World Development 151 (2022) 105777

Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

A place-based framework for assessing resettlement capacity in the context of displacement induced by climate change

Solomon Zena Walelign [a,b,c,d,*], Päivi Lujala [e,f]

[a] Department of Geography, Norwegian University of Science and Technology, Trondheim, Norway
[b] The World Bank, Washington, DC, USA
[c] Center for Effective Global Action, University of California Berkeley, USA
[d] School of Economics, University of Gondar, Gondar, Ethiopia
[e] Geography Research Unit, University of Oulu, Oulu, Finland
[f] Chr. Michelsen Institute, Bergen, Norway

ARTICLE INFO

Article history:
Accepted 29 November 2021
Available online 30 December 2021

Keywords:
Climate change
Displacement
Livelihoods
Resettlement
Assets
Conditions

ABSTRACT

Place-based resettlement capacity assessments to identify potential resettlement places for climate migrants are needed to guide resettlement programs related to climate change. This article proposes and validates a conceptual climate change resettlement capacity (CCRC) framework that can be used to identify potential resettlement places for climate migrants. The CCRC framework focuses on livelihood reconstruction, as this is the primary aim of most resettlement programs and a key for successful resettlement and mitigation of impoverishment of resettled people and communities. The framework has two main dimensions – assets and conditions – as its foundation, with a set of subdimensions and generic indicators identified for both of them. Expert evaluation was used to validate the framework. The operationalization of the framework is illustrated through a case study of two regions of Ethiopia vulnerable to climate change. The framework is designed to assist international organizations, governments, planners, and policymakers in identifying both the most suitable and least suitable places to resettle communities in the face of actual or anticipated displacements due to climate change. In addition, the framework can be used by researchers to undertake theoretical and empirical studies on resettlement induced by climate change. With minor modifications, the framework can also be applied to resettlement capacity assessments for non-climate resettlement programs and research.

1. Introduction

Many places in the world will become less and less inhabitable due to the increasing frequency and severity of hazards related to climate change, such as floods, droughts, salinization, coastal erosion, and heat stress (Bukvic, 2018; Mathur, 2015; Rigaud et al., 2018). By 2050, climate change is expected to cause either temporary or permanent displacement of hundreds of millions of people (Barnett & Webber, 2010; Rigaud et al., 2018) as *in situ* adaptation strategies aiming to build resilience become increasingly ineffective and expensive (Bukvic, 2018). Countries most vulnerable to climate change must thus incorporate resettlement in their adaptation plans (López-Carr & Marter-Kenyon, 2015). This will require identification of places with high potential for the resettlement of climate migrants.

While both temporary and permanent migration by individuals, households, and even entire communities are acknowledged as ex-ante or ex-post responses to climate change hazards and stresses (Black et al., 2011; Gemenne & Blocher, 2017; McLeman, 2011; Mueller et al., 2014), the poor in particular are often unable to move (Black et al., 2011; Wilmsen & Webber, 2015). As a response to the magnitude of the predicted displacement in the most adversely affected countries, and to overcome barriers to migration, planned resettlement of people and communities affected by climate change may become inevitable (de Sherbinin et al., 2011; Brookings et al., 2015). Planned resettlement is therefore increasingly reframed as an adaptive strategy to climate change and its consequences, albeit often as a last resort (Arnall, 2019). In some places that are vulnerable to climate change (e.g., China, Ecuador), people and communities have already been resettled either in response to or in expectation of natural hazards (López-Carr & Marter-Kenyon, 2015).

However, the few existing climate change related resettlement programs have failed to restore or improve the livelihoods of the

* Corresponding author.
E-mail address: solomon.walelign@ntnu.no (S.Z. Walelign).

https://doi.org/10.1016/j.worlddev.2021.105777
0305-750X/

resettled communities. In some cases, the programs have even exacerbated impoverishment and livelihood vulnerability among the resettled people and communities (e.g., Rogers & Xue, 2015; Connell & Lutkehaus, 2017). As a consequence, the resettled tend to return to their homeplaces or migrate onward to other places, while many of those who opt to remain at the resettlement place face poor prospects of rebuilding their livelihoods there (Artur & Hilhorst, 2012; Connell & Lutkehaus, 2017). Evidence also shows that climate change resettlement programs have caused other problems – such as environmental degradation and conflicts due to increased competition over resources, jobs, and public services – in the resettlement areas (e.g., Brzoska & Fröhlich, 2016; Getahun et al., 2017; Rigaud et al., 2018).

