival. Information about the establishment of early furrows has to be sought for specific schemes, groups of people and areas, primarily among elders within the resident family branches descended from the furrow initiators.

The Chagga of Kilimanjaro are virilocal, and their settlements have developed into sedentary patrilineages (*ukoo*) which hold a common interest in land and other

Appendix 2

resources. The ideas of the ancestor cult are intertwined with the local discourse on rights in resources, and were subordinated and transformed rather than thrown out with the near universal adoption of Christianity. The virilocal pattern of residence and the tight bonds between people and their ancestral land make it possible to access location-specific oral history of considerable depth, namely the traditions of the area. Information on genealogy and settlement is remembered because it can be used in local struggles over resources such as water, but also because it may be needed in the explanation and remedy of misfortune and in the observance of avoidances. The initiator of a *mfongo* canal establishes management rights over a scheme, and the scheme is usually named after him (but schemes are often known as the furrow of a past furrow manager, not of the initiator). His patrilineal descendants have the right to appoint the new furrow elder, who usually serves for life. The authority of the furrow elder stems from his relationship to the furrow initiator. It is his obligation to call upon users of the water to carry out communal work on it. He is also the ritual head of the group of furrow users, and the one who can make offerings at the canal to ensure that the water flows smoothly when it is let in after repairs. In cases where nothing has broken the normal succession of furrow managers, elders with management rights remember stories of furrow establishment, as they are required to legitimise them.

Case study of an upland settlement

Komalyangoe village (Fig. A2:2) is well established and well supplied with water. It is typical of areas where the *mfongo* technology is carried on under family and neighbourhood organisation. The springs, natural waterways and artificial canals are so densely located that it can be difficult to locate a spot where one cannot hear the trickle of water. It is situated in the upper part of a landscape on the southeastern slope of Mt. Kilimanjaro named Marangu, 'a lot of water', describing the essential beauty that early settlers saw in this landscape. The village name may suggest that neighbouring settlements are older; the name is an ecological derivation, and describes a place where poles for construction can be collected. The local small-scale farmers recognise it as a traditional Chagga area. Such areas are distinguished by landscape features such as the dense vegetation of the small agroforestry groves, separated by hedges of *masale* (*dracaena* ssp.) and border trees. Interspersed are small open areas used for arable crops

Oral history and the development of indigenous irrigation

and lawns where grass is cut with sickles. The community is tightly knit along the lines of patrilineal affinity, but also by obligations of neighbourhood and friendship. The informal process of canal management relies on hereditary 'furrow chairmen', other local institutions and negotiations in the community of water users. Life in the core area is linked to Chagga identity, and to ideals of tradition and continuity. Access to canal water is part of all this, as expressed in the common blessing, 'may you sleep beneath a furrow' (Kichagga: '*Laa sera mfongo*'), which is still used.

There are two sources of furrow water: the Ruwa stream and its tributary, Kizuru stream. Both are spring fed, and they supply 36 individually named furrows. Of these schemes, 17 convey water to different sections of Komalyangoe village (personal observation October 1995, and executive officer of Komalyangoe village A. Minja, personal communication 1995). The canal network is extensive, and it has a high degree of connectivity (Fig. A2:3). There are c.30 households for each furrow scheme in the village, as compared to 50 households for each public standpipe. The schemes are generally small, with actual discharges ranging from 8 l/s to 42 l/s (M. Temu, water technician, personal communication 1996). The furrows and the locally acknowledged leaders were identified while walking with staff from Marangu West Ward. The furrow chairmen of four schemes and some other elders were recruited as informants and interviewed in several sessions. Relevant data and quotes from interviews with members of 65 households in the same area are also used in the analysis. The informants' identities remain anonymous in accordance with the provisions agreed upon with them, and instead they are represented by a capital letter.

First, I will describe some technical aspects of water control. Water is abstracted either from streams or springs, or sometimes from both. The stream water is checked by a small permeable dam, or by a stone wall which protrudes into the streambed, in order to create a hydraulic head. Dams are constructed with boulders, stones, twigs, and mud. Intake structures are often located at a point where the water flows more smoothly, such as at a pond, or where the stream divides naturally. Permeable structures and overflow structures are useful, as the stream flow is variable. Both large flow in the rainy season and low flow are problematic. It is necessary to repair or modify the check structures from time to time, after heavy rains, or when the flow is small. Evidently, quite often the furrow takes most of the available water during the dry parts of the year, yet some

Appendix 2

water is always available for the next furrow below. This is due, first, to the loss or return of water to the stream close to the abstraction point and, second, to the augmentation of stream flow through spring recharge along the stream (groundwater seeps out within the stream valleys). The stream diversion technology also makes it technically difficult capture all the water at a single abstraction point. If a furrow threatens to overflow during heavy rains, the canal bank is cut at a point close to the stream in order to avoid damage. Within the river valley, the water is carried on a gentle gradient in a canal running on an embankment, in places several metres high, towards the settlement and farms on the ridge. Seepage is exploited for sugar cane, taro (cocoyam), and watercress.

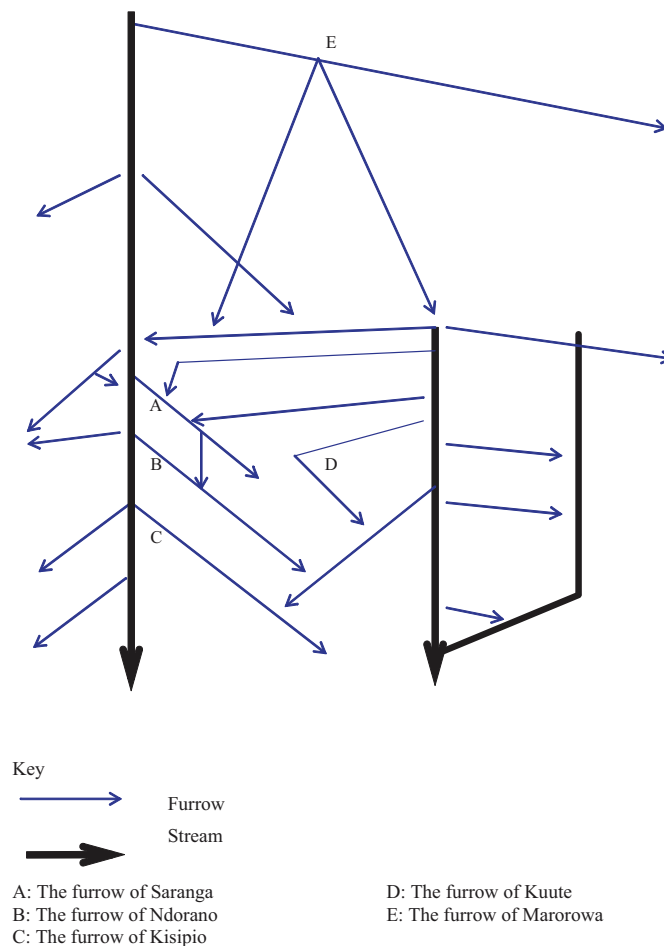


Fig. A2:3. The canal network of Komalyangoe, Marangu (schematic).

Regular abstraction points in the earth banks of the canal can be seen from the small packs of grass and mud used to block them. These can be seen first above the terraced plots for seasonal crops in the river valley and then above the first vihamba (agroforestry groves). A furrow usually divides upon reaching the main settlement on the ridge. The proportional weir is used to divide permanently flowing water into secondary canals. It is possible to adjust the distribution of water here by placing and adjusting a small pack of mud, twigs and grass on either branch. The canals divide to provide running water close to most homesteads and fields. Other secondary canals are dry. The terrain on the ridge is sloping, and it is sometimes necessary to bring the water down rapidly. A simple drop structure is used to release the potential energy of the water in a controlled manner. This structure also makes a convenient tapping place for domestic water. Stone lining to prevent scouring was also observed as an alternative solution for energy control.

The horizontal footpaths tend to run alongside the canals in the river valleys and on the ridge. As the furrows tend to run more or less along the contours, they are also convenient routes for walking. The co-localisation of paths and canals has the advantage of facilitating the monitoring of the canal and the flow of water. Most turning points are situated on a public path, which also facilitates monitoring. Vertical paths have to be taken across the furrows. Solutions to furrow crossing vary in sophistication, from miniature 'Roman arch' bridges and stone culverts, to stone reinforcement of the banks, or simply a log thrown across the ditch. There is little need for structures to drain irrigation water on the sloping and naturally well-drained terrain. The control of runoff during heavy rains is a more important issue. Surface water is drained into the river through the irrigation canals and separate drainage canals.

The establishment of the furrows

At micro-scale the establishment of the furrows is linked to the cultivation and settlement of specific areas. The naming of places and furrows can be important. Places are usually named after early settlers and their patrilineages, or after natural features. The lower hamlet of Kisu may be the oldest settlement within the village, and it could have originated as an extension of the village below, Kyala. The hamlet name means

Appendix 2

‘the knife’, and could be related to a ritual site. Such sites - for instance the site with an engraved stone used in the past for initiation of youths into adulthood in Kyala, as described by Fosbrooke & Marealle (1952) - can confirm that an area is a long-established cultural landscape. The stone has c.20 engraved lines, each being the record of one of the ceremonies which reportedly had been held every 3-7 years until the practice was discontinued in c.1900 (personal observation and interview October 2006). The upper area of Komalyangoe village and a section of the adjacent forest reserve were covered in open bush, while the lower section was cultivated at the time of colonial impact according to Meyer’s (1890) map.

All furrows in Komalyangoe village were found to be well established, and no new furrow had been cut since the development of the upper section of the village in the 1920s. This is perhaps due to changes in the social and agricultural systems, making furrow construction more difficult or less important. The construction of furrows is remembered as a co-operative undertaking. According to the elders, the economy in the peasant communities has become more individualised since the time of construction, and the creation of a new scheme would have to rely on new arrangements for labour mobilisation. The furrow elders maintained that ‘all the water is taken’, the water supply would not be able to sustain more furrows, and also that the best sites have been developed. The pattern of abstractions is thus stable. Since one of the reasons given is that the water has been taken, it is possible to argue that a principle of prescription or usufruct is in operation. According to the principle of prescription, those who made the first abstractions established the strongest claim to water, while usufruct rights are based on long undisturbed use.

Even though ‘no one would remember how to survey a furrow today’ (informant B), the existing schemes continue to be maintained and used. This applies to all 17 furrows within the village, and generally for the area between Ona and Moonjo Rivers in the western uplands of Marangu, in contrast to the eastern and more central sections along the hard surface road where furrow abandonment appears to have been more widespread. Marorowa’s furrow (located 2.5 km to the north of Kisu Hamlet and indicated as E in Fig. A2:3) appears to be a downscaled remnant of the larger Mangi furrow. The embankments of abandoned furrows can remain visible for some time, as lines along the contour within the river valleys. An investigation was focused on

Oral history and the development of indigenous irrigation

furrows controlled by two families in one hamlet. The O family initiated and controlled Kuute's furrow, while members of the N family were said to 'own' three adjacent furrows (Figs. 3 and 4). The case history of the development of the three schemes controlled by the 'N's', presented in the following, builds on a series of interviews with the three furrow chairmen (informants D, E and F) and other elders.

The Kuute's furrow, also known as Ndekylio's furrow, taps the source area of Kizuru spring. The original simple structure was made with digging sticks. It was expanded from a modest beginning to include more farms, and improved by members of subsequent generations. The objective of the construction was to provide water to irrigate the groves and the millet fields, for mole rat control and for household use. The leadership of the furrow has been handed down from father to son within the 'O lineage' since the furrow's construction. In oral tradition, it is held that a child and later a man were killed at the source area. The spring area is respected as a sacred place (informants H and P). At construction, and also in times of crisis, a goat or a bull used to be sacrificed in order to make the water flow smoothly (informants B and G). In the former case, the sacrifice was made to the supreme god (Ruwa), and in the latter case to ancestors. The furrow chairman reported that he offered libations of milk and the local brew *mbege* (made of finger millet and banana) for the same purpose. Ritual practice in connection with the furrows appears to have declined. Members of the clan controlling the furrow of Kuute also used to take part in rain rites at Fumvu Iya Mku (ancestor hill) above Marangu. In times of famine and drought, 'they went to the Fumwu Iya Mku hill above and slaughtered a bull and a male goat. It used to start raining the same day' (informant M).

The furrow of Kuute was initiated by a man named Ndekylio, who belonged to a family which clusters in the higher areas of the village. Ndekylio was claimed to have been a contemporary of *mangi* Kwembere, who ruled the area during the civil wars some time before Ndalio rose to power over Marangu in the 1840s. If construction preceded *mangi* Ndalio, dating from Stahl's (1964, 318) political history suggests a date prior to the 1840s. Ndekylio was the great grandfather of the ageing furrow chairman; his father and grandfather were furrow elders before him. The chairman (informant G) believed that he was born in c.1920. As the last born son of the third wife of Marorowa, he inherited his mother's farm and his father's headquarters. Still, the chairman claimed

Appendix 2

to be the fourth furrow elder. A reliance on the family history would push the date forward towards the mid-19th century, assuming a generation span of 30 years. The best estimate appears to be a date in the 1830s. In this case, data does not permit comparison between different informants within one family, so the best option is to correlate family history with contemporary events.

In the second example, three schemes initiated by members of the same family group can be correlated, thus permitting a greater density and reliability. A genealogy of the N lineage, with key roles in canal leadership is shown in Fig. A2:5. The furrow of Ndorano was the first of a series of small furrows built by the members of this family as they grew in numbers. The original settler (1) came to settle here from an unknown place due to conflicts over pasture between two clans there. His son (2) initiated the first furrow. Today, it is called Ndorano's furrow, after a former furrow chairman: 'The name changes for each generation, it is the grandfather's furrow', the current furrow chairman explained. According to the chairman, the furrow was constructed 'because it was too far to go to the river to fetch water for irrigation and domestic purposes' (informant E). The initiator of the furrow had four sons. The resident lineage continued through two of them, (3) and (6). The last born son (6) took over his father's homestead, while his older brother (3) had other plots in the area. The son (7) of the latter (3) built the second furrow in order to provide water for irrigation of finger millet, maize, beans, and bananas in an area above the original furrow, and set up a homestead there. It was also used for domestic purposes and fire protection. This second furrow is called Saranga's furrow after a former chairman. According to the current chairman (informant D), 'There was no involvement from the *mangi*. The people of the area used to organise themselves to do it. All the people who were going to use the water took part'. The son (10) of the mentioned last born (6) constructed the third and last furrow. This small scheme is usually referred to as Kisipio. The scheme improved the water supply to the former tail-end users of the first furrow, as new farms were established. According to the current furrow chairman (informant E), the great grandson of the furrow initiator, it was constructed for the 'irrigation of finger millet. There is too little land for that now. We mainly irrigate vegetables and beans'. The detailed genealogy shows that the establishment of the schemes was related to the expansion of the resident lineage, and to the increase in cultivated acreage which took place before the process of subdivision

Oral history and the development of indigenous irrigation

into increasingly small adjoining compound farms. The lineage still has common slaughter parties (sacrifices), but it is developing towards three segments, each controlling its own furrow. Control over the furrow has been inherited by direct descendants of the canal founders, despite the inclusion of non-kin in the group of users. The close correspondence between position in kin groups and management rights does not imply a close relationship between family allegiance and water use for irrigation (Tagseth 2000, 115-120).

Thus, furrow construction is said to have started with the son of the original settler, the great-great-grandfather of the oldest generation alive in 1995. Relying on genealogical data, counting back 30 years for each generation, he could have been born in c.1800, and he could have established his own farm in c.1830. The next two furrows were made by grandfathers of the oldest people alive in 1895, towards the end of the 19th century.

At the time when the first furrow schemes were constructed in the area, Kisu appears to have been on the upper fringe of the settlement (c.1670 m a.s.l.). The last furrow constructed in the village starts above the boundary of the forest reserve, at c.2000 m a.s.l. (Scheme E, Fig. A2:3). The construction of the last furrow was undertaken when the upper sections of the village were opened up for settlement in the 1920s. By that time, all existing intakes and main canals had been established, but quite a lot of modifications have been made since. Upwards expansion is controlled by a forest reserve (the 'Half Mile Strip'). Abandoned terraces (fieldwork July 2002) and Meyer's (1890; 1900) description of the area as open bush in the 1880s suggests earlier cultivation or other use.

Furrow establishment is linked to the expansion of the settlement and the subdivision of land for new homesteads. In the case of the N's, the first scheme was developed within one generation of settlement, and two subsequent schemes were added as the family grew in numbers, until three lineage segments controlled three separate schemes. It is estimated that the two oldest schemes were established in c.1830 and the two younger schemes at the end of the 19th century. Informants held that no new furrow had been dug since the 1920s, when the uppermost part of the village was settled. There is a fair degree of correlation between settlement and scheme establishment at village level. *Mfongo* irrigation is only one element in a complex farming system that combines

Appendix 2

a high number of elements tailored to suit conditions in this locality. The oral history of the area is also a source of information on how furrow irrigation has been used and on its role in the farm system.



Fig. A2:4. The Kisu area, Komalyangoe village (sketch map 1996, not to scale).

The case of Komalyangoe represents a type of irrigation scheme that could have been established relatively early. However, it appears that irrigation was already a

Oral history and the development of indigenous irrigation

standard part of the agricultural repertoire at the time of settlement. The methodology could be tested in locations with a longer history of settlement, if these could be identified. Estimation of a date through correlation with chiefly reign according to Stahl (1964), following Masao's example, was possible in one case. The regional study of irrigation identified different types of schemes. It is likely that the continuity of scheme tenure is less in the case of the larger old furrows, which may have relied on other institutions.

Concluding remarks

Methods for research on the establishment and development of hill furrows in an early phase prior to written history in north-eastern Tanzania have been discussed and developed in this article. Archaeological and conventional historical methods have been reviewed. The identification of the central institutions of resource management was found to be a key element in establishing a reliable location and group-specific oral history of resource utilisation. Methodology relying on oral history, legend and documentary sources has been tested with reference to changes in the management of specific canal systems and locations in Moshi, Kilimanjaro.

The case study documents one phase in a long history of furrow development. The results suggest that small canal schemes were established as a part of the spread of the settlement, and that it was an established technology by the first half of the 19th century. The assumption that the establishment of these four schemes in Komalyangoe in Moshi constituted the beginnings of irrigation is contradicted in the oral traditions of the district, and also by the established knowledge of irrigation in Mbokom in Moshi.

The prevalent type of irrigation organisation throughout the highlands of north-eastern Tanzania relies on a furrow elder (Kichagga: *meku o mfongo*). The furrow elder, the resident patrilineage (*ukoo*), the neighbourhood, and the group of canal users were thus identified as central and relatively stable institutions in local water management. The depth of location- and family-specific oral traditions can be considerable, due to the combination of a virilocal residence pattern, elements of ancestral cult and a continued patrilineal control over key resources (land, water, personnel). Members of family groups that had retained autochthon management rights over furrows were able to provide genealogies and data on key events and actors, so that sequence and dates in

Fig. A2:5: The N lineage and key events in canal development.

The hill furrow irrigation systems in eastern Africa are important examples of early agricultural intensification and specialisation. The existence of more than 2000 stream diversion schemes make the Kilimanjaro Region in Tanzania a centre of this type of irrigation technology. Here, practices and organisational models of pre-colonial origin have provided some of the answers to the need for continued intensification in areas of high population densities. This article started with Masao's (1974) question on the age of the canal systems and the problems of dating. Subsequently, Soper (1983) introduced the question of sequence in canal development. Several possible approaches have been reviewed. Some of the past attempts to reconstruct early furrow development have relied on correlation with the central institutions of water control. The discovery that in many instances furrow construction was independent of the chieftaincy was an important premise, which initiated a search for other central institutions.

ⁱ Local historian Nathaniel Mtui wrote in c.1916 a manuscript in Old Kichagga. An annotated translation of this was made by Atanasio Mneney, Kilimanjaro-Mamba, dated 1959 (unpublished), on assignment for Kathleen Stahl.

Appendix 2

Acknowledgements. -I acknowledge the assistance of the late Michael Minja of Marangu, who interpreted during most of the interviews from the Kichagga language and Kiswahili. Atanasio Mneney of Mamba, former administrative officer of Vunjo, gave a valuable introduction to the local history of the area and during fieldwork in 1995 allowed me to study Mneney's translation from 1959 of Mtui's unpublished manuscript written in c.1916. Principal Water Officer J.M Kobalyenda and staff provided access to their records of water rights. Pangani Basin Water Officer J. Sarrett and staff provided advice and access to their records. I.J. Matcha, Regional Hydrologist-Kilimanjaro provided access to notes and records on water use kept by his office. Comments from Professor Michael Jones and two anonymous referees have been helpful in finalising this article.

Oral history and the development of indigenous irrigation

References

- Adams, W.M. 1988. Irrigation before development: Indigenous and induced change in agricultural water management in East Africa. *African Affairs* 87, 519-535.
- Adams, W.M. 1989. Definition and development in African indigenous irrigation. *Azania* 24, 21-27.
- Adams, W.M. 1992. *Wasting the Rain. Rivers, People and Planning in Africa*. University of Minnesota Press, Minneapolis.
- Adams, W.M. & Watson, E. 2003. Soil erosion, indigenous irrigation and environmental sustainability, Marakwet, Kenya. *Land Degradation & Development* 14:1, 109-122.
- Baumann, O. 1891. *Usambara und seine Nachbargebiete*. Reimer, Berlin.
- Beez, J. 2005. *Die Ahnen essen keinen Reis. Vom lokalen Umgang mit einem Bewässerungsprojekt am Fuße des Kilimanjaro in Tansania*. Bayreuth African Studies Working Papers No. 2. University of Bayreuth, Bayreuth.
- Börjeson, L. 2004. *A History under Siege. Intensive Agriculture in the Mbulu Highlands, Tanzania, 19th Century to the Present*. Acta Universitatis Stockholmiensis, Stockholm.
- Boserup, E. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. George Allen & Unwin, London.
- Buckland, L.L.R. 1939. *Water Executive Annual Report*. Document in the University of Dar es Salaam East Africana collection EAF Per TP319T3A3. Government Printer, Dar es Salaam.
- Buckland, L.R.R. 1940. *Water Executive Annual Report 1940*. Document in the University of Dar es Salaam East Africana collection EAF Per TP319T3A3. Government Printer, Dar es Salaam.
- Burra, R. & van den Heuvel, K. 1987. *Traditional Irrigation in Tanzania*. Vol. 1. *Historical Analysis of Irrigation Tradition and Government Intervention*. SNV-TIP, Dar es Salaam.
- Daluti, L.R. 1994. *Report on the Agro-socio-economic Situation in Pangani River Catchment*. United Republic of Tanzania-Zonal Irrigation Office, Moshi.
- Devenne, F. 2006. On the 'mountain of waters' the furrows are running dry: Rethinking Mount Kilimanjaro's irrigation system. Bart, F., Mbonile, M.J. & Devenne, F. (eds.)

Appendix 2

- Kilimanjaro. Mountain, Memory, Modernity*, 177-200. Mkuki na Nyota, Dar es Salaam.
- Dundas, C. 1924. *Kilimanjaro and its People. A History of the Wachagga, Their Laws, Customs and Legends, Together with Some Account of the Highest Mountain in Africa*. Frank Cass, London.
- Fairhead, J. & Leach, M. 1996. *Misreading the African Landscape. Society and Ecology in a Forest-Savanna Mosaic*. Cambridge University Press, Cambridge.
- Feierman, S. 1990. *Peasant Intellectuals. Anthropology and History in Tanzania*. University of Wisconsin Press, London.
- Fleuret, P. 1985. The social organisation of water control in the Taita Hills, Kenya. *American Ethnologist* 12, 103-118.
- Fortmann, L. 1995. Talking claims: Discursive strategies in contesting property. *World Development* 23:6, 1053-1063.
- Fosbrooke, H.A. & Marealle, P.I. 1952. The engraved rocks of Kilimanjaro: Part 1. *Man* 52, 161-162.
- Francaviglia, V.M. 2000. Dating the ancient dam of Ma`rib (Yemen). *Journal of Archaeological Science* 27:7, 645-653.
- Gillingham, M.E. 1999. Gaining access to water: Formal and working rules of indigenous irrigation management on Mount Kilimanjaro, Tanzania. *Natural Resources Journal*. 39:3, 419-441.
- Government of Tanganyika. 1956. *Report of the Water Legislation Committee 1956*. Document in the University of Dar es Salaam East Africana collection: EAF pam k T164 1956. Government Printer, Dar es Salaam.
- Griffith, A.W. 1930. *Chagga Land Tenure Report*. Document in the University of Dar es Salaam Hans Cory Collection EAF Cory 272. Government of Tanganyika-Moshi District, [Moshi].
- Grove, A. 1993. Water use by the Chagga on Kilimanjaro. *African Affairs* 92:368, 431-448.
- Gutmann, B. 1926. *Das Recht der Dschagga. Mit einem Nachwort des Herausgebers*. Beck, München.

Oral history and the development of indigenous irrigation

- Hakansson, N.T. 1995. Irrigation, population pressure, and exchange in precolonial Pare, Tanzania. *Research in Economic Anthropology: A Research Annual* 16, 297-323.
- Holand, I.S. 1996. *More People, More Trees. Population Growth, the Chagga Irrigation System, and the Expansion of a Sustainable Agroforestry System on Mount Kilimanjaro*. Cand. polit. thesis, Norwegian University of Science and Technology, Trondheim.
- Johnston, H.H. 1886. *The Kilima-njaro Expedition. A Record of Scientific Exploration in Eastern Equatorial Africa. And a General Description of the Natural History, Languages, and Commerce of the Kilima-njaro District*. Kegan, Paul Trench, London.
- Keesing, R.M. 1981. *Cultural Anthropology. A Contemporary Perspective*. Holt, Rinehart and Winston, Fort Worth, TX.
- Kimambo, I. 1996. Environmental control and hunger. Maddox, G., Giblin, J. & Kimambo, I. (eds.) *Custodians of the Land. Ecology and Culture in the History of Tanzania*, 71-95. James Currey, London.
- Lawi, Y.Q. (2003). Potentials and challenges in using oral traditions in reconstructing environmental history of Eastern Africa. Dahlberg, A., Trygger, S., Holmgren, K. & Lane, P. (eds.) *Second PLATINA Workshop 17-19 October 2002 Usa River, Arusha, Tanzania*, 28 (Working Paper from the Environment and Development Studies Unit, 46). The University of Stockholm and the British Institute in East Africa, Stockholm.
- Lent, C. 1896. Das Kilimandjaro Gebiet zwischen Moshi und Taweta mit der wissenschaftlichen Marangu-station. *Mitteilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten* 9, 42.
- Maingi, J. (2006). Growth rings in tree species from the Tana River floodplain, Kenya. *Journal of East African Natural History* 95:2, 181-211.
- Marealle, T.L.M. 1952. The Wachagga of Kilimanjaro. *Tanganyika Notes and Records* 32 (January), 57-64.
- Martin, D. & Moss, J. 1997. Age determination of *Acacia tortilis* (Forsk.) Hayne from northern Kenya. *African Journal of Ecology* 35:3, 266-277.

Appendix 2

- Masao, F.T. 1974. The irrigation system in Uchagga: An ethno-historical approach. *Tanzania Notes and Records* 75, 1-8.
- Mascarenhas, A., Ngana, J. & Yoshida, M. 1985. *Opportunities for Irrigation Development in Tanzania*. Institute of Developing Economies, Tokyo.
- Meyer, H. 1890. Originalkarte des Kilima-Ndscharo. Nach astronomischen Ortsbestimmungen, Wege-Aufnahmen und trigonometrischen Messungen des Hans Meyer, konstruiert bei B. Hassenstein. Karte II. *Ostafrikanische Gletscherfahrten: Forschungsreisen im Kilimandscharo-Gebiet*. Duncker & Humblot, Leipzig.
- Meyer, H. 1900. *Der Kilimandjaro*. Dietrich Reimer (Ernst Vohsen), Berlin.
- Molohan, M.J.B. 1960. *Annual Reports of the Provincial Commissioners for the Year 1959*. Northern Province. Document in the University of Dar es Salaam East Africana collection. Government Printer, Dar es Salaam.
- Moore, S.F. 1986. *Social Facts and Fabrications. 'Customary' Law on Kilimanjaro 1880-1980*. Cambridge University Press, Cambridge.
- Mosgrove, D.L. 1998. *Watering African Moons: Culture and History of Irrigation Design on Kilimanjaro and Beyond*. PhD thesis, Cornell University, Ithica, NY.
- New, C. 1971 [1873]. *Life, Wanderings and Labours in Eastern Africa. With an Account of the First Successful Ascent of the Equatorial Snow Mountain, Kilima Njaro and Remarks upon East African Slavery*. Frank Cass, London.
- Niemeijer, D. 1996. The dynamics of African agricultural history: Is it time for a new development paradigm? *Development and Change* 27:1, 87-110.
- Odnor, K. 1971. A preliminary report on an archaeological survey on the slopes of Kilimanjaro. *Azania* 6, 131-149.
- Östberg, W. 2004. The expansion of Marakwet hill furrow irrigation in the Kerio Valley of Kenya. Widgren, M. & Sutton, J. (eds.) *Islands of Intensive Agriculture in Africa: Past and Present*, 19-48. James Currey, Nairobi.
- Pike, A.G. 1965. Kilimanjaro and the furrow system. *Tanganyika Notes and Records* 64, 65-67.
- Pomel, S. 1999. Soils indicators of anthropic actions on Kilimanjaro. *IFRA les cahiers* 16, 74-78.
- Rebmann, J. 1860. Journey to Jagga. Krapf, D.J.L. (ed.) *Travels, Researches, and Missionary Labours During an Eighteen Years' Residence in Eastern Africa*.

Oral history and the development of indigenous irrigation

Together with Journeys to Jagga, Usambara, Ukambani, Shoa, Abessinia, and Khartum; and a Coasting Voyage from Mombaz to Cape Delgado, 230-265.

Trübner, London.

Sarmett, J.D., Mvaa, A.K., Monyo, S.E., Kajigili, N.J. & Mushi, K.Z. 1997.

Ushirikishwaji wa wananchi katika usimamizi wa matumizi bora ya rasilimali za maji bonde la mto Pangani. Taarifa ya rasilimali za maji wilaya za Hai, Moshi Vijijini na Moshi Mjini, Moshi.

Schanz, J. 1913. Mitteilungen über die Besiedlung des Kilimandscharo durch die

Dschagga und deren Geschichte. *Baessler-Archiv. Beiträge zur Völkerkunde* 4, 1-55.

Sheridan, M.J. 2002. An irrigation intake is like a uterus: Culture and agriculture in precolonial North Pare, Tanzania. *American Anthropologist* 104:1, 79-92.

Soper, R. 1983. A survey of the irrigation systems of the Marakwet. Kipkorir, B.E.,

Soper, R.C. & Ssenyonga, J.W. (eds.) *Kerio Valley. Past, Present, Future*.

Proceedings of a Seminar Held in Nairobi at the Institute of African Studies,

University of Nairobi, 21-22 May 1981, 75-95. Institute of African Studies, Nairobi.

Stahl, K. 1964. *History of the Chagga People of Kilimanjaro*. Mouton & Co., London.

Stump, D. 2006. The development and expansion of the field and irrigation systems at Engaruka, Tanzania. *Azania* 41, 69-94.

Sutton, J.E.G. 1984. Irrigation and soil conservation in African agricultural history with

a reconsideration of the Inyanga terracing (Zimbabwe) and Engaruka irrigation

works (Tanzania). *Journal of African History* 25:1, 25-41.

Tagseth, M. 2000. *Knowledge and Development in Mifongo Irrigation Systems. Three*

Case Studies from Mt. Kilimanjaro, Tanzania. Cand. Polit. thesis, Department of

Geography, Norwegian University of Science and Technology, Trondheim.

Tagseth, M. 2002. Local practices and changes in farmer managed irrigation in the

Himo catchment, Kilimanjaro. Ngana, J.O. (ed). *Water Resources Management. The*

Case of Pangani River Basin - Issues and Approaches, 48-63. Dar es Salaam

University Press, Dar es Salaam.

Tagseth, M. 2006. The 'mfongo' irrigation systems on the slopes of Mt. Kilimanjaro,

Tanzania. Tvedt, T., Coopey, R., Jakobsson, E. & Ostigaard, T. (eds.) *A History of*

Water. Vol. 1. *Water Control and River Biographies*, 488-506. I.B Tauris, London.

Appendix 2

- Terral, J.F. & Durand, A. 2006. Bio-archaeological evidence of olive tree (*Olea europaea* L.) irrigation during the Middle Ages in southern France and north eastern Spain. *Journal of Archaeological Science* 33:5, 718-724.
- Therrell, M.D., Stahle, D.W., Ries L.P. & Shugart, H.H. 2006. Tree-ring reconstructed rainfall variability in Zimbabwe. *Climate Dynamics* 26:7-8, 677-685.
- Tiffen, M., Mortimore, M. & Gichuki, F. 1994. *More People, Less Erosion: Environmental Recovery in Kenya*. Wiley, Chichester.
- United Republic of Tanzania - Ministry of Water Energy and Minerals. 1994. *Report on the Meeting on Water Utilisation and Shortage in the Pangani River Basin*. United Republic of Tanzania - Ministry of Water Energy and Minerals, Moshi.
- von der Decken, C.C. 1869. *Reisen in Ost-Afrika in den Jahren 1859 bis 1865*. C.F. Wintersche Verlagshandlung, Leipzig.
- Widgren, M. 2004. Towards a historical geography of intensive farming in eastern Africa. Widgren, M. & Sutton, J. (eds.) *Islands of Intensive Agriculture in Eastern Africa*, 1-18. James Currey, Irthlingborough.
- Wittfogel, C. 1957. *Oriental Despotism. A Comparative Study of Total Power*. Yale University Press, New Haven, CT.

Paper 3:

The expansion of traditional irrigation in Kilimanjaro, Tanzania⁸⁵

Introduction

The largest cluster of the stream diversion irrigation systems known as “hill furrows” in eastern Africa is found on the southern slopes of Mt Kilimanjaro. The history of this extensive furrow system is relevant to the debate on the history and geography of intensive agriculture in the region.⁸⁶ Further, the history of the hill furrows in Kilimanjaro is relevant to current development problems because perceptions of the history and dynamic of water use are used to justify interventions in local water management in response to a perceived water scarcity in the region.⁸⁷ The main objective of this article is to test hypotheses about processes in land and water use, two of which have been used to guide policy and interventions in traditional irrigation. According to the first hypothesis, the hill furrow system is in decline, as schemes become redundant with development and the transition to piped water supply. According to the second, conflicting hypothesis, the post-Independence era has seen an increase in the hill furrow technology driven by population growth. Population growth in recent decades, associated with increase in hill furrow irrigation, is said to cause water scarcity in Kilimanjaro. This explanation appears to be based on a neo-Malthusian model of development, given that neither of these theses seem to be based on historical data on changes, nor on studies of how and when the systems were initiated and subsequently expanded.

⁸⁵ This manuscript has been published as: M. Tagseth (2008). *International Journal of African Historical Studies* 41(3), 461-490.

⁸⁶ John E.G. Sutton, “The History of African Agricultural Technology and Field Systems,” *Azania* XXIV, (1989), 98-112. Mats Widgren, “Towards a Historical Geography of Intensive Farming in Eastern Africa,” in Mats Widgren and John E. G. Sutton, eds., *Islands of Intensive Agriculture in Eastern Africa* (Irthlingborough: James Currey Ltd., 2004), 1-18.

⁸⁷ Julius D. Sarmett and S.A. Faraji, “The Hydrology of Mount Kilimanjaro: An Examination of Dry Season Runoff and Factors Leading to its Decrease,” in William D. Newmark, ed., *The Conservation of Mount Kilimanjaro* (Gland: IUCN – The World Conservation Union, 1991), 53-70. IUCN, *Pangani Basin: A Situation Analysis* (Nairobi: IUCN Eastern Africa Programme, 2003).

Appendix 3

Studies of land degradation and deforestation⁸⁸ have demonstrated the importance of establishing diachronic data sets permitting analysis of landscape change. In this paper I present a diachronic study of long-term change in irrigation at Mt Kilimanjaro relevant to the debate on water and development. It is possible to analyse the development of the hill furrow systems on the slopes of Mt Kilimanjaro while drawing on oral traditions, 19th century eye-witness accounts and several studies of irrigation covering the 20th century. Oral traditions suggest that the technology was established in the region several hundred years ago, and eye-witness accounts from 1848 onwards show that the technology was widespread across the southern slopes of Mt Kilimanjaro. Interest in the water resources during the colonial periods led to the generation of more detailed data. Data from the 1990s can thus be compared with data on the hill furrow system from the early 20th century onwards. Based on this analysis I will argue that the development of substantial parts of the irrigation infrastructure appear to predate, and to be out of phase with, the population expansion of the late colonial and early postcolonial period which it has been ascribed to. Due to problems identified with the two aforementioned hypotheses, I will put forward a third, alternative hypothesis, that irrigation infrastructure was fully developed in many highland areas by the early 20th century. Changes in the 20th century can thus be seen as a restructuring of irrigation, where decline in irrigation in the densely settled highland areas has been offset partly by increase in irrigation in new areas and partly by increase in scale. A review of the dynamics of hill furrow development shows regional differences in irrigation development and suggests that changes in irrigation are not determined by a single factor, and in this respect several contributing factors are discussed.

⁸⁸ Mary Tiffen, Michael Mortimore and Francis Gichuki, *More People, Less Erosion: Environmental Recovery in Kenya* (Chichester, J. Wiley, 1994). James Fairhead and Melissa Leach, *Misreading the African Landscape. Society and Ecology in a Forest-Savanna Mosaic* (Cambridge: Cambridge University Press, 1996).

Hill furrows and development

Hill furrow systems are found in many highlands and escarpments in eastern Africa,⁸⁹ standing out as “islands of intensive agriculture”⁹⁰ in a sea of more extensive land use. This technology of water provision has been important in sustaining substantial settlements and providing food security over time. In the development debate, it has been argued that the hill furrow represents indigenous knowledge, with adaptable solutions and little dependence on external input, which has often been overlooked.⁹¹ Traditional irrigation was mobilised to boost food production in campaigns during severe droughts in 1974 and in 1987, and it continues to play an important part in Tanzanian food security today. “Traditional irrigation” still prevails over the “modern irrigation” sector. Its redevelopment has been devised as a key to improved food security in the Tanzanian irrigation master plan, and several development projects aim to improve or replace it.⁹² The system retains its role in water provision for irrigation and other purposes. The term “hill furrow” was coined to describe systems of water control which rely on stream diversion and conveyance by gravity through canals, while avoiding confusion with furrow irrigation as a method of field-level water application.⁹³ The cluster of hill furrow systems on the slopes of Mt Kilimanjaro, locally termed *mfongo* (Fig. A3:1), has been more renowned than other clusters in eastern Africa, but basic questions of how, when and why the extensive irrigation infrastructure was developed remain to be answered. The technology was often idealised by outsiders from the early days of colonisation onwards, but later also scorned as wasteful, superfluous and inferior. This debate on the virtues of the *mfongo* system still appears to be

⁸⁹ The “hill furrow” technology is found in locations in southern Ethiopia, and at least as far south as Iringa in southern Tanzania. See William M. Adams, *Wasting the Rain. Rivers, People and Planning in Africa* (Minneapolis: University of Minnesota Press, 1992), and Raphael Burra and Kick van den Heuvel, *Traditional Irrigation in Tanzania. Volume 1: Historical Analysis of Irrigation Tradition and Government Intervention* (Dar es Salaam: SNV-TIP, 1987).

⁹⁰ Widgren, “Towards a Historical Geography of Intensive Farming”.

⁹¹ Adams, *Wasting the Rain*.

⁹² World Bank, *Staff Appraisal Report. River Basin Management - Smallholder Irrigation Improvement Project*. (Dar es Salaam: the World Bank, 1996). Samuel A. Zongolo, Shangwe Kiluvia and Grace Mghase, *Traditional Irrigation Assessment Report. Moshi Rural District* (Moshi: Traditional Irrigation and Environmental Development Organisation, 2000). Japanese International Cooperation Agency & Ministry of Agriculture and Food Security, *The Study on the National Irrigation Master Plan in the United Republic of Tanzania* (Dar es Salaam: Nippon Koei Co. Ltd, 2002).

⁹³ William M. Adams, “Definition and Development in African Indigenous Irrigation,” *Azania*, XXIV (1989), 21-27. Adams, *Wasting the Rain*, 89.

Appendix 3

unresolved, not only because of continued conflict over the water resources in the area but also because traditional irrigation practitioners, hydrologists and irrigation engineers have very different ideas of what constitutes “good” water management and “proper” irrigation practice.



Fig. A3:1: *Mfongo*, meadows and agroforestry groves at Marangu, Kilimanjaro. Photograph by author.

Most *mfongo* schemes remain under farmer management and depend on local resources, technology and models of management, despite past and current attempts at intervention in technology, scheme management and water management. If such interventions were to be guided by a better appreciation of the development and operation of the system it could help reduce problems and conflicts over water management, irrigation extension and water provision.

The Kilimanjaro Region is currently experiencing a water crisis, perceived as an increasing level of conflict and declining availability of water. The Kilimanjaro glacier has become an icon of global warming following the rediscovery⁹⁴ of its retreat.⁹⁵

⁹⁴ The process of glacial retreat is not recent, nor is it a recent discovery. It was commented upon by Hans Meyer after the first ascent in 1889, investigated by Fritz Klute after the turn of the 19th century, a

The expansion of traditional irrigation in Kilimanjaro, Tanzania

Among several possible contributing or competing explanations are a decline in precipitation, land use change, increase in smallholder irrigation, and increased water demand in other sectors. One of the challenges in making good management decisions to deal with the current “water crisis” is an inadequate knowledge not only of the available water resources but also of their past and present use. Two claims or hypotheses about processes in land and water use in the densely populated districts where the hill furrow systems are found are used to guide policy and interventions in traditional irrigation. A dominant thesis in the analysis of irrigation development in the area is that there has been a substantial growth in “traditional irrigation” on the slopes of Mt Kilimanjaro in recent decades, and that water resources have been degraded through recent clearing of land for agriculture leading to a reduction in dry season runoff. These processes are seen as consequences of rapid population growth.⁹⁶ Despite what can be described as an uncertain empirical backing,⁹⁷ this essentially neo-Malthusian understanding has been used to guide the management of water resources in the area, which aims to curtail water use in traditional irrigation. Irrigation extension, on the other hand, has been guided by the notion that the “traditional furrows” are becoming redundant through replacement by piped domestic supplies and that they are inferior as irrigation systems, needing to be replaced with systems that are more efficient in terms of water and maintenance and that are up to the standards of modern irrigation

matter of renewed studies and public attention in the 1930s and again in the 1960s. Cf. Walter Geilinger, “The Retreat of the Kilimanjaro Glaciers,” *Tanganyika Notes and Records* 2, (1936), 7-20.

⁹⁵ Stefan Hastenrath and Larry Greischar, “Glacier Recession on Kilimanjaro, East Africa, 1912–89,” *Journal of Glaciology* 43, 145 (1997), 455-459.

⁹⁶ Sarmett and Faraji, “The Hydrology of Mount Kilimanjaro,” 61-62. United Republic of Tanzania, *Report on the Meeting on Water Utilisation and Shortage in the Pangani River Basin* (Moshi: United Republic of Tanzania, Ministry of Water Energy and Minerals, 1994). Julius D. Sarmett, “Water resources management in Pangani River Basin with particular reference to Kilimanjaro Region,” Workshop on Water Management in the Pangani Basin. Bahari Beach Dar es Salaam 1-2 July 1999. R.L. Daluti, *Report on the Agro-socio-economic Situation in Pangani River Catchment* (Moshi: United Republic of Tanzania - Zonal Irrigation Office Moshi, 1994). IUCN, *Pangani Basin*, 33-34, 71-72. Miline J. Mbonile, “Population dynamics on the slopes of Mount Kilimanjaro,” in Bernard Charlerly de la Masselière, ed. *Mount Kilimanjaro: Land Use and Environmental Management* (Nairobi: IFRA, 1999), 18-23. Miline J. Mbonile, “Migration and intensification of water conflicts in the Pangani River Basin, Tanzania,” *Habitat International* 29, 1 (2005), 41-67.

⁹⁷ Cf. Ivar S. Holand, “More People, More Trees. Population Growth, the Chagga Irrigation System, and the Expansion of a Sustainable Agroforestry System on Mount Kilimanjaro” (Cand. Polit. thesis, Norwegian University of Science and Technology, 1996). Mattias Tagseth, “Knowledge and Development in Mifongo Irrigation Systems. Three Case Studies from Mt Kilimanjaro, Tanzania” (Cand. Polit. thesis, Norwegian University of Science and Technology, 2000).

Appendix 3

engineering.⁹⁸ An important objective in this article is to evaluate the two hypotheses of changes in water use on the basis of historical data. I will also forward a third, alternative hypothesis, and discuss the dynamics of irrigation development.

The hill furrow systems in eastern Africa

Canal technology with pre-colonial roots is found in many highland and some lowland areas in eastern Africa. I will use the term ‘hill furrow’ to designate the tradition in this region, and *mfongo* irrigation to designate the tradition in Kilimanjaro. The schemes are commonly described as gravity-fed, stream diversion irrigation systems, relying on dams of stones, twigs and mud, and on unlined canals. Water is abstracted from streams or springs. The stream water is checked by a small permeable dam, or by a stone wall which protrudes into the streambed. Within the river valley, the water is carried on a gentle gradient in a furrow running on an embankment towards the farms on a ridge. Upon reaching the main settlement, the furrow is often divided into permanently flowing secondary branches to provide running water close to most homesteads and fields. It is possible to adjust the distribution of water at this point by placing and adjusting a small pack of mud, twigs and grass on either branch. In other areas, water is rotated between secondary branches. Footpaths tend to run along the furrows in the river valleys and on the ridges. As the furrows tend to climb along a gentle gradient, these are convenient routes for walking, but the footpaths also facilitate the monitoring of the furrow and the flow of water. Collection tanks or ponds (Kichagga spoken in Moshi: *nduwa*, Chasu spoken in Pare: *ndiva*) for short-term storage, while common in the Pare Mountains where the water is often taken from small springs, has limited use in some areas at Mt Kilimanjaro today. According to informants (Moshi, Kilimanjaro), the furrows were built “to be close to water”. Detailed reports on the use of water from different sources (streams, furrows, springs and pipelines) show that the furrows supply water for household and other usage in addition to irrigation (Fig. A3:2).