As the success of a resettlement program depends on reducing impoverishment risks and providing opportunities to reconstruct the livelihoods of resettled people and communities, a good understanding of available resources and enabling contextual factors are the key to choosing high-potential resettlement locations during the planning phase (Bukvic, 2018; Cernea, 2000; Correa et al., 2011; Sipe & Vella, 2014; Wilmsen & Webber, 2015). However, little attention has so far been paid to the selection of resettlement places (e.g., Findlay, 2011; Bukvic, 2018; Peng et al., 2020). Most programs have focused on moving the vulnerable or affected communities away from their original place of residence, without prioritizing destination places – and thus overlooked vital livelihood elements that go beyond engaging in the construction of housing in the resettlement area (Gebauer & Doevenspeck, 2015; He et al., 2019). Moreover, many programs have been sidelined by governments to meet political goals – to weaken or control political resistance, for example, – rather than maintaining the promised focus on identifying the most suitable locations for the displaced people and communities (Correa, Ramirez, & Sanahuja, 2011; Gebauer & Doevenspeck, 2015; He, Aitchison, Hussey, & Chen, 2019).

Identification of suitable resettlement locations for climate migrants would greatly benefit from an underlying conceptual framework outlining key aspects to be considered in an assessment of potential resettlement places (Bukvic, 2018). To this end, Bukvic (2018) proposed a limited set of economic and physical aspects (such as housing and employment rate), though the article overlooked many relevant components of resettlement capacity (such as conflicts and violence, availability of natural resources, disease outbreak, soil quality, and both physical and human capital infrastructures). More comprehensive assessment frameworks would improve the planning and implementation of climate change resettlement programs, safeguard the livelihood and other needs of resettled people, and support the host communities in adapting to the new situation (de Sherbinin et al., 2011; López-Carr & Marter-Kenyon, 2015).

In this article, we develop a conceptual framework for climate change resettlement capacity (CCRC). CCRC is designed to be used in assessing the resettlement capacity of places to accommodate displaced people and communities in the face of climate change. The framework acknowledges that the primary objective of climate change resettlement programs is to reconstruct and improve the livelihoods of the displaced people, and that there are risks associated with resettlement (such as joblessness, homelessness, and food insecurity). Hence, the CCRC framework draws on (i) the sustainable livelihood (SL) framework (Ellis, 2000; Scoones, 2015) and the impoverishment risks and reconstruction (IRR) model (Cernea, 1997, 2000; Correa et al., 2011), (ii) international protocols and guidelines for resettlement (e.g., Brookings et al., 2015; UNHCR, 2018; World Bank, n.d.), and (iii) other empirical and theoretical studies based on the above concepts, models, protocols, and guidelines (e.g., Winters et al., 2009; Angelsen et al., 2014; Rogers & Xue, 2015). An expert panel was used to validate the CCRC framework. We illustrate the use of the framework through a case study in which we assess resettlement capacity of two climate change vulnerable regions in Ethiopia using 5-kilometer grid cells and 78 indicators.

To our knowledge, our study is among the first to provide a comprehensive assessment framework for resettlement capacity. Notably, the framework was evaluated by experts to ensure its relevance and completeness, building confidence for its application by researchers, experts, and policymakers. Further, we provide a case study that illustrates the framework's potential and, importantly, highlights issues that need due consideration when it is applied. We believe that the framework can be a valuable help in processes that seek to identify suitable places for resettlement in the face of actual or anticipated displacements related to climate change, and to prevent resettlement in unsuitable areas. Further, assessments based on the framework can help international organizations and governments at national, regional, and local levels to channel resources and investments that target the relative weaknesses of the more suitable resettlement areas. Although the CCRC framework was designed for climate change migration, it can easily be applied in resettlement programs unrelated to climate change as most of its components reflect what displaced and resettled people and communities need for livelihood reconstruction irrespective of the cause of displacement.