⁹⁸ A.G. Pike, “Kilimanjaro and the Furrow System,” *Tanganyika Notes and Records*, 64 (1965), 95-96. Daluti, *Report on the Agro-socio-economic Situation*. Cf. Matthew Bender, “Water Brings no Harm. Knowledge, Power and Practice on Kilimanjaro, Tanzania 1880-1980” (Ph.D. thesis, Johns Hopkins University, 2006), 247, 268, 273.

The expansion of traditional irrigation in Kilimanjaro, Tanzania



Fig. A3:2: Domestic drawing point on a secondary branch. Photograph by author.

Hill furrow irrigation can be distinguished from flood irrigation practiced in wetlands and other forms of traditional irrigation. One series of stream diversion systems on escarpments can be grouped as a Rift Wall cluster. Adams⁹⁹ mentions examples of such sites at Konso (Ethiopia), Marakwet, Njemps, and Pagasi (Kenya), and Sonjo (Tanzania), as well as the abandoned Late Iron Age¹⁰⁰ site at Engaruka (Tanzania). A series of hill furrow systems found in the highlands and mountains to the east of the Rift Valley in Tanzania and Kenya has been described by Adams as a “Kilimanjaro cluster” of irrigation.¹⁰¹ This cluster includes areas with a higher potential for agriculture. Widgren¹⁰² distinguishes between grain-based systems in the west and

⁹⁹ Adams, *Wasting the Rain*, 90.

¹⁰⁰ Early Iron Age in Tanzania dates from AD 100–1000, while Late Iron Age dates from 1000–1800. Amin A. Mturi, *Archaeology of Tanzania* (Dar es Salaam: The Open University of Tanzania, 1998).

¹⁰¹ William M. Adams and David M. Anderson, “Irrigation before Development: Indigenous and Induced Change in Agricultural Water Management in East Africa,” *African Affairs* 87, 349 (1988), 519–535.

¹⁰² Widgren, “Towards a Historical Geography of Intensive Farming”.

Appendix 3

banana-based systems in the east, while Håkansson¹⁰³ distinguishes between low rainfall and high rainfall systems. The Kilimanjaro cluster includes hill furrow irrigation found on Mt Kilimanjaro in the North and South Pare ranges (Tanzania) (Fig. A3:3) to its south and in the Taita hills (Kenya) across the plains to the east of Kilimanjaro. Further, the Shambaa of the Usambara Mountains (Tanzania) have similar pre-colonial traditions,¹⁰⁴ as is the case in Machakos¹⁰⁵ and Taveta (Kenya). The technology was introduced to Mt Meru (Tanzania) by practitioners from Kilimanjaro.¹⁰⁶ Today, the highest density and the largest cluster of indigenous irrigation schemes are found on the southern slopes of Mt Kilimanjaro.

Archaeological studies have focused on Engaruka on the Rift Valley escarpment, and suggest that irrigation was practised on terraced and manured fields by the residents of a group of villages from the 15th century until the 18th century.¹⁰⁷ Several studies have sought to contribute evidence for the possible beginnings of hill furrow irrigation in some of the aforementioned contexts, based on oral history through association with chiefly reigns, age sets, and genealogies¹⁰⁸

¹⁰³ N. Thomas Håkansson, "Livestock and the Development of Indigenous Irrigation in East Africa," *EDSU Working Paper* 46, (2003), 28-30.

¹⁰⁴ Stephen Feierman, *Peasant Intellectuals. Anthropology and History in Tanzania* (London: University of Wisconsin Press, 1990).

¹⁰⁵ Tiffen, Mortimore and Gichuki, *More People, Less Erosion*.

¹⁰⁶ Thomas Spear, *Mountain Farmers: Moral Economies of Land & Agricultural Development in Arusha & Meru* (Oxford: James Currey, 1997).

¹⁰⁷ John E.G. Sutton, "Engaruka," in Widgren and Sutton, eds., *Islands of Intensive Agriculture*, 114-132. Daryl Stump, "The Development and Expansion of the Field and Irrigation Systems at Engaruka, Tanzania," *Azania* XLI, (2006), 69-94.

¹⁰⁸ Fidelis T. Masao, "The Irrigation System in Uchagga: An Ethno-Historical Approach," *Tanzania Notes and Records* 75, (1974), 1-8. Robert Soper "A Survey of the Irrigation Systems of the Marakwet," in B.E. Kipkorir, R.C. Soper and J.W. Ssenyonga, eds., *Kerio Valley. Past, Present, Future*. (Proceedings of a Seminar Held in Nairobi at the Institute of African Studies, University of Nairobi, 21–22 May 1981. Nairobi: Institute of African Studies, 1983), 75-95. Julius T. Kodalo, "An archaeological reconnaissance of the Marakwet irrigation furrows: A case study from the Embobout and Aror Rivers, Kerio Valley, Kenya," *Nyame Akuma* 53, (2000), 12-21. Wilhelm Östberg, "The Expansion of Marakwet Hill-furrow Irrigation in the Kerio Valley of Kenya," in Widgren and Sutton, eds., *Islands of Intensive Agriculture*, 19–48. Mattias Tagseth, "Oral History and the Development of Indigenous Irrigation. Methods and Examples from Kilimanjaro, Tanzania," *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography* 62, 1 (2008), 9-22.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

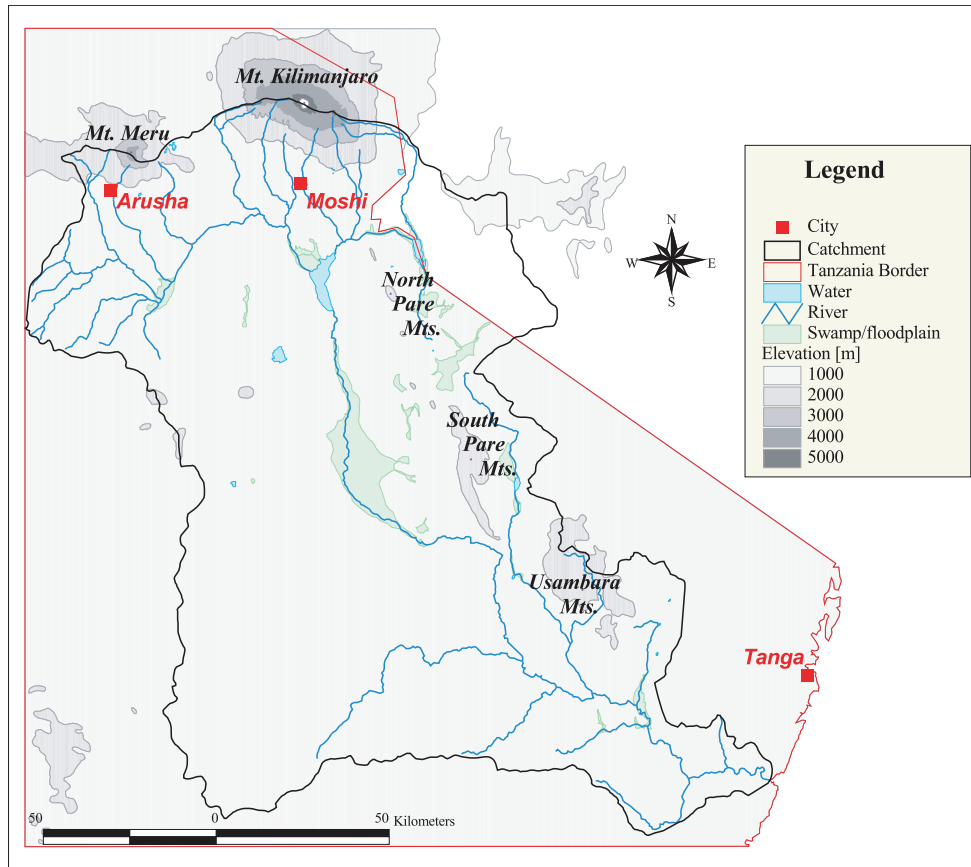


Fig. A3:3: The topography and hydrology of the Pangani River Basin. Indigenous irrigation is a long-established practice around Mt Kilimanjaro, in the North and South Pare Mountains and in the Usambara Mts. Cartography by P. Tengesdal and M. Tagseth.

The early phases of *mfongo* irrigation in Kilimanjaro

The early missionaries and explorers who ventured inland in eastern Africa in the 19th century documented the *mfongo* irrigation systems. The missionary Johannes Rebmann walked up the established caravan route from Mombasa to Kilimanjaro in the rains of 1848. He observed water furrows and trenches constructed by the warriors in Kilema (Fig. A3:4). The practice of stall-feeding that he observed and the use of manure recorded there by Von der Decken in 1861–1862 can be interpreted as indications of

Appendix 3

intensive agriculture.¹⁰⁹ The latter also observed irrigation schemes in several of the small states on the southern slopes.¹¹⁰ In the following decade, New¹¹¹ reported on the practice of irrigation, and also on abandoned furrows and overgrown defensive trenches, which suggests that there had been a decline in some districts. In the 1880s, Johnston¹¹² reported that the hill furrow network



Fig. A3:4: Furrows can extend from deep gorges and traverse more than 5 kilometres to reach the settlements and farms on the ridges, such as at the deep Ona valley at Kilema, Mt Kilimanjaro. Photograph by H. Lein in 2000.

was developed to the extent that it covered almost every ridge in Moshi. Thus, by then, the establishment of the technology had become a fact that was verified by independent reports from locations across the southern slopes of Mt Kilimanjaro. Most of the current traditional irrigation schemes are found in Hai and Moshi Rural Districts on the

¹⁰⁹ Johannes Rebmann, "Journey to Jagga," in J. Lewis Krapf, ed., *Travels, Researches, and Missionary Labours during an Eighteen Years' Residence in Eastern Africa: Together with journeys to Jagga, Usambara, Ukambani, Shoa, Abessinia, and Khartum; and a coasting voyage from Mombaz to Cape Delgado*. (London: Trübner and Co., 1860), 230-265. Otto Kersten, *Von der Decken's Reisen in Ost-Afrika in den Jahren 1859 bis 1865*, Vol. 1 (Leipzig and Heidelberg: C.F. Wintersche Verlagshandlung, 1869), 270.

¹¹⁰ I. e. from Machame, Uru, Mbokom, (Old) Moshi, Kilema. Kersten, *Von der Decken's Reisen* Vol. 1, 269, 271, 280, 290. Otto Kersten, *Von der Decken's Reisen in Ost-Afrika in den Jahren 1859 bis 1865*, Vol. 2 (Leipzig and Heidelberg: C.F. Wintersche Verlagshandlung, 1871), 40, 44, 58.

¹¹¹ Charles New, *Life, Wanderings and Labours in Eastern Africa. With an Account of the First Successful Ascent of the Equatorial Snow Mountain, Kilima Njaro and Remarks upon East African Slavery* (1873; reprint, London: Frank Cass & Co. Ltd., 1971).

¹¹² Harry H. Johnston, *The Kilima-njaro Expedition. A Record of Scientific Exploration in Eastern Equatorial Africa. And a General Description of the Natural History, Languages, and Commerce of the Kilima-njaro District* (London: Kegan, Paul Trench and Co, 1886).

The expansion of traditional irrigation in Kilimanjaro, Tanzania

southern slopes. Irrigation was also practiced in several plains locations with available water. Reports by Volkens suggest that *nduwa* ponds, a type of small dam defined by having an outlet at the base made with a wooden board that can be manipulated with a plug made of banana fibre, were once more common in Machame, Kibosho and Old Moshi. Further, he observed abandoned irrigation furrows in Keryo and Ushiri along Ungwashi River in the vicinity of Mkuu Rombo in the 1890s.¹¹³ The eastern Rombo District has less surface water on the Tanzanian side, but horticulturalists supply irrigated vegetables to urban markets from Rombo, Kenya, north east of Rombo, Kilimanjaro (see Fig. A3:5 for locations on Mt Kilimanjaro).

Mfongo irrigation was thus an established practice across the southern slopes of Mt Kilimanjaro in the second half of the 19th century. However, archaeological evidence suggests that the area has had agricultural settlements since the late first millennium AD.¹¹⁴ What is known about prehistoric periods, i.e. those without written sources? Elders in the area often claim that irrigation has been practised “since time immemorial”. The ethnography of irrigation in the late precolonial period was reconstructed by Gutmann,¹¹⁵ who described the use of irrigation structures in the initiation of boys and in the harvest festival. Water and irrigation was a metaphor for life, and could convey fertility to land and people.¹¹⁶ The brew made from the irrigated crop finger millet had, and still retains, symbolic value. The integration of irrigation in society and culture suggests that irrigation was well established and central to economy and society. The history of specific schemes on the slopes of Mt Kilimanjaro has been traced back to 1830–1845 by Masao¹¹⁷ through Stahl’s¹¹⁸ history of the chiefs, and to the 1830s through oral history from the families of commoners.¹¹⁹ The local tradition on the lineage of the chiefs in Marangu and Kilema claims that furrow schemes existed prior to their arrival from Ukamba, and furrows are mentioned in relation to events

¹¹³ Georg Volkens, *Der Kilimandscharo. Darstellung der allgemeineren Ergebnisse eines fünfzehnmonatigen Aufenthaltes im Dschaggalande* (Berlin: Dietrich Reimer, 1897), 74-75, 145.

¹¹⁴ Knut Odner, “A Preliminary Report on an Archaeological Survey on the Slopes of Kilimanjaro,” *Azania*, 6 (1971), 131-149.

¹¹⁵ Bruno Gutmann, “Feldbausitten und Wachstumsbräuche der Wadchagga“ *Zeitschrift für Ethnologie* 45, (1913), 474-511. Bruno Gutmann, *The Tribal Teachings of the Chagga* Vol. 1 (1932; translation from German, New Haven: Human Relations Area Files, 1958).

¹¹⁶ Cf. Gutmann, *Tribal Teachings*. Bender, “Water Brings no Harm”.

¹¹⁷ Masao, “The Irrigation System in Uchagga”.

¹¹⁸ Kathleen Stahl, *History of the Chagga People of Kilimanjaro*, (London: Mouton & Co., 1964).

¹¹⁹ Tagseth, “Oral History and the Development of Indigenous Irrigation”.

Appendix 3

dating to the 17th century in certain areas in Marangu.¹²⁰ Prior to this, we have to rely on other methods from historical landscape studies and archaeology for knowledge of early phases of *mfongo* irrigation.

One possible approach is to investigate the few schemes described with an identifiable location from the periods after 1860. Details are on record of activities in the 19th century when spectacular schemes were initiated by members of chieftain lineages,¹²¹ while local oral history more often suggests that members of commoner lineages from the area, “big men” or families of specialists, were actors in furrow initiation. A number of old schemes in Moshi, Kilimanjaro, were identified and visited by the author in 2001–2002, when examples of both active and abandoned pre-colonial schemes were found. Two highland furrows in Mbokom, identified by Masao¹²² as the oldest furrows there, were visited in 2002. These are technically challenging, large schemes, suggesting a mature technology. The family who built the first scheme established its chieftaincy over the area only at a later date. An aqueduct (*ilalo*) had been used to carry water across the rock face in a rather precipitous gorge, but had been replaced later with iron sheets, and subsequently by masonry work. There are several structures for short-term storage in the command areas, with similarities in technology, organisation and terminology to the *ndiva* in the highlands of Ugweno in North Pare.¹²³ Libations are used in order to make the water flow smoothly, access to the source was formerly restricted to men who had sons, and there are traditions on the construction of furrows recounting how the surveyors were guided by termites.

Irrigation in Kilema was witnessed by Rebmann in 1848.¹²⁴ The location of fields with the irrigated crop finger millet (*Eleusine coracana*) in lower Kilema in the 1890s was indicated by Lent.¹²⁵ This area still has an active furrow, and it is a centre of horticulture. The location of the only major furrow structure in Mwika was also shown.

¹²⁰ Nathaniel Mtui, [1916]. [Untitled]. Annotated translation by Atanasio Mneney dated 1959 in Kilimanjaro-Mamba of manuscript written c.1916 in old Kichagga.

¹²¹ Stahl, *History of the Chagga*.

¹²² Masao, “The Irrigation System in Uchagga”, 8.

¹²³ Fieldwork, Ugweno, Mwanga District 2003. Collection tanks are also used in South Pare and the Usambaras.

¹²⁴ Rebmann, “Journey to Jagga”.

¹²⁵ Carl Lent, “Das Kilimandjaro Gebiet zwischen Moshi und Taweta mit der wissenschaftlichen Marangu-station,” *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* 9, (1896), 42.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

It was long and so wide that sections of it are still visible as a depression in the terrain, despite having been abandoned half a century ago when a piped supply was built.

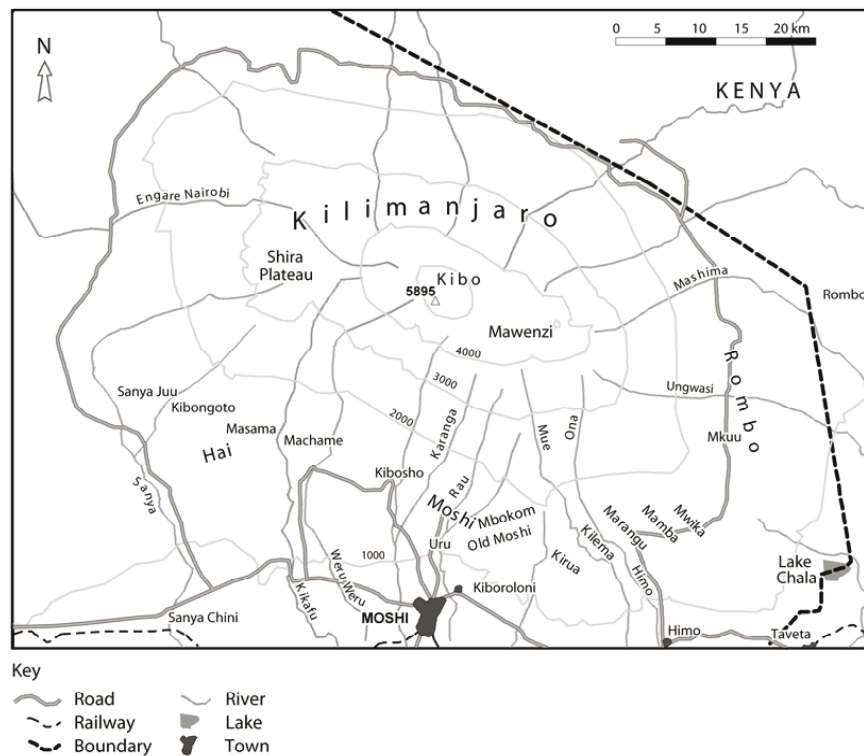


Fig. A3:5: Topography and place names on Mt Kilimanjaro.

Pre-colonial population and settlement trends are still open to debate, but crisis and contraction of the settlement in the 19th century have also been suggested.¹²⁶ Some areas, which are known to have been cultivated or settled in previous periods, fall outside the boundaries of the cultivated areas mapped by Meyer in 1890.¹²⁷ The

¹²⁶ Ludger Wimmelbücker, *Kilimanjaro – A Regional History. Vol 1. Production and Living Conditions: c.1800–1920* (Münster: LIT Verlag, 2002).

¹²⁷ Hans Meyer, *Ostafrikanische Gletscherfahrten: Forschungsreisen im Kilimandscharo-Gebiet* (Leipzig: Duncker & Humblot, 1890), Karte II.

Appendix 3

argument that the population was concentrated due to conflict with pastoralists or to increased insecurity following the expansion of the long-distance trade could support the case for the “population pressure” theory of the adoption and growth in irrigation.¹²⁸ Bender¹²⁹ mentions security as a motivating factor, along with dry season cultivation. Håkansson¹³⁰ has suggested an alternative explanation for the adoption of irrigation, whereby members of the mountain communities in South Pare, Kilimanjaro, were motivated by the regional exchange of grain with groups of people in the plains who were richer in livestock. Irrigation could thus be established under conditions of low population density as a form of regional specialisation or division of labour. In another political economy explanation, Fleuret and Sheridan attribute the construction of an irrigation scheme to a strategy pursued by pioneer settlers to attract more dependants and to accumulate wealth in people.¹³¹ In effect, this reverses the postulated relationship between the furrows and population growth. Irrigation schemes in Moshi and Pare are often reported in oral histories to have been initiated during the settlement of (or migration to) a locality, which supports the latter explanation. Based on Kimambo’s suggestions,¹³² the adoption of the technology can be described as part of a risk-reducing adaptation to the mountain environment which allowed an efficient exploitation of the different climatic zones defined by altitude through different seasons.

In the late 19th century there were more than 35 distinct political units on Mt Kilimanjaro, each under the leadership of a prince (*mangi*) engaged in shifting alliances and raids, whereby the control over the trade with coastal caravans may have been an important objective.¹³³ Trade in clay pots, salt (soda) and iron, obtainable in the region

¹²⁸ This “siege hypothesis” has been criticised by Lowe Börjeson, “Boserup Backwards? Agricultural Intensification as ‘Its Own Driving Force’ in the Mbulu Highlands, Tanzania,” *Geografiska Annaler, Series B: Human Geography* 89, 3 (2007), 249-267.

¹²⁹ Bender, “Water Brings no Harm,” 46-47.

¹³⁰ Thomas N. Håkansson, “Irrigation, Population Pressure, and Exchange in Precolonial Pare, Tanzania,” *Research in Economic Anthropology* 16, (1995), 297-323.

¹³¹ Patrick Fleuret, “The Social Organisation of Water Control in the Taita Hills, Kenya,” *American Ethnologist: A Journal of the American Ethnological Association* 12, 1 (1985), 103-118. Michael J. Sheridan, “An Irrigation Intake is Like a Uterus: Culture and Agriculture in Precolonial North Pare, Tanzania,” *American Anthropologist* 104, 1 (2002), 79-92.

¹³² Isaria N. Kimambo, “Environmental Control and Hunger,” in Gregory Maddox, James Giblin and Isaria N. Kimambo, eds., *Custodians of the Land. Ecology and Culture in the History of Tanzania* (London: James Currey Ltd., 1996), 71-95.

¹³³ Sally Falk Moore, *Social Facts and Fabrications. ‘Customary’ Law on Kilimanjaro 1880–1980*. (Cambridge: Cambridge University Press, 1986).

The expansion of traditional irrigation in Kilimanjaro, Tanzania

though not within most mountain districts, testifies to older established regional trade links. The borders of some districts or “statelets” were reportedly under permanent guard, and protected by defensive trenches, in some places in several lines.¹³⁴ Water was an object of politics, as exemplified by the attempt by the *mangi* of Moshi to enlist Von der Decken’s party on a raid on the community upstream in Mbokom because it had taken the water.¹³⁵ Water could also be used for political purposes: When Von der Decken’s party fled from Uru, a trench was flooded in order to make it slippery and difficult for carriers and donkeys to pass.¹³⁶ On other occasions, both Johnston and Abbott had their water cut off while negotiating with the *mangi* of Moshi in order to increase pressure on them.¹³⁷

The main settlement appears to have extended from c.1100 m.a.s.l. up to 1800 m.a.s.l. at the time of colonial impact.¹³⁸ There were no nucleated villages, only dispersed farmsteads situated in banana groves. Cooking bananas were supplemented by a variety of produce from groves and fields. There were also meadows in the agricultural landscape. Grass and banana pseudo-stems were fed to cattle kept in huts, and the groves were fertilised using cattle manure.¹³⁹ Some terracing was also used.¹⁴⁰ There was a wide variety of farm produce, but agriculture was centred on banana crops and millet fields, with tubers and beans being among the important subsidiary crops.¹⁴¹ The extensive furrow system, some terracing, and evidence for manuring and the transport of bundles of grass for stall fed cattle, are indications of an intensive agricultural system. However, it can also be argued that irrigation reflected adaptation to the mountain conditions and risk management. Irrigation can enable the area where the more valued *mchare* variety of banana can be cultivated to be extended down into dryer areas. More significantly, grains do not do well on the middle and higher slopes during

¹³⁴ Kersten, *Von der Decken’s Reisen 1; Von der Decken’s Reisen 2*.

¹³⁵ Kersten, *Von der Decken’s Reisen 2*, 58.

¹³⁶ Kersten, *Von der Decken’s Reisen 2*, 44.

¹³⁷ Johnston, *The Kilima-njaro Expedition*. A. Widenmann, “Die Kilimandscharo-Bevölkerung. Anthropologisches und Ethnographisches aus dem Dschaggalande,” *Petermanns Mitteilungen Ergänzungsheft*, 129 (1899), 71.

¹³⁸ Cultivated and settled areas are documented in several route descriptions. The limits of the cultivated areas are shown by Meyer, “Originalkarte des Kilima-Ndscharo,” and Lent, “Das Kilimandjaro Gebiet”.

¹³⁹ Kersten, *Von der Decken’s Reisen 1*, 269-270. Volkens, *Der Kilimandscharo*, 135. Widenmann, “Die Kilimandscharo-Bevölkerung,” 65.

¹⁴⁰ Volkens, *Der Kilimandscharo*, 74, 234. Widenmann, “Die Kilimandscharo-Bevölkerung,” 71.

¹⁴¹ Rebmann, “Journey to Jagga”. Kersten, *Von der Decken’s Reisen 1*. New, *Life, Wanderings and Labours*. Gutmann, “Feldbausitten”.

Appendix 3

the main rains (*masika*). They are planted in the cool season, when they are susceptible to drought even where annual precipitation is high. Thus, access to supplementary irrigation together with cultivation strategies utilising the different seasonality along the mountain slope would have made survival less uncertain and led to more efficient utilisation of labour.

There is clear evidence that there were forested patches, bush and meadows both within and close to the agricultural landscape on Mt Kilimanjaro. The agricultural landscape in Moshi was described as characterized by “rising columns of smoke”, probably from field preparation.¹⁴² Reports from 1899 and 1939 describe the cultivation of finger millet on an irrigated and manured swidden (*citemene*), which would subsequently have been used for less demanding crops.¹⁴³ The irrigated swidden presents a challenge to our understanding of irrigation as a land-intensive agricultural practice. It is difficult to know to what extent resources were stretched, or whether the societies on Mt Kilimanjaro had experienced a decline. It is possible that the area may have experienced cycles of growth and decline prior to the mid-19th century. Kjekshus and Wimmelbücker have argued that the expansion of the coastal trade and subsequent colonisation was a demographic disaster.¹⁴⁴ The legends from Mamba (an important centre in the period preceding the Swahili trade) mention disaster due to drought and overpopulation during the rule of the rainmaking chieftainess Mashina in c.1800.¹⁴⁵ Accounts of abandoned banana groves,¹⁴⁶ overgrown trenches¹⁴⁷ and abandoned house sites located in the high forest¹⁴⁸ from the 1860s onwards tend to support the thesis that a crisis had been experienced in the mid-to late 19th century.

¹⁴² Kersten, *Von der Decken's Reisen 1*. New, *Life, Wanderings and Labours*, 368. Joseph Thomson, *Through Masai Land. A Journey of Exploration among the Snowclad Volcanic Mountains and Strange Tribes of Eastern Equatorial Africa, being the Narrative of the Royal Geographical Society's Expedition to Mount Kenia and Lake Victoria Nyanza, 1883–84*. (London: Sampson Low, Marston, Searle & Rivington 1885), 142. Johnston, *The Kilima-njaro Expedition*, 95.

¹⁴³ Widenmann, “Die Kilimandscharo-Bevölkerung,” 71. J.R. Curry, “Eleusine Cultivation by the Wachagga on Kilimanjaro,” *The East African Agricultural Journal* 5, March (1939), 386–390.

¹⁴⁴ Wimmelbücker, *Kilimanjaro*. Helge Kjekshus, *Ecology Control and Economic Development in East African History. The Case of Tanganyika 1850–1950* (Berkeley: University of California Press, 1977).

¹⁴⁵ Mtui, [Untitled]. Wimmelbücker, *Kilimanjaro*.

¹⁴⁶ Kersten, *Von der Decken's Reisen 1*.

¹⁴⁷ New, *Life, Wanderings and Labours*.

¹⁴⁸ M. Merker, “Rechtsverhältnisse und Sitten der Wadschagga,” *Petermanns Mitteilungen Ergänzungsheft*, 138 (1902), 40.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

Colonial conquest brought missionaries, and after 1885 German officers arrived, and eventually settlers. The missionaries at Mamba entered into partnership with local agents who built a new and bigger furrow into a watercourse above neighbouring Marangu, nicknamed the “furrow of blood” after the resulting conflict.¹⁴⁹ The first statutory water laws were partly motivated by the need to handle such conflicts between European settlers and the local Chagga.¹⁵⁰ When colonialists arrived to farm in lower Marangu after the turn of the century, they copied the technology, expanded existing furrows and constructed new schemes when they occupied the land,¹⁵¹ mostly on the lower slopes. Land across the lower slopes, used more extensively by the Chagga, and to some extent by the Maasai, who were chased from the foothills into a reserve in 1905–1906,¹⁵² was alienated in the first decade of the 20th century. This lower belt of alienated land made expansion difficult from 1911 onwards, and alienation was suspended.¹⁵³ The confiscation of estates during World War 1 by the British interrupted the development of this sector, but most of the land was eventually sold to new settlers. Land alienation on the lower slopes and the creation of a forest reserve that restricted upward expansion, and the rapid increase in coffee as a peasant cash crop, coupled with population growth, all pointed towards an imminent land crisis, as was realised by the British administration by 1930.¹⁵⁴ The combined action of land alienation on the lower slopes and the forest reserve was described by colonial planners as acting like “a vice”.¹⁵⁵ The rapid expansion of the area under coffee cultivated by smallholders,

¹⁴⁹ Interviews, Marangu West Ward, Moshi Rural District 1996.

¹⁵⁰ D.M. Mwita, *Rights in Respect of Water in Tanganyika* (Dar es Salaam: University of Dar es Salaam, 1975).

¹⁵¹ As shown by the water rights records of the Principal Water Officer at Ubungu, Dar es Salaam.

¹⁵² Yngve Sjöstedt [Baron Bror v. Blixen], *Bland Storsvildt i Ostafrika* (Stockholm: P.A. Norstedt & Söners Förlag, 1911).

¹⁵³ Official measurements showed 0.42 hectares of available land per capita in 1913. Juhani Koponen, *Development for Exploitation. German Colonial Policies in Mainland Tanzania, 1884–1914* (Helsinki: Finnish Historical Society, 1995), 630. Data from 1930 calculate to 0.26 ha cultivated land per capita and 0.8 ha of unalienated land, and a population density of 114 persons per km². A.W. Griffith, *Chagga Land Tenure Report* (Moshi District: Government of Tanganyika, 1930), Appendix b.

¹⁵⁴ Griffith, “Chagga land tenure”.

¹⁵⁵ Cf. R.J.M. Swynnerton, “Some Problems of the Chagga on Kilimanjaro,” *East African Agricultural Journal (Amani)* 15, January (1949), 117–132.

Appendix 3

together with bananas under shade-providing trees, in the period after 1930¹⁵⁶ can be seen as one of the responses to a politically induced land scarcity.

The 20th century records and the two theses on change in the *mfongo*

The first systematic study of irrigation in the area was made by Gutmann, probably based on fieldwork before the advent of World War I.¹⁵⁷ He estimated that there were more than 1000 furrow schemes on the southern slopes of Mt Kilimanjaro. The more detailed study was based upon his observations in Old Moshi and Mbokom, where he found 66 schemes. These could be classified into different types, according to tenure and water control. The chiefs had initiated a few large schemes, and they had gained control over others, but most schemes remained under the control of furrow elders. These elders were drawn from the patrilineage of the furrow initiator, and they had key roles in ritual and maintenance relating to the furrows. The organisation surrounding the furrow was defined by the command area, not by kinship. In terms of water control, there was a distinction between spring-fed and stream-fed schemes, between schemes with and without collection tanks (*nduwa*), and between permanently flowing and intermittently flowing furrows. Most furrows in Old Moshi and Mbokom had collection tanks (*nduwa*), which indicates that the demand placed on the water resources was considerable.

¹⁵⁶ Coffee was introduced by missionaries at Kilema in the 1890s (Volkens, *Der Kilimandscharo*). African actors, *mangi*, headmen and big men first, started experimenting with the crop and integrated it into the banana groves. Its expansion is shown by an increased export through Moshi from 1200 tonnes in 1932-1933 to 6000 in 1952. G.F. Webster "Northern Province," in *Annual Reports of the Provincial Commissioners on Native Administration for the Year 1932* (Dar es Salaam: The Government Printer, 1933), 38-62. D.S. Troup "Northern Province," in *Annual Reports of the Provincial Commissioners for the Year 1952* (Dar es Salaam: The Government Printer, 1953), 85-112. The expansion of *kihamba* agroforestry is documented by Holand, "More People, More Trees", and by Patrick Bailey and John Mumford, "The Changing Economy of the Chagga Cultivators of Marangu, Tanzania," *Geography* 53, 2 (1968), 163-169.

¹⁵⁷ Gutmann, Bruno, "Das Wasserrecht. Dargestellt nach dem Bewässerungssystem der Wamotsi und Wambokomu," in Bruno Gutmann, *Das Recht der Dschagga. Mit einem Nachwort des Herausgebers: Zur Entwicklungspsychologie des Rechts* (München: Beck, 1926), 413-421.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

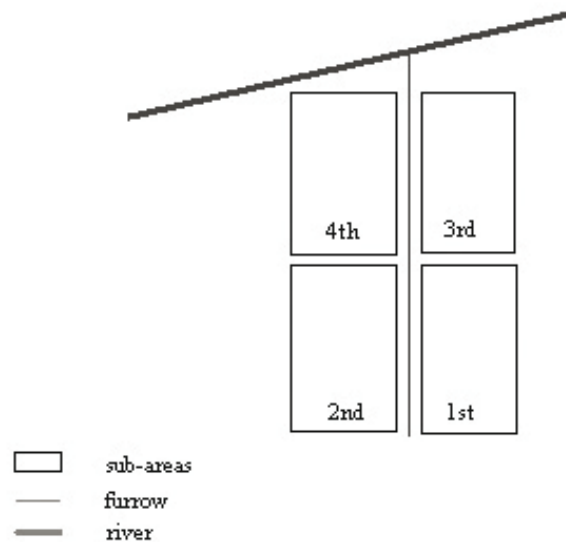


Fig. A3:6: The sequence of water rotation in a *mfongo* irrigation scheme at Mt Kilimanjaro in the early 20th century, as described by Gutmann¹⁵⁸. The tail-end users in two blocks were served before the water was redirected to the upstream allocation blocks.

The distribution of water¹⁵⁹ followed joint decisions at a meeting at the water source (tank or intake). The distribution of water could be organised as a sequence or in time-shares allocated to different irrigated areas, in a cycle starting with the end users (Fig. A3:6). There were different allocations for various purposes, and separate allocations for the furrow elder on market days. The purpose of water use was mixed. The small short-horned zebu cattle kept in the highlands acquired their water by eating banana stems rather than by drinking, but other domestic purposes (brewing, fire control, washing) are recounted in the oral history of water use. According to Gutmann,¹⁶⁰ the irrigation of banana groves was just as important as the irrigation of the millet fields. While recounting changes in furrow utilisation since the time of Gutmann's studies, elders interviewed during my fieldwork in Marangu associated a

¹⁵⁸ Gutmann, Bruno, "Das Wasserrecht," 419.

¹⁵⁹ Gutmann, "Feldbausitten". Gutmann, "Das Wasserrecht".

¹⁶⁰ Gutmann, "Feldbausitten".

Appendix 3

decline in highland irrigation with the phasing out of finger millet and a decline in arable cultivation. The pressure on land due not only to alienation and population growth, but also to the demand for land for coffee and banana groves, meant that little land was available for irrigated millet upslope after 1930. Competition for labour for growing coffee crops was another factor. Some millet was cultivated on the lower slope, but by the 1950s it had been replaced by the less labour-intensive maize.

The employment of more professional government staff from the 1930s, combined with a stronger interest in the water resources and the control over them, led to increased production of sources. The increased interest was due firstly to early concerns about water for hydropower development downstream and for the new European settlers,¹⁶¹ and, secondly due to the emergence of plans for new irrigation schemes in the plains which could allow the resettlement of mountain dwellers from congested areas as an alternative to land reform.¹⁶² An irrigation engineer was commissioned by the government, and 602 schemes on the slopes of Mt Kilimanjaro were identified in a subsequent survey in 1939–1940. The survey of the whole mountain was not completed as planned, but the coverage of certain districts was good, and permits a regional breakdown.¹⁶³ Assuming that these districts are representative, it can be estimated that there were between 1000 and 1500 furrow schemes at Mt Kilimanjaro at that time.

Pike, a colonial water warden in Moshi, wrote in 1965 that “there are now so many furrows, most houses on Kilimanjaro are within a very short distance of one”.¹⁶⁴ This statement on the multitude of schemes, instead of the total of 726 furrows from the survey he had made in 1959,¹⁶⁵ may suggest that the original survey was not comprehensive. Despite this uncertainty, the survey suggests that there was a decline in

¹⁶¹ Edmund O. Teale and Clement Gillman, *Report on the Investigation of the Proper Control of Water and the Re-organisation of Water Boards in the Northern Province of Tanganyika Territory November–December 1934* (Morogoro: [Government Printer], 1935). Mwita, *Rights in Respect of Water*.

¹⁶² Teale and Gillman, *The Proper Control of Water*. L.L.R. Buckland, *Water Executive Annual Report* (Dar es Salaam: Government Printer, 1939). L.L.R. Buckland, *Water Executive Annual Report 1940* (Dar es Salaam: Government Printer, 1940). G.J. Partridge, “Northern Province,” in *Annual Reports of the Provincial Commissioners on Native Administration for the Year 1939* (Dar es Salaam: Government Printer, 1940), 45-59. C.F.C.V. Cadiz, “Northern Province,” in *Annual Reports of the Provincial Commissioners for the Year 1953* (Dar es Salaam: Government Printer, 1954), 79-92.

¹⁶³ Buckland, *Water Executive 1939*. Buckland, *Water Executive 1940*.

¹⁶⁴ Pike, “Kilimanjaro and the Furrow System”.

¹⁶⁵ M.J.B. Molohan, “Northern Province,” in *Annual Reports of the Provincial Commissioners for the Year 1959* (Dar es Salaam: Government Printer, 1960), 103-134.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

the furrow technology in the period between the two surveys undertaken in 1939–1940 and 1959. Pike suggested that abandonment of furrow schemes was likely to have followed from the development of piped water supplies, which had started in this period.¹⁶⁶ Competing systems of water delivery may have threatened the sustainability of some multipurpose schemes by making purely household schemes redundant, or simply by competing for the same water sources. Social, economic and technological changes on a larger scale affecting smallholder irrigated agriculture may have played a more important role.

The plans for irrigated resettlement in the lowlands were taken up after World War II, but only limited development resulted from government initiatives in the period before Independence (1961), including a pilot scheme at Uru Chini (Lower Moshi)¹⁶⁷ and the Kimashuku furrow in Machame.¹⁶⁸ Such plans are still an issue when planning land and water use in the region, but the conflict between these plans and the use of water for hydropower downstream and also the high demand for water on the higher slopes have made their realisation a slow process.¹⁶⁹ More resources have gone into piped water supply schemes; including the construction of three small dams in 1959¹⁷⁰ in order to facilitate increased settlement in relatively sparsely populated upland areas in Kirua Vunjo that had poor access to water. Transition to piped rural domestic supplies after 1950 was intended to reduce water consumption through increased efficiency, according to Bender.¹⁷¹

The thesis of a decline in indigenous irrigation was adopted in the 1970s by the Japanese International Cooperation Agency,¹⁷² which used its estimate that peasant irrigation upslope had halved since its peak, and was down to 500 schemes, as a basis for assessing the availability of water for a major lowland irrigation project. The Lower

¹⁶⁶ Pike, “Kilimanjaro and the Furrow System”. The number of private connections at Mt Kilimanjaro increased fourfold to 1304 between 1950 and 1959. East African Statistical Department–Tanganyika Unit, *Statistical Abstract 1960* (Dar es Salaam: Government Printer, 1960), 71.

¹⁶⁷ Molohan, “Northern Province 1959”.

¹⁶⁸ Bender, “Water Brings No Harm,” 257.

¹⁶⁹ Teale and Gillman, *The Proper Control of Water*. Swynnerton, “Some Problems of the Chagga”. William Halcrow, *The Development of the Pangani River Basin* (London: Sir William Halcrow and Partners, 1962). United Republic of Tanzania–MWEM, *The Meeting on Water Utilisation and Shortage*.

¹⁷⁰ Molohan, “Northern Province 1959,” 125.

¹⁷¹ Bender, “Water Brings No Harm,” 263.

¹⁷² Japan International Cooperation Agency [JICA], *Kilimanjaro Region Integrated Development Plan* (Dar es Salaam: JICA, 1977).

Appendix 3

Moshi Irrigation Scheme, operational from 1987, has become rather stunted by poor access to water in relation to demand, apparently due to an underestimation of the extent of irrigation prior to project, and to the changes in cropping pattern it inspired among the upstream irrigators who appropriated green revolution technology more selectively.¹⁷³ The hypothesis of a decline thus led to an underestimation of the dynamism and vitality of the system, and can be rejected, but with the provision that a decline did take place in certain areas. While some instances of abandonment correspond to the construction of pipelines, this process is more closely associated with social and economic changes on a larger scale, leading to changes in the farming system.

Changing numbers of schemes through the 20th century

The second hypothesis is that there has been a growth in water use for irrigation in traditional irrigation due to population growth since Independence.¹⁷⁴ On the basis of analysis of data from a field survey by Pangani Basin Water Office, it is estimated that there were *c.*1000 furrow schemes at Mt Kilimanjaro in 1992–1993,¹⁷⁵ probably slightly less than in 1939–1940 when the number of schemes may have peaked. Analyses of changes based on three areas selected to represent the three main regions of the southern slopes of Mt Kilimanjaro (Table A3:1), are more reliable, however. Marangu is situated on the south-eastern slopes in Vunjo,¹⁷⁶ while Old Moshi and Mbokom are on the south-central slopes in Moshi Rural District. Machame is located on the south-western slopes and lies within Hai District (Fig. A3:5). From 1939–1940 to 1992–1993 there was a marked decline of 41% in the number of schemes in Marangu, but a moderate increase

¹⁷³ M.A. Burton and C.K. Chiza, "Water, Conflicts and the Environment," in Tom R. Franks, Laurence E.D. Smith and Melvin Kay, eds., *Water: Economics, Management and Demand* (London: Spoon Press, 1997), 173-180. Koichi Ikegami, "The Traditional Agrosilvopastoral Complex System in the Kilimanjaro Region, and its Implications for the Japanese-assisted Lower Moshi Irrigation Project," *African Study Monographs* 15, 4 (1994), 189-209.

¹⁷⁴ Daluti, *Report on the Agro-socio-economic Situation*. Sarmett and Faraji, "The Hydrology of Mount Kilimanjaro". United Republic of Tanzania–MWEM, *The Meeting on Water Utilisation and Shortage*.

¹⁷⁵ The PBWO database from field survey undertaken by the Pangani Basin Water Office in 1992-1993 identifies 1388 "traditional furrows" in the administrative Kilimanjaro Region, which includes the Mt Kilimanjaro districts of Hai, Moshi Rural, Moshi Urban, and Rombo, as well as the two districts of Pare (Same and Mwangi). In addition to these, a fraction of the 485 registered water rights in the region refer to furrow schemes.

¹⁷⁶ Vunjo is the eastern half of Moshi Rural District.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

by 28% in a part of Machame.¹⁷⁷ The number of furrow schemes in old Moshi and Mbokom in the 1910s was comparable to that in the 1990s (within 2%).

Table A3:1. Changes in the number of *mfongo* irrigation schemes in three sectors of the southern slopes of Mt. Kilimanjaro.

Period	1910s	1930s	1950s	1970s	1990s
Marangu		251			148
Old Moshi & Mbokom	66				65
Part of Machame		72			92
Mt Kilimanjaro	1000*	602**	726**	500*	1000*

* estimates **partial

Sources: Gutmann, "Feldbausitten," for Mt. Kilimanjaro and Old Moshi with Mbokom in the 1910s. Griffith, "Chagga land tenure," for Machame in the 1930s. Buckland, *Water Executive 1940*, for Marangu in the 1930s. Molohan, "Northern Province 1959," for Mt Kilimanjaro in the 1950s. Donald Lee Mosgrove, "Watering African Moons: Culture and History of Irrigation Design on Kilimanjaro and Beyond" (Ph.D. thesis, Cornell University, 1998), for Machame in the 1990s. Pangani Basin Water Office data 2003 for Mt Kilimanjaro in the 1990s and Marangu and Machame in the 1990s. Records of the Regional Hydrologist, Kilimanjaro. Julius D. Sarmett, A.K. Mvaa, S.E Monyo, N.J. Kajigili and K. Z. Mushi, *Ushirikishwaji wa Wananchi katika Usimamizi wa Matumizi Bora ya Rasilimali za Maji Bonde la Mto Pangani* (Moshi: Taarifa ya Rasilimali za Maji Wilaya za Hai, Moshi Vijijini na Moshi Mjini, 1997), for Old Moshi and Mbokom in the 1990s.