The rest of this article is organized as follows. Section 2 provides a brief review of studies on resettlement programs. Section 3 presents the theoretical and conceptual work that forms the basis for the CCRC framework. Section 4 presents the CCRC framework, Section 5 its validation, and Section 6 an illustration of its use. Section 7 identifies and discusses major issues that need to be considered when applying the framework. Section 8 concludes.

2. Experiences from previous resettlement programs

Resettlement can be defined as a process by which displaced people and communities are assisted to restore or improve their livelihoods at their places of resettlement (World Bank, n.d.). Resettlement has been a popular strategy by national governments and international development agencies, such as the World Bank, to promote local and national development (Gomersall, 2018; Rogers & Wilmsen, 2019). Typically, people and communities are resettled when land is needed for alternative uses. These include infrastructural development such as dam or road construction (e.g., Cernea, 2008; Tilt & Gerkey, 2016; Asiama et al., 2017), large-scale natural resource extraction (e.g., Owen & Kemp, 2015; Yang et al., 2017; Owen et al., 2018), and conservation of nature (including nature reserves and ecological restoration) (e.g., Agrawal & Redford, 2009; Torri, 2011; Karanth et al., 2018). In these cases, resettlement is a secondary outcome of other projects (Gomersall, 2018).

Resettlement to reduce poverty has been incorporated in national poverty reduction and food security programs in some countries, including China and Ethiopia. These programs aim to move people and communities from resource-poor areas to locations with better livelihood opportunities and better public infrastructure (e.g., Lo et al., 2016; Lo & Wang, 2018). Contrary to resettlement induced by infrastructure construction, natural resource extraction, and conservation schemes, the primary aim of poverty reduction and food security resettlement projects is to improve the living standards of the resettled persons whose resettlement is not a secondary outcome of any other project.

In most cases, resettlement is involuntary and often involves controversies among stakeholders, particularly between govern-

ment bodies and the resettled (Gomersall, 2018).[1] Controversies may arise from limited consultation and engagement with resettled people and communities in the planning and implementation of the program (e.g., Mathur, 2015; Lo & Wang, 2018) and the prevalence of hidden motives, often political, that compromise the rebuilding of and improvements to the livelihoods of resettled people and communities(e.g., De Wet, 2012). Furthermore, the compensations for lost assets tend to be inadequate as non-economic assets (e.g., social capital within the community) are often overlooked (Arnall, 2019; Peng et al., 2020; Tadgell et al., 2018; Wilmsen & Webber, 2015). Likewise, additional financing needed for infrastructural development in resettlement areas is often insufficient (Cernea, 2008). Hence, most resettlement programs have so far been associated with negative outcomes, such as an increased risk of landlessness and joblessness, and higher morbidity (Cernea, 2000; Cernea, 2008; Correa et al., 2011). Consequently, the resettlement literature has concluded that planned resettlement is a complicated developmental process that requires a rigorous assessment of factors that promote people's and community's willingness to relocate (Peng et al., 2020) and careful planning, implementation, and follow-up (Wilmsen & Webber, 2015). Based on a review of the literature on resettlement programs, Tadgell et al. (2018) highlight five guiding principles to improve the success of resettlement programs: proactive resettlement; communication and engagement with people being resettled; permanent resettlement wherever possible; appropriate compensation; and livelihood protection in the destination places. The CCRC framework developed in this article seeks in particular to facilitate proactive and permanent resettlement in the context of climate change, and focuses on livelihood protection at the destination.