The somewhat diverging trends in the data do not support a "recent growth" thesis that new schemes were constructed faster than old ones were abandoned. Neither is there any firm support for the thesis of an overall decline in irrigation, allowing for some increase of scale. Rather, the review of hill furrow history in Kilimanjaro supports a third, alternative hypothesis, namely that irrigation infrastructure was fully developed in many highland areas by the early 20th century, and that there has been no substantial increase in the number of schemes there since the 1930s. Accordingly, subsequent changes should be understood as processes of restructuring and technological change, with decline in some areas and growth in others. A more detailed analysis of two available surveys shows that the amount of water abstracted in the Marangu district in

¹⁷⁷ By 1930 irrigation infrastructure served at least 19% of the cultivated land in the district of Machame through 183 schemes according to Griffith, "Chagga land tenure", 116-117. The area was reduced to be comparable with 121 schemes in a hydrological region centred on Machame listed by Mosgrove, "Watering African Moons", 253-257.

Appendix 3

the dry season was the same in 1992 as it had been in 1940.¹⁷⁸ An abandonment of schemes in the highlands had been accompanied by a growth in the average size of the remaining schemes and by intensification of irrigation in the foothills and lowlands. Among other factors, these changes could be related to changes in agriculture and the effects of land scarcity.¹⁷⁹ The three areas listed in Table A3:1 include sections of the mountain slope with long established, densely populated farming and irrigating communities. Data do not permit a separate quantitative analysis of the less densely populated lowlands, where an increase in water use since Independence appears likely. Changes and conditions in the lowlands have been addressed by Lein, Lerise and Beez.¹⁸⁰

The establishment and expansion of the considerable infrastructure with *mfongo* technology can be compared with available data on population (Table A3:2). The figures from 1948 onwards are compiled from reliable census data, while population data prior to this are drawn from counts for taxation and other purposes.¹⁸¹ Some of the

¹⁷⁸ Mattias Tagseth, "Local Practices and Changes in Farmer-managed Irrigation in the Himo Catchment, Kilimanjaro," in Ngana, James O., ed., *Water Resources Management – The Case of Pangani River Basin*. (Dar es Salaam: University of Dar es Salaam Press, 2002), 48-63.

¹⁷⁹ Mattias Tagseth, "The 'Mfongo' Irrigation Systems on the Slopes of Mt. Kilimanjaro, Tanzania," in Terje Tvedt and Eva Jakobsson, eds., *A History of Water*. Volume 1: *Water Control and River Biographies* (London: I.B. Tauris, 2006), 488-506.

¹⁸⁰ Haakon Lein, "Migration, Irrigation and Land Use Changes in the Lowlands of Kilimanjaro," in James O. Ngana, ed., *Water Resources Management. The Case of Pangani River Basin, Issues and Approaches* (Dar es Salaam: Dar es Salaam University Press, 2002), 28-38. Fred Simon Lerise, *Politics in Land and Water Use Management: Study in Kilimanjaro, Tanzania* (New Dehli: Mkuki na Nyota Publishers, 2005). Jirgal Beez, *Die Ahnen essen keinen Reis. Vom lokalen Umgang mit einem Bewässerungsprojekt am Fuße des Kilimanjaro in Tansania* (Bayreuth: Universität Bayreuth, 2005), Available from: <http://opus.ub.uni-bayreuth.de/volltexte/2005/168/> (accessed 19 February 2007).

¹⁸¹ William Louis Abbott, "Ethnological Collections in the U.S. National Museum from Kilima-Njaro, East Africa," in *Annual Report of the Board of Regents of the Smithsonian Institution, Showing the Operations, Expenditures and Condition of the Institution for the Year Ending June 30th, 1891* (Washington: Government Printing Office, 1892), 381–420. Charles Dundas, *Kilimanjaro and its People. A History of the Wachagga, Their Laws, Customs and Legends, Together with Some Account of the Highest Mountain in Africa* (London: Frank Cass & Co. Ltd., 1924). Griffith, "Chagga Land Tenure". Paul S. Maro, "Population and Land Resources in Northern Tanzania: The Dynamics of Change, 1920–1970" (Ph.D. thesis, University of Minnesota, 1974). East African Statistical Department–Tanganyika Unit *Statistical Abstract 1960*. URT, Bureau of Statistics, *1967 Population Census*. Volume 1 *Statistics for Enumeration Areas* (Dar es Salaam: Central Statistical Bureau, 1969). URT, Bureau of Statistics, *Tanzania Sensa 1978. Population Census* (Dar es Salaam: United Republic of Tanzania–Takwimu/Bureau of statistics, 1982). URT- Bureau of Statistics, *Tanzania Sensa 1988. Population Census. Regional Profile 3, Kilimanjaro* (Dar es Salaam: Bureau of Statistics, 1990). President's Office, Planning Commission, *Sensa ya Watu na Makazi ya Mwaka 2002* (Dar es Salaam: United Republic of Tanzania, Takwimu, 2003). Available from: <http://www.tanzania.go.tz/sensa/kilimanjaro.htm> (accessed 15 February 2007).

The expansion of traditional irrigation in Kilimanjaro, Tanzania

growth prior to 1948 reflects an increasing ability of the government to count and tax people. The data refer to a “Mt. Kilimanjaro region” consisting of Hai, Moshi Rural and Rombo Districts from the latest population census.¹⁸² The population of Moshi town is included until 1957, but the problems of comparability are small because urbanisation was not very significant up to that date. The increase in rural population has been substantial. There was a period of high to moderate population growth from 1948 to 1978, but growth rates have fallen substantially since then. A comparison between the counts of the schemes and the population increase shows that a substantial expansion of the hill furrow infrastructure took place prior to the period of rapid population growth in the second half of the 20th century which it has been ascribed to.

Table A3:2. Mt Kilimanjaro rural population and annual growth rates 1890–2002.

Year	1890	1913	1921	1931	1948	1957	1967	1978	1988	2002
Population (thousands)	60	99	128	155	231	359	476	642	741	909
Annual growth (%)		2.2	3.3	1.9	2.3	4.9	3.3	3.0	1.9	1.4

The transition to piped supplies for the provision of domestic water can explain only some of the discrepancies. The expansion of the hill furrow systems is not well explained in terms of a process of agricultural intensification as an effect of increased population density in the second half of the 20th century. Agricultural intensification leading to the adoption of irrigation may have taken place at lower population densities than assumed, or due to localised population concentration. Some models which can explain the early establishment of irrigation at low population densities in terms of adaptation, strategies of accumulation and regional trade from the debate on intensive agriculture in eastern Africa have been mentioned above.

The existence of an extensive irrigation infrastructure cannot be explained in terms of recent population growth, neither does the thesis of a decline fit the data. The changes in irrigation over the 20th century can instead be described as a restructuring,

¹⁸² Bureau of Statistics/President’s Office, Planning Commission, *Sensa 2002*.

Appendix 3

with decline in some areas and growth in others. Other contributing factors have to be sought to account for the development of *mfongo* irrigation: in the historically and geographically contingent ways that the local farmers responded to increasing levels of land scarcity, in technological change, in the changing role of irrigation farming in the economy, and in policy and planning. The dynamics of change in irrigation and factors of explanation are explored further in the following sections.

The dynamics of “traditional” irrigation

The question of why the practice of irrigation on Mt Kilimanjaro emerged and expanded has often been raised,¹⁸³ but there have been few attempts to discuss the question in relation to the history and geography of the area. Östberg’s study of Marakwet irrigation was focused on causation, while the analysis of change was somewhat restricted by the available historical data.¹⁸⁴ Anderson¹⁸⁵ was able to show how irrigation in Baringo in Kenya could expand and contract under the influence of economic and political factors. Irrigation in Kilimanjaro has evolved, expanded, contracted, and changed through a long series of phases, under the changing influence of several factors.

There are regional variations in the changes in irrigation. Comparing along the horizontal axis across the slope, there are cases of abandonment in locations in pre-colonial times, for instance in Keryo and Ushiri (Rombo), stagnation (Machame highlands, Old Moshi), and decline (Marangu highlands) in the 20th century. Taking the vertical axis along the gradient into account, there has been a process of expansion in the lower slopes and lowlands, but a decline or stagnation in the highlands in the late colonial and postcolonial periods.¹⁸⁶ In general, a decline in irrigation from pre-colonial times has taken place in many highland areas in the Pangani River Basin.¹⁸⁷

¹⁸³ See e.g. Johnston, *The Kilima-njaro Expedition*. Dundas, *Kilimanjaro and its People*. Teale and Gillman, *The Proper Control of Water*.

¹⁸⁴ Östberg, “The Expansion of Marakwet Irrigation”.

¹⁸⁵ David M. Anderson, *Eroding the Commons: the Politics of Ecology in Baringo, Kenya 1890s-1963* (Oxford: James Currey, 2002).

¹⁸⁶ Cf. Tagseth, “Practices and Changes in Farmer Managed Irrigation”.

¹⁸⁷ Franz D. Huijzendveld, “Changes in Political Economy and Ecology in West-Usumbara, Tanzania: ca. 1850-1950,” *International Journal of African Historical Studies* 41, 3, 384–409. Thomas Håkansson, “Regional Political Ecology and Intensive Cultivation in Pre-Colonial and Colonial South Pare, Tanzania,” *International Journal of African Historical Studies* 41, 3, 433–459. Michael J. Sheridan,

The expansion of traditional irrigation in Kilimanjaro, Tanzania

The development and expansion of irrigation is often explained as a result of population growth, exemplified by Mbonile's suggestion of a direct and dynamic relationship between population and resources such as water.¹⁸⁸ While it is reasonable to assert that population as a variable is involved in the changes, the emphasis of this single-factor explanation appears simplistic. The establishment of a substantial irrigation infrastructure on the higher slopes predates the population expansion it has been ascribed to. This makes it possible to ask whether population can be seen as a dependent variable for some periods. It appears reasonable to assume that a causal relationship between population and irrigation would lead to a systematic regional co-variation between population densities and density of irrigation infrastructure. A comparison of population density between districts across the slopes of Mt Kilimanjaro reveals no obvious relationship between the degree of reliance on irrigation and population density, neither in 1934 nor in 1962.¹⁸⁹ Irrigation has in fact declined in locations with very high and increasing population densities, such as parts of the Marangu highlands, from the 1930s to the 1990s. There has been a persistent tendency through several phases for irrigation to expand towards the extensive margin rather than at the intensive core.

The highlands

The processes of change differ between the agro-ecological zones.¹⁹⁰ I will discuss highland and foothill processes first, before moving on to changes in the lowland. Early innovation or adoption of the technology of irrigation could be seen as a form of adaptation to the mountain environment and as part of a strategy of accumulation under lineage organisation. The old local and regional trade networks for salt, pottery, iron, and food may have facilitated irrigated grain production as a regional specialisation.

“Cooling the Land: Politics, Ecology, and Culture in the North Pare Mountains of Tanzania” (Ph.D. thesis, Boston University 2001).

¹⁸⁸ Mbonile, “Migration and intensification of water conflicts”.

¹⁸⁹ High population densities in areas with little irrigation are striking (Rombo: Mkuu and Usseri, Moshi; Mamba). Teale and Gillman, *The Proper Control of Water*. Philip W. Porter and Norman J.W. Thrower, “Annals Map Supplement. Number Six: East Africa-Population Distribution,” *Annals of the Association of American Geographers* 56, 1 (1966), 180.

¹⁹⁰ A regionalisation into a lowland zone (below 900 m), a foothill zone (900–1250 m) and a highland zone (1250–2000 m) simplifies the substantial variations in natural conditions and land use along the gradient.

Appendix 3

Local food trade took place at the markets centrally located around the 1300 m contour, while regional trade took place at markets below the settlement. The latter are described as Maasai markets in the late 19th century,¹⁹¹ where agricultural products were bartered for livestock, milk and iron.¹⁹²

From c.1800, Kilimanjaro was linked to the coast through direct caravan routes from Mombasa and later Pangani. Trade in prestige goods, guns, ivory and slaves, had wide but regionally differing impacts on local economy and society. Among other things, large caravans added a new market for food.¹⁹³ The effects of long distance trade are a better candidate than the need for coordination of irrigation in the explanation of political centralisation on Mt Kilimanjaro in the 19th century. The apparent abandonment of irrigation north of Rombo Mkuu in the 19th century can be related to political and economic change. The change of coastal trade routes from the eastern to the southern slopes of Mt Kilimanjaro led to a decline in Rombo, and the change in political and economic dominance with the establishment of the German headquarters in Marangu meant that the area could be raided. Increased warfare and changes in the control over trade¹⁹⁴ may have created centres or growth poles where investment in irrigation was feasible as well as unfortunate districts where irrigation infrastructure, fields and terraces were abandoned, as recorded in the travelogues.¹⁹⁵ Irrigation infrastructure was expanded in the highlands across the southern slopes during the 19th and early 20th century in order to cater for new settlements. Maize was known in the late 19th century, but not widely cultivated. Finger millet production motivated the construction of new irrigation schemes. The need for water for new arable outfields can explain why irrigation development during several phases often has taken place on the extensive margin and not as intensification at the core.

Finger millet has good storage properties and a high value for weight, and could be traded, hoarded and redistributed as grain or in the form of beer. Today, *mbege* brew made with millet and bananas is used for ceremonial occasions because of its symbolic value. According to oral histories, *mbege* had prestige value, it was required in the

¹⁹¹ Lent, "Das Kilimandjaro Gebiet". Volkens, *Der Kilimandscharo*.

¹⁹² Gutmann, "Feldbausitten," 502. Widenmann, "Die Kilimandscharo-Bevölkerung," 69.

¹⁹³ Moore, *Social Facts and Fabrications*.

¹⁹⁴ Wimmelbücker, *Kilimanjaro*.

¹⁹⁵ New, *Life, Wanderings and Labours*. Volkens, *Der Kilimandscharo*, 74, 283.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

mobilisation of labour parties, it was paid as tribute (*mashiro*) for land, and as part of the bride-price¹⁹⁶ along with livestock. Banana groves probably produced more calories per acre, but irrigated millet was important in the production and appropriation of a surplus which could be traded, circulated and invested in social relations. According to Bender, it was “used as a form of currency” in the pre-colonial economy,¹⁹⁷ but the details of how it entered the regional trade, with Maasai for livestock, Wagweno for iron and pots, or the Wakahe for salt, is a matter which may need further research. In the late 19th century, a powerful warlord, such as *mangi* Sina of Kibosho, had stores that could hold as much as 350m³ of the grain, some of it bartered from landscapes to the east.¹⁹⁸ The redistribution of grain in the form of beer, as well as livestock and prestige goods acquired as booty, “tax” and through the control over external trade by the *wamangi*, was important in maintaining warriors at their courts and thus their power.

German colonisation brought new changes including conquest and pacification, land alienation, the requirement to pay tax, increased availability of imported goods and after 1911 urbanisation at the railhead in Moshi. Together with rinderpest, which decimated the livestock population, especially in the plains, this would have led to profound changes in regional trade. Other areas developed into labour reserves, but at Mt Kilimanjaro farmers eventually became peasants engaged in production for subsistence and the world market. Technological changes included new cultivars, the most important of which was coffee.¹⁹⁹ Kilimanjaro became a war zone when the Germans lost the colony to the British in World War I. During British rule, millet was replaced by the less labour-intensive maize, while the widespread adoption of coffee as a peasant crop facilitated intensification through the expansion of agroforestry groves. Coffee cultivation by peasants probably started on local initiative, but was official policy from the mid-1920s.²⁰⁰ This form of intensification led to increased reliance on

¹⁹⁶ The exchange of 1640 litres of brew, corresponding in my estimation to 45 sacks of grain and 800 litres of ripe banana, is mentioned by Petro Itosi Marealle, *Maisha ya Mchagga hapa Duniani na Ahera* (Nairobi: The English Press, 1947).

¹⁹⁷ Bender, “Water Brings no Harm,” 50.

¹⁹⁸ Volkens, *Der Kilimandscharo*, 136-137. Finger millet is normally stored as unhusked ears.

¹⁹⁹ The Irish potato, Mexican cypress, silky oak (*grevillea*), cotton, *ceara* rubber, and arabic coffee were among the important new plants from the German period, according to Robert Munson, “The Landscape of German Colonialism: Mt. Kilimanjaro and Mt. Meru, ca 1890-1916 (Tanzania)” (Ph.D. thesis, Boston University, 2005).

²⁰⁰ Dundas, *Kilimanjaro and its People*.

Appendix 3

bananas and mixed agroforestry for food rather than an intensification of irrigated grain production in the highlands. This change appears to signal a decline in millet production and in investment in irrigation in the uplands. The change in technology to piped supplies after World War II is another factor in the decline in the furrows. While upland areas were converted from pasture and fields to groves, arable cultivation was extended in the foothills during the colonial periods, with maize as the dominant grain. Informants commented on how maize emerged as a co-staple, and by the 1950s the Northern Province, and mainly Mt Kilimanjaro with other volcanic areas, was the leading producer in a regulated market.²⁰¹ New irrigation schemes were constructed in some areas in the foothills, elsewhere existing schemes were extended.²⁰² Commuting from the highlands to cultivate arable fields downhill became an increasingly important strategy pursued by peasants and colonial planners,²⁰³ as far as competition with the estates for land would allow. Later, the foothills became a zone of expansion for settlement and agroforestry. Supplementary irrigation of groves is now more common in this zone. This zone has seen an increase in irrigated horticulture, benefiting from the liberalised agricultural economy developed after 1986 and good road access.

The lowlands

In the late pre-colonial period, the lowlands were used by the Kahe, Maasai and others, and were not controlled by Chagga groups. Maasai use of the Kilimanjaro lowlands was prohibited by the German colonial government and was probably permanently reduced. Some areas were alienated by the Germans.²⁰⁴ A reservation of the remaining lowland areas for Chagga expansion was confirmed by the British, who sought to establish a political geography of indirect rule, where tribes were defined and supposed to reside within their territory under a “Native Authority”. The Kahe agriculturalists indigenous to the lowlands were classified as a subgroup of the Chagga and not accorded the status of a tribe with a legitimate territorial interest. Other groups, such as the Pare irrigators,

²⁰¹ J.F.R. Hill and J.P. Moffet, *Tanganyika. A Review of its Resources and their Development* (Norwich, UK: The Government of Tanganyika, 1955), 378-379.

²⁰² Tagseth, “Practices and Changes in Farmer-managed Irrigation”. Francois Devenne, “On the ‘Mountain of Waters’ the Furrows are Running Dry: Rethinking Mount Kilimanjaro’s Irrigation System,” in Francois Bart, Milline J. Mbonile and Francois Devenne, eds., *Kilimanjaro. Mountain, Memory, Modernity* (Dar es Salaam: Mkuki na Nyota publishers, 2006), 201-214.

²⁰³ Swynnerton, “Some Problems of the Chagga”.

²⁰⁴ Munson, “The Landscape of German Colonialism”.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

were seen as alien to the area. These are some of the preconditions for the designation of the lowlands as an expansion area for the Chagga population on the mountain slopes. The concept of carrying capacity entered the debate on the administration of the region by 1930, and detailed calculations showed a problem of overpopulation on parts of the mountain slopes.²⁰⁵ A planning strategy emerged, whereby “excess” population on the lush, but densely populated slopes was to spill into the surrounding semi-arid plain, assisted by irrigation.²⁰⁶ In 1937, Provincial Commissioner Hallier wanted to direct the excess population towards an agricultural future within the region, and saw it as his “duty to control and guide the development of these people, and not to allow them to move on in a haphazard manner”. This translated into the first of a series of plans for Chagga resettlement in the plains, the “Rau-Himo Expansion Scheme”.²⁰⁷ This strategy of expansion to the lowlands has been confirmed in postcolonial planning.²⁰⁸ Planners have thus pointed to the semi-arid lowlands as the expansion zone of the Chagga over a long period of time, while slow development can be explained by concerns about water for downstream hydropower production from the 1930s onwards, competition with estates for water, and poor access to funding at least into the 1980s.

Irrigation was established in the pre-colonial period by Kahe people indigenous to the lowlands and others in locations in the plains.²⁰⁹ A few schemes were made on government initiatives and more on local initiatives during British rule. For instance, land in Lower Moshi was allocated by the chief of Uru in the 1950s.²¹⁰ Cotton was cultivated in the post-war periods, but phased out in the 1970s due to poor markets, while rice was cultivated as a crop for cash and subsistence in some limited areas. The cultivation of maize with beans and later sunflowers expanded, under supplementary irrigation where possible. Many Chagga actually preferred alternative strategies to resettlement in the lowland, involving intensification and increasing agroforestry upslope, but also education and salaried work, trade and long distance migration. A few

²⁰⁵ Griffith, “Chagga Land Tenure”.

²⁰⁶ Lein, “Migration, Irrigation and Land Use Changes”.

²⁰⁷ Mark Wilson, *Report of the Arusha-Moshi Lands Commission* (Dar es Salaam: Government Printer, 1947), Appendix E.

²⁰⁸ Lein, “Migration, Irrigation and Land Use Changes”.

²⁰⁹ Kahe, Arusha Chini, Taveta (Kenya) are known sites.

²¹⁰ Lerise, *Politics in Land and Water Use Management*.

Appendix 3

migrated to other districts to farm there.²¹¹ Thus, some sought a way out of the equation of carrying capacity used by the planners, by expanding their economic activities beyond the region and the agricultural sector.

The rehabilitation of the hydropower plant at Pangani Falls in the 1950s revitalised the conflict between water use for upstream irrigation development and downstream hydropower production. Storage of water in the Nyumba ya Mungo Dam commissioned in 1968 was intended to alleviate this, but international funding for irrigation development was not forthcoming. The policy of “African socialism,” *Ujamaa*, was developed in the 1960s. Villagisation in the 1970s involved the concentration of people into compact village communes which could be reached by state policies and infrastructure such as schools and piped water. The impact on the established, dense settlements upslope was small, but some *Ujamaa* villages were established in the plains,²¹² for instance in the Lower Moshi area. Villagisation led to redistribution of land (and water) and was a new opportunity for migrants.²¹³ The nationalisation of estates allowed for some redistribution of land, for instance at Himo in the lowland where immigrants took over the former settler furrows. When severe drought struck nationwide in 1974, a “war on drought” was declared and a call issued to rehabilitate and use traditional irrigation schemes where possible. Some schemes were established or expanded with government support. Old irrigating communities existed in the lowlands, but irrigation probably increased between the 1930s and the 1970s, as Rudengren²¹⁴ claims that it was widely practiced in Kahe and Lower Moshi. Settlement and migration histories, however, show that many migrants originated from neighbouring groups or as long distance migrants who first came to work on estates or in construction in the area.²¹⁵ The expansion of irrigation in the lowlands has some similarities with the changes described for South Pare, which are explained in terms of

²¹¹ Examples of Chagga satellites are found in Babati (interviews October 2002) and in Ugweno, North Pare (fieldwork 2003).

²¹² Moore, *Social Facts and Fabrications*. Lerise, *Politics in Land and Water Use Management*.

²¹³ Lerise, *Politics in Land and Water Use Management*. Beez, *Die Ahnen essen keinen Reis*.

²¹⁴ Teale and Gillman, *The Proper Control of Water*. Jan Rudengren, *Peasants by Preference? Socio-economic and Environmental Aspects of Rural Development in Tanzania* (Stockholm: Economic Research Institute, Stockholm School of Economics, 1981), A42.

²¹⁵ Rudengren, *Peasants by Preference?* Lein, “Migration, Irrigation and Land Use Changes”. Beez, *Die Ahnen essen keinen Reis*.

The expansion of traditional irrigation in Kilimanjaro, Tanzania

changes in the regional political economy and the trade in grains.²¹⁶ Another call to revive “traditional” irrigation was made during drought in 1987. A strategy of rehabilitation of traditional irrigation schemes emerged in the 1980s as an efficient way of improving the food production in Tanzania,²¹⁷ and some upgrading of schemes with cemented canals was funded by the FAO and more recently by the World Bank.

A different course was taken in Lower Moshi, where the Japanese International Cooperation Agency, in line with the Kilimanjaro water master plan,²¹⁸ redeveloped an area for water-intensive smallholder irrigation of rice with green revolution technology, including field levelling, cemented canals, mechanisation, a new rice variety (IR54), and fertilisers. This intervention restructured irrigation in Lower Moshi and Kahe. It deprived a number of farmer-managed irrigation schemes of their water and reduced the production of maize under a less water intensive regime of supplementary irrigation over a substantial area.²¹⁹ Key elements of the green revolution technology were appropriated selectively by irrigators upstream from the project and some other locations,²²⁰ who used the rice variety and the fertilisers to produce rice as a cash crop. The project area, however, did not have enough water for the planned three crops a year, and a plot would have been cultivated only twice in a three-year period.²²¹

The change brought by the development project, which introduced more water-intensive green revolution technology, is one cause of increased water demand since the 1980s. Further changes may result from the objectives to increase the reliance on rice and to modernise the majority of the traditional irrigation schemes under the National Irrigation Master Plan,²²² but this would depend on donor support and the development of an irrigation policy. Another factor is the privatisation of estates under the policies of liberalisation, which led to the revitalisation of dormant coffee estates on the mountain

²¹⁶ Håkansson, *The Expansion of Irrigation and Cattle Keeping in South Pare*.

²¹⁷ Burra and van den Heuvel, *Traditional Irrigation in Tanzania*.

²¹⁸ Lein, “Migration, Irrigation and Land Use Changes”.

²¹⁹ Beez, *Die Ahnen essen keinen Reis*.

²²⁰ Ikegami, “The Traditional Agrosilvopastoral Complex System”.

²²¹ Beez, *Die Ahnen essen keinen Reis*.

²²² Japanese International Cooperation Agency & Ministry of Agriculture and Food Security, *The National Irrigation Master Plan*.

Appendix 3

slopes²²³ and two large estates irrigating sugarcane in the plains. In Rudengren's analysis, livelihoods based on irrigated agriculture in the lowlands during *Ujamaa* in the 1970s, when the food market was strictly regulated constituted a retreat into subsistence.²²⁴ The liberalisation of the food trade with the adoption of structural adjustment policies after 1986 stimulated the cultivation of grains for the market. A last factor was the rehabilitation of the hydropower plant downstream at Pangani Falls in 1995, which made water not utilised in irrigation more valuable.

Three factors emerge in the explanation of change in irrigation: population, technological change, including agricultural intensification, and political economy, which includes development planning and economic policies as well as market changes. High and rising population densities in the core areas upslope did not lead to intensification of irrigation there during the 20th century. This can be attributed to the form of intensification that took place. Irrigation of arable fields declined, while intensification led to increased reliance on agroforestry with coffee and banana, and an increase in mulching and shading as methods of soil water management. This path of change in turn depended on a policy conducive to peasant production of coffee, and the abolition of the system of compulsory work and a labour card system which took place early during British rule.²²⁵ Change in technology to piped domestic supplies may have reduced the importance of the furrows in some areas, and led to their abandonment. The needs of an expanding population on the mountain slopes are a part of the explanation for the expansion of irrigation in the lowlands. Migration to the lowland was only one of several strategies pursued by Chagga in search of a livelihood. Preconditions for the lowland expansion include support by the German and British rulers to reserve part of the lowlands for this purpose. The objective of expanding Chagga settlement to the lowlands assisted by irrigation appeared in government documents from the 1930s and were reconfirmed in several plans, but it took a long time to realise. The main reasons for the delay lie in conflicts of water use and in access to funds for major development

²²³ Butingo A.S. Luhumbika, *Report on Water Availability to Coffee / Banana Belt in Kilimanjaro Region with Particular Reference to Hai and Moshi Rural Districts* (Hale: Pangani Basin Water Office, 1999). Morten Reed-Erichsen, "Negotiations over Rights to Water. The Process of Determining Allocation of Water between Farmers and Estates, in the Context of Coffee-producing Estates in Kilimanjaro Region, Tanzania" (Cand. Polit. thesis, Norwegian University of Science and Technology, 2003).

²²⁴ Rudengren, *Peasants by Preference?*

²²⁵ Bender, "Water Brings no Harm," 125-127.

projects. Increases in water use in the lowland areas have continued under conditions of comparatively low regional population growth since the 1980s, partly due to the introduction of a new rice variety which has made irrigation more water intensive, and to policies of liberalisation leading to the privatisation of estates and other changes.

Conclusions

In this article, the development of *mfongo* irrigation systems on the southern slopes of Mt Kilimanjaro has been outlined. Oral traditions suggest that hill furrow irrigation systems existed by the 17th century, while specific schemes and actors can be traced back to the early 19th century through oral history. Eye-witness accounts from the second half of the 19th century show that the hill furrow irrigation technology was established across the southern slopes of Mt Kilimanjaro by then. The establishment of a substantial furrow infrastructure in pre-colonial periods is probably better explained in terms of adaptation, strategies of accumulation, regional trade, and possibly security, than it is in terms of intensification driven by population growth. A thesis of rapid growth of these systems in recent decades due to corresponding population growth has been proposed, but there is also a competing thesis of decline due to development and transition to alternative technology. Quantitative analysis of scheme development is possible for the 20th century. Changes in the number of schemes have been moderate, lending support to the third, alternative hypothesis, that many districts in this area were well developed in terms of irrigation by the early 20th century. The existence of substantial parts of the hill furrow irrigation infrastructure on the slopes of Mt Kilimanjaro cannot be explained by the population expansion in the second half of the 20th century because its establishment predates it. Changes in the 20th century can be seen as a restructuring of irrigation, where decline in irrigation in the densely settled highland areas were offset by increase in irrigation in the foothills and lowlands and some increase in scale. This observation invites questions of the dynamics of irrigation development. Population increase alone cannot explain the changes, as it is associated both with decline or stagnation in long established irrigation areas upslope and with intensification of irrigation in the foothills and lowlands. Stagnation and decline in irrigation in upland areas under conditions of high population pressure can be related to the decline in arable cultivation and increased reliance on agroforestry as the main

Appendix 3

method of intensification. The transition to piped water supplies is a contributing factor. An intensification of irrigation has taken place in the foothills and lowlands in periods since the 1930s. The needs and strategies of an expanding Chagga population are involved, but the processes have also been influenced by policy, and technological and market factors. The dynamics of irrigation development are thus not determined by population pressure alone, but can be interpreted in relation to the historically and geographically contingent ways that the local farmers responded to increasing levels of land scarcity, to technological change, and the changing role of irrigated farming in the economy, as well as policy factors.

Paper 4

The 'mfongo' irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania.

Abstract:

The Chagga people on the southern slopes of Mt. Kilimanjaro, Tanzania, continue to rely on an extensive network of canals for irrigation and other purposes. This type of stream diversion irrigation canal (*mfongo*) is a part of the cultural and technological heritage of the area. Having been seen mainly as an obstacle in the process of development and in resource management, indigenous knowledge is now increasingly viewed as an important resource. The main objectives of this study of the relevance of local knowledge to water management are to describe and analyse changes in water use, the relationship between the irrigation system and the farm systems, and also to analyse water tenure and the organisation of the schemes. Local knowledge in the area has been faced with a series of challenges, under which it changes. One of these challenges was a water management initiative based on recommendations for integrated river basin management, following a hydropower rehabilitation project at Pangani Falls. There have been important changes in the farm system in the area through the last century, influencing the use of water. An increased reliance on agroforestry groves and diversification into vegetables are examples of these. The local organisation of irrigation by groups of smallholders varies between two main modes, but the integration with other institutions at the local level is a common trait.

Key words: water management reform, water use change, social organisation, indigenous irrigation

The manuscript is published as M. Tagseth (2006).

In T. Tvedt and E. Jakonsson (Eds.),

A history of water. Volume 1: Water control and river biographies (pp 488-506) I. B. Tauris: London.

Is not included due to copyright

Paper 5

Tanzanian water policy reforms

– between principles and practical applications²³³

Abstract

The paper presents and discusses different approaches to water management, termed 'state-centred', 'market-based' and 'community-based'. Each provides different answers to how and by whom limited water resources best could and should be managed. They are based on different development ideologies, and advocated by different professions. The article elaborates on the strengths, limitations and compatibility of the three models. These models provide a basis for discussing national water policy and water management reforms in Tanzania as well as the more practical implications of this in one of the main river basins in the country: the Pangani River Basin. Central to the water management problem in this basin are conflicts between communities and the water bureaucracy over what constitutes 'proper' management of water. The policy and the activities of the river basin authorities continue to reflect a traditional top-down bureaucratic approach to water management, with colonial roots. The water legislation and the formal water management system seem neither to be set up to facilitate the active participation of local communities in water management, nor to facilitate the development of a water market.

Keywords: Pangani River Basin, Tanzania, water legislation, water policy, water management reform

²³³ This manuscript was published as H. Lein and M. Tagseth (2009), in *Water Policy*, 11(02), 203-220.

Appendix 5

Introduction

In the International Year of Freshwater in 2003, sustainable utilisation of water resources was placed high on the international development agenda. In the years leading up to this event there were many calls for giving more attention to the problems of water scarcity (Falkenmark, *et al.* 1990) and an apparently emerging global water crisis (Postel, 1992; Clarke, 1991) as well as an increasing likelihood of violent conflicts over water. Although such crisis narratives have become widely accepted, they have been challenged by critics who questioned the idea of water as a particularly scarce (Lomborg, 2001) or conflict-ridden resource (Lonergan, 2001). Water shortages in particular regions can and are being solved by technological solutions (e.g. desalinisation) and water being traded mostly in the form of food ('virtual water'). However, both those who anticipate an impending water crisis and those presenting more optimistic visions seem to agree that freshwater in the future should be managed 'better'. Yet what does 'better' or 'improved' water management really mean? How should it be carried out in practice?

The discourse on water management in global forums dates back to the Stockholm (Sweden) conference in 1972, and the UN conference on water in Mar del Plata (Argentina) in 1977, but the 1990s witnessed the emergence of what has been described as a new international consensus on key principles for sound water management. A recent World Bank water policy paper simply states that: 'There is a broad consensus of what constitutes good water resources management, but all countries are far from managing water resources according to these principles' (World Bank, 2003, 29). This claimed consensus is referred to as being based on the four original 'Dublin principles'²³⁴ from 1992, which have since been developed and interpreted through a series of conferences and policy papers, including the 1992 RIO Earth

²³⁴ The four original 'Dublin principles' are:

No. 1 - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

No. 3 - Women play a central part in the provision, management and safeguarding of water.

No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good.

(<http://un-documents.net/h2o-dub.htm>)

Tanzanian water policy reforms – between principles and practical applications

Summit (Rio de Janeiro, Brazil) (Johnson, 1993), as well as various reports and policy papers prepared by international institutions (e.g. UNESCO, 2003; World Bank, 1993; 2003). The World Bank report previously quoted also summarises the current version of this consensus as follows: ‘water resources should be managed holistically and sustainably, respecting subsidiary and ensuing participation, and treating the resource as an economic as well as social good’ (World Bank, 2003, 29). With the exception of the claim that water should be treated as an economic good (on which there is definitely no consensus, at least not on what it means in practice), this statement is apparently not very controversial. However, moving beyond the rhetoric and finding ways of implementing these principles may lead to practical solutions which are much more controversial.

In the first part of this article, we present and discuss three different approaches or models (these two terms will be used interchangeably) to water management (Table A5:1). All can be said to address the problems of ‘sound’ water management and the need to prescribe solutions and interventions in response to the approaching ‘water crisis’. These three approaches have been labelled ‘state-centred’ ‘market-based’ and ‘community-based’, respectively. Each provides different practical answers to how and by whom water resources best could and should be managed. They are grounded in different (‘classic’, ‘neoliberal and ‘neo-populist’) development ideologies (Blaikie, 1998; Tagseth, 2002; Lein, 2004), and they are advocated by different professions. The three models will be used as a basis for analysing and discussing past and current approaches to water management in Tanzania, showing how the practice of water management is influenced by the global water policy process as well as geographically and historically contingent national and regional settings. The main focus is on the new National Water Policy of Tanzania (United Republic of Tanzania, 2002a) as well as recent experiences from water management reform in the Pangani River Basin.

Three models of water management

State management

For many, the term ‘water management’ is closely associated with what is here labelled a state-centred or technocratic approach to water resource management.²³⁵ This technocratic management model is based on the notion that the state, through its administrative and political institutions, can and should plan and allocate scarce water resources in the interest of the common good. The model is based on a strong notion of expert decisions and the ideology that water, societies and humans can be planned and managed so as to produce optimal solutions.

Due to the nature of the resource, water management should be carried out within the framework of the river basin. Planning, management and conflict resolution are tasks to be carried out by special water management authorities, having superior knowledge and overview of available resources, possible ways of using water, and also ideas and tools to decide on the optimal way of allocating resources. Such water management organisations are to be governed by boards, often involving different ‘stakeholders’, understood to represent various interests groups or sectors (civil administration, ministries, economic actors, farmers, women, etc.). The main purposes of water fees are to recover costs of providing water (infrastructure) and to fund the operations of water management authorities. The dominant professional perspective is hydrological, and water management is primarily seen as a task for hydrologists and to some extent for agronomists and irrigation engineers.

The prime example of such a technocratic water management approach is what is termed ‘integrated river basin planning’. Inspired by the Tennessee Valley Authority (TVA) model, associated with the New Deal policies of the depression in USA, river basin planning has been applied in several African countries since the 1960s. Adams (1992) argues that this model initially became so popular because it appealed to the idea of modernisation, rationality and planning. It also carried the notion of a strong and active state as an engine of development. Further, the approach promised to solve a

²³⁵ The term water management has been defined as ‘Planned development, distribution and use of water resources (Johansson, 1983: 138).

Tanzanian water policy reforms – between principles and practical applications

number of development problems, such as hydropower development, irrigation development and general rural development, all in an ‘integrated manner’. While popular in many countries, the results of large-scale river basin projects in Africa have often been quite disappointing. This can be attributed to a number of aspects linked to design and practical implementation (Barrow 1998). It is easy to imagine that the systematic use of river basins or watersheds – cutting across strong existing social boundaries (e.g. ethnic groups) as well as political and administrative boundaries – as a territorial basis for environmental planning and action, may lead to substantial political and practical controversies. Furthermore, it is important to acknowledge that the systematic use of ecological boundaries as political and planning units is a modern idea with little historical precedence, and that what Barham (2001) terms the ‘watershed rule’ may come into conflict with basic democratic rights. Further, and linked to this, is the notion that participation and many democratic aspects of ‘water management’ can be adequately served through ‘stakeholder participation’ in river basin institutions at various levels. Such stakeholder participation may range from nothing more than token interest to serious attempts at initiating real participation. However, the idea of stakeholder participation raises a series of fundamental issues linked to the identification and selection of stakeholders, and to how these could be held responsible vis-à-vis their ‘constituencies’ (Wester, 2003).

The aforementioned technocratic approach falls well within what Blaikie (1998) has termed the classical, statist top-down approach to rural development and environmental management. This development approach was challenged in the 1990s by both neoliberal and neo-populist development paradigms.

Management by the market

The ‘market-based’ model presents a critique of the principles of the technocratic model outlined in the previous section. This critique is primarily related to questions of how, and by whom, decisions about the allocation of water should be made.

The most controversial issue in global water reforms outlined in the Introduction is the argument that ‘water has an economic value in all its competing uses and should be recognized as an economic good’, as stated in the fourth principle in the Dublin

Appendix 5

statement on water and sustainable development.²³⁶ Perry (2001) identifies three main motivations for water charging: it can be used to recover the cost of providing the service; it can provide an incentive for the efficient use of scarce water resources; and water charges can be used as a benefit tax on those receiving water services to provide potential resources for further investment to the benefit of others in society. The idea of a water fee or tax to cover the cost of providing services may be controversial and difficult to carry out in practice, but in theory it could easily be incorporated into the traditional river basin model. The second point is more complicated, as it requires the establishment of some kind of private property rights to water and some kind of water market.

The market-based model for water management is based on the very fundamental neoliberal argument that while markets may not be perfect, they are certainly better than bureaucrats and politicians in allocating scarce resources. As regards the water sector, this general argument has been phrased thus: ‘As with anything in water management, the choice is not between first and second best but between “imperfect” and “even more imperfect”’ (World Bank, 2003, 26). It is argued that water can and should be treated as a commodity along with oil and other natural resources and can thus be traded at auctions or in other ways. By establishing clear tradable property rights, a market for water can be established. Efficient use of scarce water resources would be secured if those who are willing and able to pay the most for water gained access to it, assuming that these would be able to secure the highest returns. A water market can be organised in different ways, but in this model, water management is basically about developing a legal framework and setting up functioning water markets based on, for instance, tradable water rights (Rosegrant & Binswanger, 1994).

Developing a system of tradable water rights is seen as a way of empowering water users, providing security of tenure regarding water rights, and providing incentives to consider the full opportunity costs of water (Schleyer & Rosegrant, 1996). A market can be seen as a highly decentralised system of decision making, so it

²³⁶ It is worth noting that the text following the statement presents what is basically an environmental argument for the claim: ‘Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources’ (<http://un-documents.net/h2o-dub.htm>).

Tanzanian water policy reforms – between principles and practical applications

resonates with the requirement of another core principle of the Dublin statement, that water should be managed at the ‘lowest appropriate level’.

Despite the push towards allocation through the market, examples of functional water markets with a significant trade in water in developing countries are still hard to come by. In 1981 Chile introduced a new water law, defining transferable water rights separated from land rights, and this has been termed a success story where an active water market has led to more efficient use of water and, it is claimed, more pro-poor use of resources (Schleyer & Rosengrant, 1996). Other empirical studies on Chile have shown a fairly limited market with very few transactions in general and especially between sectors, leading to a suggestion that some of the claims about the functioning of the market are ‘so sweeping that they are best understood as political and theoretical statements rather than balanced or empirical analysis’ (Bauer, 1997, 646; 2004).

Within this model there is little room for river basin authorities to make priorities or plan strategically. The role of the state lies in facilitating and overseeing that the market works, which can be challenging enough in some situations. This approach to treating water as a commodity to be traded on a market has also been criticized for being based on a reductionist view of what is a truly multifaceted resource, and for ignoring the strong symbolic and cultural elements and values associated with it (e.g. Strang, 2004). Others have argued against giving private investors control over this ‘blue gold’, and claim that access to water should rather be seen as a human right (Gleick, 1998; Mehta, 2000; Petrella, 2001), more in line with prior global recommendations from the Mar del Plata conference in 1977 (Gleick, 1998).

Management by community

The statist, technocratic approach to water management has been challenged not only by the market model of water management but also increasingly by neo-populist ideas which gained ground in the general development discourse in the 1980s, when new arguments about the need for increased participation by community in development as well as in natural resource management, and criticisms of the practice of ‘normal professionalism’ emerged (Chambers, et al. 1989). Since then, ‘community-based natural resource management’ (CBNRM) has become a standard part of the

Appendix 5

international aid vocabulary. The idea that local communities can manage resources – also water – in a sustainable way corresponds well with the second original Dublin statement, which states that ‘Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels’.²³⁷

The importance of local or indigenous knowledge is emphasised in (but is not exclusive to) the populist development discourse. It is claimed that there are important lessons to be learned from local management practice (Coward, 1977; Adams, 1992), and that we should look for more creative interactions between indigenous and scientific (or ‘Western’) knowledge systems (deWalt, 1994). In fact, many (perhaps most) water management systems in developing countries can be described as forms of ‘community management’. Such management systems developed to facilitate traditional irrigation systems may face serious challenges, for instance from increasing numbers of users (‘the tragedy of the commons’), in enforcing rules (‘the freerider problem’), or due to new management problems involving increasing regional scales and the emergence of new competitors for the water (i.e. urban water supply, large-scale irrigation schemes and hydropower). Nevertheless, there is little doubt that actual ‘community-based’ water management systems do have some success as they contribute to sustaining the livelihoods of many people, and they can have more success in mediating conflicts and mobilising local resources than other systems (Adams, 1990; Ostrom, 2002). The crucial point from the neo-populist discourse on development is not so much the insight that irrigators can know how to run the schemes that they have made, but the vision that these models and capabilities can be successfully mobilised or replicated in outsiders’ quests to improve water management.

A ‘water management community’ may typically be a village or a group of water users sharing a scheme or a source of water. Although there are wide variations in actual institutional set-up and practices in such communities, it can be argued that they share some common traits. The ‘members’ of the community have the right to utilise the resource, but there is usually no individual ownership. Rights in these commons are embedded in a system of reciprocal rights and obligations. In order to access water one has to fulfil certain obligations (e.g. be a member of the village or group, contribute in

²³⁷ <http://un-documents.net/h2o-dub.htm>

Tanzanian water policy reforms – between principles and practical applications

construction or maintenance of infrastructure). Once these obligations are fulfilled, a person has a claim to water along with other members of the community. ‘Payment’ for water takes place mainly in the form of labour or other contributions needed for running the system. Various types of community organisations decide on the principles and rules for water allocation and negotiate in cases of conflicts, for example in parleys or hearings negotiated by water specialists, local leaders and village elders. Influential attempts to systematise and formalise such principles more theoretically have taken place within the field of institutional economics. Common Pool Resources (CPR) theories provide a possible basis for designing and setting up new community-based systems. Ostrom’s well-known design principles for successful CPR systems can be seen as guidelines in processes of crafting institutions (Ostrom, 1990; 1992). Further, it has been argued that it is possible for outsiders to strengthen social capital in farmers’ irrigation organisations and that this may yield positive results as regards water use efficiency and output (Uphoff & Wijayarathna, 2000). Within the water sector, the idea that water users associations (WUAs) can be crafted or transformed and given responsibilities for running irrigation schemes or even smaller catchments has rapidly gained ground and seems to have become a panacea. References to participation and the need to establish WUAs have become the standard rhetoric repertoire of both technocratic and neoliberal approaches to water management.