Due to the increasing frequency and intensity of hazards induced by climate change, communities have increasingly been resettled, temporarily and permanently, from places exposed to actual or anticipated slow-onset climate-related hazards (e.g., drought, sea level rise) and rapid-onset climate-related hazards (e.g., floods, storms) to places with better environmental conditions (Rogers & Wilmsen, 2019). Resettlement programs for climate-change migrants primarily aim to reduce human and economic losses in the exposed areas, move communities closer to public infrastructures (e.g., health centers, schools, roads), and provide support for the continuation of people's livelihood strategies and the creation of new livelihood opportunities at the resettlement place (e.g., Brookings et al., 2015; UNHCR et al., 2015).

Since climate change can pose a direct threat to livelihoods, well-being, and even life, people and communities in climate change affected places may be more willing to relocate (e.g., Li et al., 2014). However, like for other types of resettlement programs, people and communities rarely consent to resettle voluntarily through climate change related programs (e.g., Brookings et al., 2015; Bukvic et al., 2015). There are various reasons for this. First, people's and households' exposure to and perception of hazards induced by climate change, even within a community, can vary considerably, as can their socioeconomic situation and dependence on livelihoods sensitive to climate change. As a result, the perceived need and urgency for resettlement are likely to vary from person to person and from household to household within a community, with some people being more positive towards being resettled and others being less positive. Second, people who are considering relocation may be uncertain about whether the assets (e.g., land) that are to be provided at their resettlement place will be adequate and of good enough quality to enable them to rebuild their livelihoods (Gebauer & Doevenspeck, 2015; Lindegaard, 2018; Peng et al., 2020). Third, people may also be uncertain about whether their existing social capital (such as local institutions and networks) and place attachment can be restored (Bonaiuto et al., 2016; Brown et al., 2019; He et al., 2019; Peng et al., 2020; Tilt & Gerkey, 2016; Vanclay, 2017).[2]

Research and policymaking relating to resettlement induced by climate change can benefit from the experiences gained from other resettlement programs (Arnall, 2019; Wilmsen & Webber, 2015). Key aspects of a successful program include sufficient engagement with people and communities in all aspects of resettlement to ensure that they feel they have a certain amount of control over the process (Brookings et al., 2015; Tadgell et al., 2018), allocation of sufficient funding to provide compensation to the resettled people and communities, and infrastructural development at the resettlement places (Cernea, 2008; Tadgell et al., 2018). Most importantly, unlike other resettlement programs, most climate-related programs to date have occurred as ad hoc responses to disaster events. In the future, a much more proactive approach to long-term relocation and resettlement is needed (Wilmsen & Webber, 2015).

3. Approaches to understanding resettlement outcomes

Several approaches have been used to study socioeconomic consequences of resettlement. One such approach is the impoverishment risks and reconstruction (IRR) framework, developed by Cernea (2000) on the basis of experiences of dam resettlement programs and their effects on resettled people and communities. The IRR framework is used to identify and predict impoverishment risks among resettled people, to guide research towards reaching an understanding of such risks and outcomes, and to mitigate potential problems of resettlement while improving livelihood outcomes (Wilmsen et al., 2019). The IRR framework has been used in the planning and implementation of resettlement programs by national governments and international organizations and in studies that assess the impacts of such programs on the livelihoods of resettled people and communities (Rogers & Wilmsen, 2019; Wilmsen et al., 2019).

The IRR framework integrates risk, impoverishment, and reconstruction, which are three fundamental aspects of resettlement. The model identifies joblessness, landlessness, homelessness, marginalization, food insecurity, increased morbidity, loss of access to common property resources, and community disarticulation as the major challenges faced by displaced people and communities and potential causes of impoverishment. The IRR framework demonstrates that overcoming the challenges in resettlement processes (such as moving from landlessness to land-based reestablishment; from joblessness to re-employment; or from homelessness to house reconstruction) is the key to successful resettlement outcomes (Cernea, 2000).