In a review of studies of various interventions and projects for increasing local participation and decentralisation of river basin management around the world, Mody (2001, 45) finds very few truly successful examples and concludes: ‘It is premature to be “disappointed” but the lessons are sobering. While examples of success exist and do show the way forward, success has tended to be localised and, even there much work lies ahead’. As funds for state-led developments projects have become more scarce, many irrigation management transfer (IMT) projects have been devised, based on the idea that communities can manage water in large-scale irrigation systems better and cheaper (at least for the government) than traditional irrigation bureaucracies (Turrall, 1995). Closer involvement of users, it is argued, should not only help to reduce operating costs, it should also make water distributors more responsible vis-à-vis the

Appendix 5

farmers, thereby increasing efficiency and contributing to a general ‘democratisation’ of the irrigation systems.

The concepts of the designed WUA and ‘community-based’ water management have been promoted with great enthusiasm in many water policy documents produced in recent years. It has been pointed out, however, that such models readily lend themselves to fairly idealistic and simplistic notions of ‘community’, or what Mosse & Sivan (2003, 15) term ‘imaginative constructs of indigenous, local or community institutions’. Such ‘imaginative constructs’ tend to underestimate political, historical and ecological specificities of communities and community institutions. As Agrawal & Gibson (1999) have demonstrated, the very idea of community in much of the writings on CBNRM is based on the questionable conception that ‘communities’ are socially homogeneous and filled with people sharing common norms and values. However, communities can be conflict ridden and highly unequal societies, not necessarily well suited for sustainable management of natural resources (Mehta, 2000). On the other hand, interventions which aim at improving or replicating existing farmer-managed irrigation organisation, built on a model which reduces the social organisation of a commons to a set of ‘operational rules’ inspired by functionalist theory in social science, are likely to show weaknesses in terms of dealing with change and politics. Cleaver (2000) and Leach *et al.* (1999), among others, have criticised the institutional approach for putting too much faith in the idea that specific strong institutions for natural resource management can be designed and crafted, and they underline the embeddedness and multifaceted aspects of water resource management.

The main elements of the three models are summarized in Table A5:1. In the remaining part of this article the ongoing water reform processes in Tanzania will be analysed. As in the global discourse on water reforms, calls for water reform in Tanzania have been based on claims and notions of a water crisis. As we will show, the ongoing reforms call upon elements from all the three models, thus creating a water policy reform and a process of implementation which is hybrid in form and historically and geographically rooted.

Tanzanian water policy reforms – between principles and practical applications

Table A5:1. Three models of water management.

ISSUES	MODEL		
	Community	State	Market
Principal agent	Community Civil society Water users associations	State (executive) Planner, expert	Market Judiciary
'Ownership' of water	Commons with varying systems of rights of use	State property	Individual property Private enterprises
Mechanism for allocating water	Access to water through participation/ investment in scheme, inheritance or usufruct	Access to water through bureaucratic allocation of water licences subject to fees	Access to water through purchase of a right in a market
Resource Mobilisation	Labour and other contributions to local water users groups	Taxes/water fees to government	Water fees and private investments
Ways of solving conflicts	Civil society: Committees, hearings, general meeting Village elders	Executive: Boards representing 'stakeholders' Expert decisions	Market/Judicial: Market Courts of law
Scale/ Regional focus	Local village, community watershed	River basin	Individual user
Dominant professional perspective	NGO professionals (Farmers)	Hydrologists Engineers (Economists)	Economists

Tanzanian water laws and policies

The first water control system and statutory water laws in what is now Tanzania were established by colonial authorities in the early 20th century. A main purpose was limiting the use of water among the native inhabitants while at the same time securing access to water for European settlers (Mwita, 1975). A draft water ordinance was prepared during the period of German rule, but the first water law was approved under British rule in 1923. A new ordinance was not passed until 1948, and was replaced in 1959 and subsequently again in 1974. According to the current water laws in Tanzania,²³⁸ water belongs to the state and all water users who want to abstract water

²³⁸ Water utilisation is basically regulated by the '*Water Utilization (Control and Regulation) Act, 1974 (No. 42)*' (United Republic of Tanzania, 1974), with later amendments. The '*Water Utilization (Control*

Appendix 5

from a river or stream must have a 'water right'. Such water rights, or licences, can be obtained from the water officer, who can grant or refuse water rights to any person. If granted, the water right defines the amount of water to be abstracted, for what purpose it can be used, the duration of the right, and also the source of the water. A water right, or part of it, can be transferred along with land, but only if the water right is made explicitly appurtenant to it. There is no other provision in the current legislation for sale or other types of direct transfers of water rights. A volumetric fee for water use was set in the Water Utilisation Act (United Republic of Tanzania, 1974), in order to provide funding for water management, as first suggested in a study of water management made during construction of hydropower plants in the Pangani River Basin in the 1930s (Teale & Gillman, 1935).

Customary or 'traditional' rights to water have coexisted with the statutory water licences since their inception. In communities with a long-standing practice of traditional irrigation, rightful access to water is seen as a matter of usufruct, inheritance or local custom. Tanzania has legal pluralism, and varying customary laws are accepted under the Judicature and Application of Laws Ordinance (No. 453) of 1961 as equal to written law (United Republic of Tanzania, 2004a). Despite this, customary rights to water are not recognised in the same way as rights to land (see United Republic of Tanzania, 1994b). The uneasy coexistence between customary and statutory rights to water has been an issue during legislative review on more than one occasion (Teale & Gillman, 1935; Government of Tanganyika, 1956; Scott, 1962; United Republic of Tanzania, 2004a). Provisions were made for the registration of 'traditional rights' in the 1959 Ordinance, but actual registration during the short moratorium was limited, and rights accrued by 'custom' or long undisturbed use are not acknowledged by the Water Utilisation Act (United Republic of Tanzania, 1974), nor by the water officers who implement it.²³⁹ Only administrative water rights already registered under the old water

and Regulation) Act (Amdt.) 1981 (No. 10)' (United Republic of Tanzania, 1981) deals with water quality issues and the establishment of water authorities. Later regulations include: '*Water Utilization (General) (Amendment) Regulations, 1994*' (United Republic of Tanzania, 1994a), '*Water utilization (general) (amendment) regulations, 1996*' (United Republic of Tanzania, 1996), and '*Water Laws (Miscellaneous Amendments) Act, 1997*. An act to amend certain written laws pertaining to water. April 4th, 1997' (United Republic of Tanzania, 1997). These are regulations concerning fees for water right applications and volumetric fees for water abstractions.

²³⁹ Interviews, principal water office at Ubungo, Dar es Salaam 18.01.1996.

Tanzanian water policy reforms – between principles and practical applications

ordinances or the current Act, are acknowledged as existing rights. As a result, the legislation and the records of water rights still tend to favour the estate sector, formal irrigation and hydropower over farmer-managed irrigation (Tagseth, 2000; Reed-Erichsen, 2003).²⁴⁰

A new water policy document, replacing the 1991 water policy, was prepared by the Ministry of Water in 2000 (United Republic of Tanzania, 2000a) and eventually sanctioned in 2002 (United Republic of Tanzania, 2002a). The new national water policy emphasises the river basin as the administrative unit and the vision of integrated water resources management. The previous priorities²⁴¹ between alternative sectors have been abandoned in the new policy, where human needs are defined as a first priority before environmental flow, while water allocation for ‘other uses will be subject to social and economic criteria, which will be reviewed from time to time’ (United Republic of Tanzania, 2002a, 18). Furthermore, the policy proposal states that ‘in order to realize the objectives of water resources management all water uses, especially water use for economic purposes will be charged for’ (United Republic of Tanzania, 2002a, 29). The principle that ‘[w]ater has a value in all its competing uses’ (United Republic of Tanzania, 2002a, 15) and the volumetric pricing of water in order to increase efficiency (United Republic of Tanzania, 2002a, 7, 14) are also recognised. Trading of water rights is to be introduced as a means of demand management and water conservation (United Republic of Tanzania, 2002a, 19). The documents also mention water user and stakeholder participation, which could be interpreted as embracing more neo-populist methods of water management.

Through adoption of the basin as a management unit, through attempting to place a value on the use of water, and through the focus on stakeholder involvement at various levels, the policy document undoubtedly embraces core elements of the ‘international consensus’ on water management as expressed in the Dublin principles.

²⁴⁰ An examination of the records of water rights at regional, basin and national level showed that past management has resulted in a bias towards a ‘formal’ sector of water use on matriculated, alienated land. Many registrations date from the British colonial period, while some certificates originate in the original German alienation of land in Kilimanjaro more than one hundred years ago. Water rights acknowledged by a sovereign *mangi* (Prince, chief) prior to 1886 have left no such records.

²⁴¹ The former (1991) water sector policy ranked priorities (in order of importance) for domestic use, livestock, food production, and industries before hydropower (informants under the Ministry of Water and the Ministry of Agriculture interviewed in Dar es Salaam January 1996 and Moshi in June 2000.)

Appendix 5

Integrated water resources management at river basin level, as well as water fees for the recovery of administrative and catchment management costs are, however, in line with old-established suggestions and priorities for this basin (Teale & Gillman, 1935, 137, 146; Scott, 1962). The policy also takes up again the old objective of establishing a universal system of water licences, still not fulfilled after two legislative reviews and fifty years to implement it (Government of Tanganyika, 1956). The idea that the volumetric water pricing is a method of demand management can be described as novel, yet in line with international neoliberal recommendations on water management. The implementation of this water policy will, among other things, depend on the ongoing revision of the national water legislation. Furthermore, the implementation will take place in the context of other (sectoral) policies and strategies which will tend to counteract the centralisation of water management and the use of price mechanisms for allocation.

Tanzanian planning is guided by the framework of a development vision (United Republic of Tanzania, 1999) and associated strategies for poverty reduction (United Republic of Tanzania, 2000b) and poverty eradication. These should, at least in principle, guide sectoral policy papers and finally strategy papers. However, various policies are likely to contain conflicting objectives. With food security as a national priority, the national irrigation master plan (United Republic of Tanzania, 2002b) aims to increase the irrigated area by 9% and to redevelop half of the area under 'traditional irrigation' by 2017. The energy policy (United Republic of Tanzania, 1992), on the other hand, gives priority to hydropower development, which may reduce the use of foreign currency to import fossil fuels, but this is very likely to compete with irrigation development.²⁴² The implementation of the new water policy (United Republic of Tanzania, 2002a) will be guided by the National Water Sector Development Strategy, (United Republic of Tanzania, 2004c)(still in draft form), but the process will also be affected by other policies, strategies and processes, including the process of decentralisation intended to empower the district level (United Republic of Tanzania, 1998).

²⁴² It is apparent that the conflict has not been resolved at this policy level, but it seems that the situation is somewhat eased by the development of domestic natural gas resources as an alternative to erratic hydropower.

Tanzanian water policy reforms – between principles and practical applications

A legislative review was called for in the water policy paper (United Republic of Tanzania, 2002a, 9, 28). The dual system of water rights has been identified as an issue in the ongoing legislative process, and the recognition of ‘customary rights’ was among the objectives of a proposed ‘*bill for the water resources management act of 2004*’ (United Republic of Tanzania, 2004b), whereby customary rights are to be ‘of equal status and effect to a granted right’ (United Republic of Tanzania, 2004b, Paragraph 21(1)). Within a two-year period, those who have abstracted and used water undisturbed for a period of time are entitled to ‘water use permits’ upon application to the water officer. After this period has expired, the water officer will be authorised to register them regardless. Various local organisations are to be registered and given a formal status by the officer. An apparent objective is to incorporate customary rights in the registry of statutory licences, thus creating a single path to a legitimate right to water. This is in line with the water policy, which states that ‘[r]elevant customary law and practice ... will be institutionalised into statutes’ (United Republic of Tanzania, 2002a, 29). This is an improvement over the past assessment that all unlicensed abstractions are illegal, even if it could be seen as a repetition of a strategy that failed following water legislation reforms in 1959 and 1974. Juma & Maganga (2005) have warned that the expectation that customary laws are a transitory system which will die out may not be fulfilled. The acknowledgement of customary or common law principles of prescriptive rights could nevertheless be seen as a movement towards a community-based management model. However, the provisions will also make it easier to incorporate and charge traditional abstractions. Another important suggestion involves authorising the permanent or temporary transfer of water permits, which is one of the prerequisites for establishing a water market. This is clearly a licence to the market-based ideas. Furthermore, provisions are made to set up sub-catchment organisations with boards and water officers. The latter would involve some decentralisation of authority to local level, and possibly some adaptation to local practice in water management. These provisions are closer to suggestions from NGOs involved in the water sector and aiming to improve communication, participation and representation in water management.

Water management in the Pangani River Basin

It can be argued that developments in the Pangani River Basin have been important in defining problems and solutions in Tanzanian water management for a long time, due to the intensive utilisation of the available resources for smallholder irrigation, plantations, industrial irrigation, and hydroelectric power. European explorers arriving in the highland areas in the Pangani River Basin from the mid-19th century onwards were impressed by the hill furrow irrigation systems found in the mountain areas in the basin, and by the available water resources (Rebmann, 1860, New, 1873, Johnston, 1886, Baumann 1891, among others). However, from the period of colonisation onwards, the system was often described as wasteful and in need of improvement, reflecting increasing conflicts of interest²⁴³ (Swynnerton, 1949). The independent state of Tanzania as well as the many donors involved in water development projects in the region over the years appear to have inherited the latter perception (Daluti, 1994; United Republic of Tanzania 1994c). Despite many attempts to control, reform and ‘improve’ the indigenous water management systems (see for instance, Lein, 1998; 2004), most irrigation schemes operate under forms of farmer and community management and these continue to play a key role in intensive local farming systems.

Mt. Kilimanjaro, together with other mountain areas, catches orographic precipitation which makes up most of the runoff for Pangani River. The retreating glacier on Mt. Kilimanjaro is now rapidly becoming an icon of global climate change, following a remote sensing study by Hastenrath & Greischar (1997) and a much quoted study of palaeoclimate by Thompson *et al.* (2002, 580), warning that that ‘if current climatological conditions persist, the remaining ice fields are likely to disappear between 2015 and 2020’. This is, however, not a new claim, as the process of glacial retreat has been observed and published since shortly after Hans Meyer’s first climb in 1887 (Geilinger, 1936, 9), and investigated by Klute (1920) and Geilinger (1936). Geilinger (1936: 20) warned that ‘[s]hould the climatic conditions that have existed for the last fifty years prevail, ... the ice within the crater may disappear entirely in the decades to come, followed later by the disappearance of the glaciers on the outer

²⁴³ Griffith, A.W. 1930 Chagga land tenure report. Moshi District. Available from the archives of the University of Dar es Salaam, East Africana collection EAF Cory 272.

slopes'.²⁴⁴ The glacial retreat may reflect changes since the 19th century and not only the recent decades (see Cullen et. al. 2006).

With the dwindling snows of Kilimanjaro having become the most visible and powerful icon of global climate change, the International Union for the Conservation of Nature (IUCN) (2003) and others have started to blame the inadequate water supplies on a regional impact of climate change (global warming). However, the perception that the ice in the high alpine desert is a significant source of runoff at lower elevations (e.g. Gasse, 2002) can be rejected on the basis of a review of data on precipitation by altitude.²⁴⁵

The African climate is an uncertain factor, and it does change on varying temporal scales. A change in precipitation on the mountain has been ruled out by some hydrologists (Sarmett & Faraji, 1991), while increased demand and environmental degradation due to population growth were identified as key causes of the regional water crisis in the basin (Sarmett & Faraji, 1991; Daluti, 1994). Mkhandi & Ngana (2001) have identified negative trends in linear regressions for the period 1930–1990 from the precipitation records. Three precipitation stations which started recording in the first quarter of the 20th century yielded data showing negative regressions for the period up to 2004, according to Hemp (2005). The glacial retreat and the reduction in precipitation could be caused by the same climatic changes, whether this is due to an increase in temperature or other changes, such as a reduction in cloud cover. It now appears likely that changes in climate in the form of a decrease in precipitation during the 20th century and an associated reduction in runoff are contributing factors to water scarcity in the region.

Policy makers and various consultants have identified poor implementation of existing regulations as a major cause of the impending water crisis in the basin (United Republic of Tanzania 1994c). Among these were the Scandinavian donors, who pushed

²⁴⁴ The reading that Professor Meyer concluded in 1896 from his observations that the glaciers of the Kibo crater were likely to disappear prior to Geilinger's publication is even more intriguing (Geilinger, 1936: 9).

²⁴⁵ The precipitation peaks in the lower part of the forested belt at c. 2000 m.a.s.l., while the alpine zone is arid, covers a small area and presumably has high levels of evaporation (see Fig. 2.2 in Tagseth, 2000: 18).

Appendix 5

for changes in water management in the 1990s (Rudberg, 1994; Hjorthol, 1994; *Development Today*, 1995), due to concerns about the availability of water to run the redeveloped hydropower plant downstream at Pangani Falls (Bryceson, 1994). An interpretation of a 'water crisis' was developed, and a set of interventions prescribed and given backing from the Norwegian Agency for Development Cooperation (NORAD) and the World Bank. The Scandinavian involvement in water management reforms in the Pangani Basin lasted through the 1990s, in parallel with World Bank involvement, which is still ongoing. More recently, the basin has become a pilot site for the Water and Nature Initiative of the IUCN.

The 'water crisis' in Kilimanjaro and the Pangani Basin is multifaceted and experienced in different ways by different actors. Its causes are still open to debate, as are the cures. Thus, in a constructivist interpretation, the emergence and definition of a 'water crisis' in Pangani and Kilimanjaro is linked not only to a possible physical process of desiccation but also to concerns about water for the major development projects in the region, and to the need for state control over water.

A conflict perspective on water management at the basin level shows that interpretations of the crisis are associated with the diverging interests of sets of actors. In the Pangani Basin, farmer-managed irrigation competes with irrigation development projects, and irrigation competes with hydropower (Mujwahuzi, 2001). Plans for irrigated development in the lowlands have existed since the 1930s (Buckland, 1939). These plans have been reconfirmed on many occasions, but concerns about water for hydropower are among the factors that have slowed the development (Teale & Gillman, 1935). Irrigation development in the semi-arid lowland followed at a moderate pace (Lein, 2004). A Scandinavian preoccupation with hydropower and a Japanese preoccupation with the production of paddy led to two major development projects within a decade. The first phase of the Japanese-sponsored Lower Moshi Irrigation Scheme was completed in 1986, and had been funded by 31 million USD by 1992 (Beez, 2005, 33-34), while the rehabilitation of the hydropower station at Pangani Falls was completed in 1995 at a cost of 850 million NOK (c.136 million USD). This contributed significantly to the water stress in the region, resulting in the establishment of the Pangani Basin Water Office (PBWO) in 1992, as the first river basin authority in

Tanzanian water policy reforms – between principles and practical applications

Tanzania. The Pangani Basin's water officer was given the tasks of bringing water use under control through implementation of the mandatory water licence in accordance with statutory law, and to implement the new volumetric fees for water use. When the PBWO was established the basin officer was given the task of collecting data on hydrology and water use, and 1015 abstractions with water rights and 1881 unlicensed abstractions were identified.²⁴⁶ A crash programme to install several hundred control gates to limit the abstractions of water for farmer-managed irrigation was launched. The unlicensed users were told to apply for statutory water rights and to pay an application fee. Other important objectives were to collect the revised fees for water use in order to fund the activities of the PBWO, and also to reform the traditional organisation of farmer-managed irrigation into registered, standardised 'water users associations', which could be held accountable to the water authorities.

The implementation of river basin management along these lines met with resistance, and what can be described as widespread non-cooperation in the effort to install control structures and in the process of implementing the administrative water licence. The relationship with groups of irrigators became strained during the crash programme, and there were locations which the Basin Water Officer and his staff could not visit safely.²⁴⁷ There was also resistance and non-cooperation from local government, and water management became an object of debate during the first multiparty parliamentary elections in Tanzania. In the districts with long-established practices of irrigation, the prescribed measures have been met with different notions of the rightful access to water and what constitutes proper management of water. Water itself is understood to be 'a gift from God', owned by no one. The scheme may belong to a family group ('clan'), which appoints the leader of water, while members of the community maintain rights of use. Contribution to the common good (the scheme), long undisturbed use, and inheritance are the principles underlying discussions over rightful access to water. The relevance of the statutory licence in local disputes remains minor, and it is associated with the colonial estates and other outside interests. The local institutions and practices of water management are varied, but in some of the

²⁴⁶ PBWO database 1994: *watright* and *tradfur*.

²⁴⁷ Interviews with Ministry of Water personnel at Ubungo Dar es Salaam, Hale and Moshi 18.08.1995–20.02.1996.

Appendix 5

communities with a long history of irrigation, the combination of cash payment and access to water from a canal is seen as immoral, ‘a sin against God’. The apparent problem of legitimacy of statutory water rights and the efforts to improve water management through integrated water resources management is still seen as a problem of an inefficient communications strategy (United Republic of Tanzania, 2004c), rather than as a conflict over resource tenure, procedure and the objectives of water management.

By 2002–2003, the PBWO was able to collect 75,000 USD, i.e. 38% of the amount due from water rights holders.²⁴⁸ Due to the cost of monitoring the many water abstractions, a flat rate minimum fee (van Koppen *et al.* 2004) and a practice of billing according to installed capacity rather than actual water use have been adopted. This is rational in terms of cost recovery, as the costs of monitoring and billing these abstractions even on an annual basis in areas with poor road access are considerable, but it undermines the intended role of fees as an economic incentive. The progress in registration of water rights was limited, due to lack of both applications and caution in issuing new water rights. The difficulties in establishing a single statutory system of licences may have been underestimated, repeating the failures of the campaigns following the legislative reforms in 1959 and 1974. Despite of emergency measures in water management, and due to subsequent droughts and competing demands for water for irrigation in the industrial and ‘traditional’ sectors, in recent years the flow of water through the turbines has been less than the hydropower plant at Pangani Falls was designed for (the reservoir’s water level was within 4 cm of the critical level in 2004²⁴⁹). In 2006 the national power grid had to schedule blackouts due to water shortage in reservoirs across the country (IPP 2006; Saleh, 2006).

Alternative proposals have been put forward by NGOs engaged in assistance to traditional irrigation and the environment,²⁵⁰ with some support from the World Bank’s Traditional Irrigation Improvement project and the IUCN. The suggestion is to integrate the varied scheme organisations into catchment organisations controlling a source of

²⁴⁸ Regional Hydrologist, Kilimanjaro, archive (H1\22RBM-SIIP).

²⁴⁹ PBWO data for Week 44 in 2004 reported by Pål Tengedal (personal communication 4 November 2004).

²⁵⁰ Among these are PAMOJA (Kilimanjaro Joint Action Project), TIP (Traditional irrigation and environmental development organisation).

Tanzanian water policy reforms – between principles and practical applications

water²⁵¹. These could form a basis for a tiered water management organisation and make improved representation of stakeholders on the River Basin Board possible.²⁵² These principles have been tested only to a limited extent in a few project areas in this river basin,²⁵³ but they are given consideration in the review of the water legislation (United Republic of Tanzania 2004b). The water sector development strategy (United Republic of Tanzania, 2004c, 15), suggests an organisational structure with financially and administratively autonomous Basin Water Boards funded by user charges (and free to negotiate support independently) and Sub-Catchment Committees with powers delegated from the basin level. The latter will be financially self-sustaining through user charges. Finally, the objective of organising the users into legal, registered formal organisations (water users associations) financed from user fees is reconfirmed. The strategy devises charges for water mainly as a way to overcome inadequate funding for management activities (United Republic of Tanzania, 2004c, 57). The Pangani River Basin Management Project supported by the IUCN and the United Nations Development Programme is planning to implement a ‘Catchment Forum’ for a sub-basin (Kikuletwa) as a pilot project where water users can be given a voice (United Republic of Tanzania 2006). This strategy has backing in the water policy, and is seen as important by the PBWO.²⁵⁴ The prospects and importance of this forum will improve if provisions for a formal status are made by new water legislation.

Conclusion

The three approaches to water management outlined in this article each provide different answers to how and by whom limited water resources best can and should be managed. The traditional technocratic model found in many river basin water

²⁵¹ ‘Water Use Management and Traditional Irrigation Systems in Tanzania. A presentation for the Second World Water Forum’, TIP/Traditional irrigation and environmental development organisation, World Water Fair, The Hague, 17–22 March 2000, (TIP Archive Moshi).

²⁵² TIP/Traditional irrigation and environmental development organisation. Hans Keizer 2001 ‘Catchment management within the Pangani Basin’ Workshop, 6–7 December 2000, Uhuru hostel, Moshi, (TIP Archive Moshi). H. Keizer personal communication, 2001; field conversations TIP staff Moshi (June 2003).

²⁵³ Zongolo, S.A. ‘Identification of problems experienced in irrigation practice in Rundugwai area, Hai District’ Memo, PAMOJA (Kilimanjaro Joint Action Project), Moshi, December 2001.

²⁵⁴ Pangani Basin Water Office file PBWO/PBWOQR # 24: Quarterly report for the period October-December 2004, p. 9.

Appendix 5

management projects around the world is currently being challenged by both neoliberal and neo-populist ideas.

In the recent water policy documents (United Republic of Tanzania, 2002a; 2004c) as well as in the activities of the PBWO there is evidently some adjustment to more general and global trends in water management reforms, with at least some token references to issues such as water pricing and local participation. The suggestion to legalise the sale of permits is clearly a gesture to the neoliberal model, but with the implementation of the new policy there remains a distinct possibility that ‘the value of water’ may translate into a water tax and not a competitive market-based pricing ensuring efficient use of available resources in economic terms. The drive towards ‘demand management’ through the price mechanism has provided arguments for a strategy based on water fees, but in practice this is more about cost recovery for water management than about attempting a more controversial and difficult market allocation mechanism.

Devolution or decentralisation is definitely an issue in African and in Tanzanian resource management,²⁵⁵ but the impact on the water sector still remains comparatively small. The Dublin principles on public participation and devolution of management to the ‘lowest appropriate level’ can be, in the Tanzanian policy context, translated into campaigns for the ‘creation of awareness’ in order to increase compliance with regulations. Consultation, transparency or the transfer of responsibilities to sub-catchment organisations or communities may be more difficult to achieve. The acknowledgement of customary or common law principles of prescriptive rights in the proposed new water legislation could be seen as a movement away from the technocratic model. The establishment of sub-catchment organisations would involve some decentralisation of authority to a local level, and perhaps some adaptation to local practice in water management related to the neo-populist influence. A water management organisation covering a smaller hydrological region could provide a meeting place between the ‘traditional’ and ‘modern’ water management systems

²⁵⁵ The local government reforms and the reforms towards village land titling in Tanzania from the 1990s are two examples.

Tanzanian water policy reforms – between principles and practical applications

(Tagseth, 2006), or a framework for incorporating ‘traditional’ irrigation into the state management system.

Central to the development of water management in the Pangani River Basin in Tanzania is what can perhaps best be understood as a conflict between a local, community-based water management system and a fairly technocratic water management system. The activities of the Pangani Basin Water Office and the donors supporting it, as well as the new water policy and strategy can probably best be interpreted as a continuation of a traditional top-down bureaucratic approach to water management, rather than representing a renewal. The water laws and the water management system – formulated by the British and later carried on by Nyerere’s socialist government, and continuing right up to present-day policies – have neither been designed to secure local communities’ active participation in water management nor to facilitate the emergence of a functioning market for water.

Appendix 5

References

- Adams, W. M. (1990). How beautiful is small? Scale, control and success in Kenyan Irrigation. *World Development*, 18(10), 1309-1323.
- Adams, W. M. (1992). *Wasting the Rain. Rivers, People and Planning in Africa*. University of Minnesota Press, Minneapolis.
- Agrawal, A., & Gibson, C. C. (1999). Enchantment and disenchantment: The role of community in natural resource conservation. *World Development*, 27(4), 629-649.
- Barham, E. (2001). Ecological boundaries as community boundaries. The politics of watershed. *Society and Natural Resources*, 14, 181-191.
- Barrow, C. J. (1998). River basin planning and management. A critical review. *World Development*, 26(1), 171-186.
- Bauer, C. J. (1997). Bringing water markets down to earth: The political economy of water rights in Chile, 1976-95. *World Development*, 25(5), 639-656.
- Bauer, C. J. (2004). *Siren Song: Chilean Water Law as a Model for International Reform*. Resources for the Future, Washington DC.
- Baumann, O. (1891). *Usambara und seine Nachbargebiete*. Reimer, Berlin.
- Beez, J. (2005). Die Ahnen essen keinen Reis. Vom lokalen Umgang mit einem Bewässerungsprojekt am Fuße des Kilimanjaro in Tansania. *Bayreuth African Studies Working Papers* No. 2. Universität Bayreuth Institut für Afrikastudien & Kulturwissenschaftliches. Bayreuth. [Available from: <http://opus.ub.uni-bayreuth.de/volltexte/2005/168/> accessed 19.04.2007].
- Blaikie, P. (1998). Paradigms for environment and development. de Haan, L., & Blaikie, P. (eds.) *Looking at Maps in the Dark. Directions for Geographical Research in Land Management and Sustainable Development in Rural and Urban Environments in the Third World*, 9-40. Nederlandse Geografische Studies/Netherlands Geographical Studies 240. Royal Dutch Geographical Society, Utrecht.
- Bryceson, I. (1994). Norske kraftutbyggere i Tanzania. *Kraft og konflikter. Norske vannkraft-utbyggere i den tredje verden*, 97-104. FIVAS, Oslo.
- Buckland, L. L. R. (1939). *Water Executive Annual Report*. Government Printer, Dar es Salaam.

Tanzanian water policy reforms – between principles and practical applications

- Chambers, R., Pacey, A., & Thrupp, L. A. (eds.) (1989). *Farmer First. Farmer Innovation and Agricultural Research*. Intermediate Technology Publications, London.
- Clarke, R. (1991). *Water – The International Crisis*. Earthscan, London.
- Cleaver, F. (2000). Moral ecological rationality, institutions and the management of common property resources. *Development and Change*, 31, 361-383.
- Coward, E. W. (1977). Irrigation management alternatives. Themes from indigenous irrigation systems. *Agricultural Administration*, 4, 223-237.
- Daluti, L. R. (1994). *Draft report on the agro-socio-economic situation in Pangani river catchment. Consultancy for NORPLAN*. Zonal Irrigation Office, United Republic of Tanzania, Moshi.
- Cullen, N. J., T. Mölg, G. Kaser, K. Hussein, K. Steffen, D. R. Hardy (2006). Kilimanjaro Glaciers: Recent areal extent from satellite data and new interpretation of observed 20th century retreat rates. *Geophysical research letters* 33(16): art. no. L16502.
- Development Today* (1995). Conflicts over Pangani dampen enthusiasm for hydro power in Tanzania. *Development Today. Nordic outlook on Development Assistance, Business and the Environment* 5, 1–6.
- deWalt, B. R. (1994). Using indigenous knowledge to improve agriculture and natural resource management. *Human Organization*, 53(2), 123-131.
- Falkenmark, M., Lundqvist, J., & Widstrand, C. (1990). *Water Scarcity: An Ultimate Constraint in Third World Development: A Reader on a Forgotten Dimension in Dry Climate Tropics and Subtropics*. (Tema V Report 14, 1990). University of Linköping Department of Water and Environmental Studies, Linköping.
- Gasse, F. (2002). Kilimanjaro's secrets revealed. *Science*, 18 October, 548-549.
- Geilinger, W. (1936). The retreat of the Kilimanjaro glaciers. *Tanganyika Notes and Records*, 2(October), 7-20.
- Gleick, P. H. (1998). The human right to water. *Water Policy*, 1, 487-503.
- Government of Tanganyika (1956). *Report of the Water Legislation Committee 1956*. The Government Printer, Dar es Salaam.
- Hastenrath, S., & Greischar, L. (1997). Glacier recession on Kilimanjaro, East Africa, 1912-89. *Journal of Glaciology*, 43(17), 455-459.

Appendix 5

- Hemp, A. (2005). Climate change-driven forest fires marginalize the impact of ice cap wasting on Kilimanjaro. *Global Change Biology*, 11, 1013-1023.
- Hjorthol, L. M. (1994). Norad-press mot Tanzania. *NTB*, 27.05.1994. Oslo.
- IPP (2006). Tanzania should boost water management - World Bank. *IPP media* 2006-04-05.
<http://www.ipp.co.tz/ipp/finacial/2006/04/05/63581.html> (accessed 29.03.2007).
- IUCN (2003). *Pangani Basin: A Situation Analysis*. International Union for the Conservation of Nature and Natural Resources, Eastern Africa Programme. Nairobi.
- Johansson, I. (1983). *Nordic Glossary of Hydrology*. Almqvist & Wiksell International, Stockholm.
- Johnson, S. P. (1993). *The Earth Summit: The United Nations Conference on Environment and Development (UNCED)*. Graham & Trotman, London.
- Johnston, H. H. (1886). *The Kilima-njaro Expedition. A Record of Scientific Exploration in Eastern Equatorial Africa. And a General Description of the Natural History, Languages, and Commerce of the Kilima-njaro District*. Kegan, Paul Trench and Co., London.
- Juma, I. H., & Maganga, F. P. (2005). Current reforms and their implications for rural water management in Tanzania. *International workshop on African water laws: Plural legislative frameworks for water management in Africa*. 26-28 January 2005, Johannesburg. <http://www.nri.org/waterlaw/AWLworkshop/JUMA-IH.pdf> (accessed 11.04.2007).
- Klute, F. (1920). *Ergebnisse der Forschungen am Kilimandscharo 1912*. Dietrich Reimer (Ernst Vohsen) A.G., Berlin.
- Leach, M., Mearns, R., & Scoones, I. (1999). Environmental entitlements: Dynamics and institutions in community-based natural resources management. *World Development*, 27(2), 225-247.
- Lein, H. (1998). Traditional versus modern water management systems in Pangani River Basin, Tanzania. de Haan, L., & Blaikie, P. (eds.) *Looking at Maps in the Dark. Directions for Geographical Research in Land Management and Sustainable Development in Rural and Urban Environments of the Third World*, 52-64. Royal Dutch Geographical Society, Utrecht & Amsterdam.

Tanzanian water policy reforms – between principles and practical applications

- Lein, H. (2004). Managing the water of Kilimanjaro: Irrigation, peasants and hydropower development. *Geojournal*, 61, 155-162.
- Lomborg, B. (2001). *The Sceptical Environmentalist: Measuring the Real State of the World*. Cambridge University Press, Cambridge.
- Loneragan, S. C. (2001). Water and conflict: Rhetoric and reality. Diehl, P. F., & Gleditsch, N. P. (eds.) *Environmental Conflicts*, 109-124. Westview Press, Boulder.
- Mehta, L. (2000). *Water for the Twenty-First Century: Challenges and Misconceptions*. IDS Working Paper 111. Institute of Development Studies, Brighton.
- Mkhandi, S., & Ngana, J. (2001). Trend analysis and spatial variability of annual rainfall. Ngana, J. (ed.) *Water Resources Management in the Pangani River Basin. Challenges and Opportunities*, 11-20, Dar es Salaam University Press, Dar es Salaam.
- Mody, J. (2001). *Management of river basin systems through decentralization*. World Bank, Washington. [http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/07/23/00112742_20040723110731/Rendered/INDEX/wps3346.txt](http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/07/23/000112742_20040723110731/Rendered/INDEX/wps3346.txt) (accessed 02.05.04).
- Mosse, D., & Sivan, M. (2003). *The Rule of Water: Statecraft, Ecology and Collective Action in South India*. Oxford University Press, New Delhi & Oxford.
- Mujwahuzi, M. R. (2001). Water use conflicts in the Pangani Basin, an overview. Ngana, J. (ed.) *Water Resources Management in the Pangani River Basin. Challenges and Opportunities*, 128-137. Dar es Salaam University Press; Dar es Salaam.
- Mwita, D. M. (1975) *Rights in Respect of Water in Tanganyika*. LLM degree thesis. University of Dar es Salaam, Dar es Salaam.
- New, C. (1873). *Life, Wanderings and Labours in Eastern Africa. With an Account of the First Successful Ascent of the Equatorial Snow Mountain, Kilima Njaro and Remarks upon East African Slavery*. Frank Cass & Co. London.
- Ostrom, E. (1990). *Governing the Commons. The Evolution of Institutions for Collective Action*. Cambridge University Press, Cambridge.
- Ostrom, E. (1992). *Crafting Institutions for Self-Governed Irrigation Systems*. ICS Press, San Francisco.

Appendix 5

- Ostrom, E. (2002). How farmer managed irrigation systems build social capital to outperform agency management systems that rely primarily on physical capital. Preadhan, P., & Gautam, U. *Farmer managed irrigation systems in the changes context*, 25-32. Farmer managed irrigation systems promotion trust, Kathmandu.
- Perry, C. J. (2001). *Charging for Irrigation Water: The Issues and Options, With a Case Study from Iran*. International Water Management Institute Research Report 52. IWMI, Colombo.
- Petrella, R. (2001). *The Water Manifesto. Arguments for a World Water Contract*. Zed Books, London.
- Postel, S. (1992). *The Last Oasis*. Earthscan Publications, New York.
- Rebmann, J. (1860). Journey to Jagga. Krapf, D. J. L. (ed.) *Travels, Researches, and Missionary Labours During an Eighteen Years' Residence in Eastern Africa. Together with Journeys to Jagga, Usambara, Ukambani, Shoa, Abessinia, and Khartum; and a Coasting Voyage from Mombaz to Cape Delgado*, 230–265. Trübner and Co., London.
- Reed-Erichsen, M. (2003). *Negotiations over Rights to Water. The Process of Determining Allocation of Water between Farmers and Estates, in the Context of Coffee-Producing Estates in Kilimanjaro Region – Tanzania*. Cand. polit. thesis. Department of Geography, Norwegian University of Science and Technology (NTNU), Trondheim.
- Rosegrant, M. W., & Binswanger, H. P. (1994). Markets in tradable water rights: Potential for efficiency gains in developing country water resource allocation. *World Development*, 22(11), 1613-1625.
- Rudberg, T. (1994). Spilt vann kan koste Tanzania norsk støtte for 400 mill. *NTB*, 29.06.1994. Oslo.
- Saleh, A. (2006). Drought cutting Tanzania's power supply. *Reuters News Service*, 9 January 2006
<http://www.planetark.com/dailynewsstory.cfm/newsid/34374/story.htm> (accessed 18.06.2005).
- Sarmett, J. D., & S. A. Faraji (1991). The hydrology of Mount Kilimanjaro: An examination of dry season runoff and factors leading to its decrease. Newmark,

Tanzanian water policy reforms – between principles and practical applications

- W. D. (ed.) *The Conservation of Mount Kilimanjaro*, 53–70. IUCN (World Conservation Union), Gland.
- Schleyer, R. G., & Rosegrant, M. W. (1996). Chilean water policy: The role of water rights, institutions and markets. *Water Resources Development*, 12(1), 33–48.
- Scott, P. (1962). *The Development of the Pangani River Basin*. Sir William Halcrow and Partners, London.
- Strang, V. (2004). *The Meaning of Water*. Berg, Oxford.
- Swynnerton, R. J. M. (1949). Some problems of the Chagga on Kilimanjaro. *East African Agricultural Journal, (Amani) January 1949*, 117–132.
- Tagseth, M. (2000). *Knowledge and Development in Mifongo Irrigation Systems. Three Case Studies from Mt. Kilimanjaro, Tanzania*. Cand. Polit. thesis. Department of Geography, Norwegian University of Science and Technology (NTNU), Trondheim.
- Tagseth, M. (2002). Contested waters. Issues in water management for the Pangani Basin. Setten, G. & Rudsar, S. (eds.) *Geographical Methods – Power and Morality in Geography. Proceedings of the Annual Conference of the Norwegian Geographical Society, 5-6 April 2002, Acta Geographica Trondheim. Series. A: 2*, 226-235. Department of Geography, Norwegian University of Science and Technology, Trondheim.
- Tagseth, M. (2006). The ‘mfongo’ irrigation systems on the slopes of Mt. Kilimanjaro, Tanzania. Tvedt, T., Coopey, R., Jakobsson, E., & Ostigaard, T. (eds.) *A History of Water*. Volume 1: *Water Control and River Biographies*, 488-506. I.B. Tauris, London.
- Teale, E. O., & Gillman, C. (1935) *Report on the Investigation of the Proper Control of Water and the Reorganisation of Water Boards in the Northern Province of Tanganyika Territory November–December 1934*. [The Government Printer], Morogoro/Dar es Salaam.
- Thompson, L. G., Mosley-Thompson, E., Davis, M. E., Henderson, K. A., Brecher, H. H., Zagorodnov, V. S., Mashiotta, T. A., Ping-Nan Lin, Mikhalenko, V. N., Hardy, D. R., & Beer, J. (2002). Kilimanjaro ice core records: Evidence of Holocene climate change in tropical Africa. *Science* 298:5593, 589-593.

Appendix 5

- Turrall, H. (1995). *Devolution of Management in Public Irrigation Systems: Cost Shedding, Empowerment and Performance*. Working Paper 80. Overseas Development Institute, London.
- UNESCO (2003). *Water for People – Water for Life. The United Nations World Water Development Report*. UNESCO-World Water Assessment Programme, Barcelona.
- United Republic of Tanzania (1974). *Water Utilization (Control and Regulation) Act, 1974 (No. 42)*. Dar es Salaam.
- United Republic of Tanzania (1981). *Water Utilization (Control and Regulation) Act (Amdt.) 1981 (No. 10)*. Dar es Salaam.
- United Republic of Tanzania (1992). *The Energy Policy of Tanzania*. URT, Ministry of Water, Energy and Minerals. Government Printer, Dar es Salaam.
<http://www.tzonline.org/pdf/theenergypolicyoftanzania.pdf> (accessed 18.01.2006).
- United Republic of Tanzania (1994a). *Water Utilization (General) (Amendment) Regulations, 1994*. Dar es Salaam.
- United Republic of Tanzania (1994b). *Report of the Presidential Commission of Inquiry into Land Matters*. The Ministry of Lands, Housing and Urban Development, Government of the United Republic of Tanzania in cooperation with the Scandinavian Institute of African Studies, Uppsala.
- United Republic of Tanzania (1994c). *Water Utilisation and Shortage in the Pangani River Basin*. United Republic of Tanzania. Ministry of Water Energy and Minerals, Moshi.
- United Republic of Tanzania (1996). Water utilization (general) (amendment) regulations 1996. *Gazette 77:6*, Supplement No. 23.
- United Republic of Tanzania (1997). Water laws (Miscellaneous Amendments) Act, 1997. An act to amend certain written laws pertaining to water. April 4th, 1997. *Gazette 8:1997*.
- United Republic of Tanzania (1998). *Policy Paper on Local Government Reform*, October 1998. Ministry of Regional Administration and Local Government, Dar es Salaam.
- United Republic of Tanzania (1999). *Development Vision 2025*. Planning Commission. Dar es Salaam. <http://www.tzonline.org/pdf/theTanzaniadevelopmentvision.pdf> (accessed 18.01.2006).

Tanzanian water policy reforms – between principles and practical applications

- United Republic of Tanzania. (2000a). *National Water Policy*. Ministry of Water, United Republic of Tanzania, Dar es Salaam.
- United Republic of Tanzania (2000b). *Poverty Reduction Strategy Paper (PRSP)*. Government Printer, Dar es Salaam.
<http://www.tzonline.org/pdf/FinalPRSP25.pdf> (accessed 18.1.2006).
- United Republic of Tanzania (2002a). *National Water Policy*. Ministry of Water and Livestock Development, United Republic of Tanzania, Dar es Salaam.
- United Republic of Tanzania. (2002b). *The Study on the National Irrigation Master Plan*. Japan International Cooperation Agency and United Republic of Tanzania-Ministry of Agriculture and Food Security, November 2002. Nippon Koei Co., Dar es Salaam.
- United Republic of Tanzania (2004a). *Review of Customary Water Law Regimes: Issues for the Reform of Water Laws. Consultancy Services on Reviewing Water Resources Legislation Water Supply and Sewerage and Rural Water Supply & Sanitation by Mawenzi Advocate's Chambers*. RBM SIIP project. Ministry of Water and Livestock Development United Republic of Tanzania, Dar es Salaam.
- United Republic of Tanzania (2004b). *Proposed Draft Bill for the Water Resources Management Act, 2004. Consultancy Services on Reviewing Water Resources Legislation Water Supply and Sewerage and Rural Water Supply & Sanitation by Mawenzi Advocate's Chambers*. RBM SIIP project. Ministry of Water and Livestock Development, United Republic of Tanzania, Dar es Salaam.
- United Republic of Tanzania (2004c). *National Water Sector Development Strategy*. United Republic of Tanzania-Ministry of Water and Livestock Development. Circulation draft June 2004. Dar es Salaam.
- United Republic of Tanzania 2006. *Developing a Forum for Water Users in the Kikuletwa River Catchment*. (folder) United Republic of Tanzania – Pangani River Basin Management Project, Moshi.
- Uphoff, N., & Wijayaratna, C. M. (2000). Demonstrated benefits from social capital: The productivity of farmer organizations in Gal Oya, Sri Lanka. *World Development*, 28(11), 1875-1890.
- van Koppen, B., Sokile, C., Hatibu, N., Lankford, B., Mahoo, H., & Yanda, P. (2004). *Formal Water Rights in Tanzania: Deepening the Dichotomy?* International Water

Appendix 5

Management Institute, Colombo.

<http://www.iwmi.cgiar.org/pubs/working/WOR71.pdf> (accessed 01.01.2006).

Wester, P. (2003). Boundaries of consent: Stakeholder representation in river basin management in Mexico and South Africa. *World Development*, 31(5), 797-812.

World Bank (1993). *Water Resources Management. A World Bank Policy Paper*. The World Bank, Washington DC.

World Bank (2003). *Water Resources Sector Strategy. Strategic Directions for World Bank Engagement*. The World Bank, Washington DC.