The IRR model has been criticized for five reasons: (1) it focuses on economic losses; (2) it places limited emphasis on complex issues, such as political context; (3) it downplays heterogeneity in the willingness of people, households, and communities to participate in resettlement programs; (4) it overlooks people's and communities' degree of engagement in resettlement planning and implementation; and (5) it poorly identifies beneficiaries eligible for resettlement (Rogers & Wilmsen, 2019; Wilmsen et al.,

[1] The fact that people are reluctant to move is consistent with migration studies indicating that most people prefer not migrate unless they are forced to do so (see e.g., Li et al., 2014).

[2] As the CCRC framework focuses on the potential of the destination places, it cannot include aspects on the place of origin. For the same reason, it cannot consider the similarity of origin and destination places, an important consideration with regard to resettlement outcomes as similarity, for example, in terms of occupation, level of education, or ethnicity, can promote empathy and inclusion among host community members (Bonaiuto et al., 2016; Brown et al., 2019; Lujala et al., 2020; Peng et al., 2020). The framework, however, includes components that represent local institutions and place attachment at the resettlement place.

2019). However, the climate change literature has acknowledged the relevance of the IRR model and its empirical applications for understanding the effect of resettlement programs on livelihoods (Arnall, 2019; Wilmsen & Webber, 2015).

In response to both the weaknesses of the IRR model, especially its focus on economic losses and lack of emphasis on a wider perspective of people's livelihoods, and the growing recognition of importance of livelihoods in successful resettlement (Arnall, 2019; de Sherbinin et al., 2011; Warner, 2010), a holistic approach to livelihoods[3] – the sustainable livelihood (SL) framework – has increasingly been applied by researchers and policymakers to better understand resettlement outcomes (e.g., Wilmsen, 2016; Owen et al., 2018). The SL framework has been instrumental in researchers' understanding of people's livelihoods, and it has shaped poverty reduction policies, particularly in developing countries (e.g., Angelsen et al., 2014; Scoones, 2015; Walelign et al., 2017).

Different versions of the SL framework exist, but all tend to identify four major attributes of a sustainable livelihood: assets (e.g., land, infrastructure); contextual and institutional processes (e.g., shocks, local institutions); livelihood activities and strategies (e.g., crop production, diversification); and outcomes (e.g., income, consumption) (Ellis, 2000; Walelign & Jiao, 2017). While the SL framework and literature have been criticized for not paying due attention to the issues of dynamics, power, politics, and knowledge (de Haan & Zoomers, 2005; Scoones, 2009), they have been acknowledged in both climate-change and non-climate-change resettlement literature for having the potential to contribute to understanding and improving resettlement outcomes through identifying mechanisms and necessary conditions for the reconstruction of the livelihoods (Arnall et al., 2013; Chen et al., 2017; Liu et al., 2018; Owen et al., 2018; Wilmsen, 2016). Both the IRR and SL have been criticized for being too general and too complex to be operationalized in contexts such as climate change migration and resettlement (Patnaik & Prasad, 2014; Xiao et al., 2018).

Insights from the literature on IRR and SL form the basis of the CCRC framework. It incorporates strengths of IRR and SL while addressing limitations (among these, limited focus on social elements in the case of IRR; underplaying contexts, particularly conflicts and natural hazards, in the case of SL; and the low operational suitability of both frameworks for studying emerging issues). To overcome these limitations, the CCRC encompasses social and political factors and provides a comprehensive list of other factors that are relevant in assessing resettlement capacity for climate change induced displacement at different scales.[4] Both strands of the literature underscore the importance of rebuilding and improving the livelihoods of resettled people and communities, although the IRR literature explains resettlement outcomes through impoverishment risks while the SL literature concentrates on livelihood elements. For the CCRC, the IRR literature identifies the potential resettlement risks and what is needed to reduce such risks at resettlement places. Guided by the IRR literature, we have drawn on the SL literature to identify the components of the CCRC framework. Other strands of resettlement literature were also consulted when choosing the generic indicators and examples of specific measurable indicators. These include resettlement literature in relation to human rights and ethical issues in planning and implementing resettlement programs (e.g., Gromilova, 2014; O'Sullivan, 2016; Draper & McKinnon, 2018), as well as resettlement guidelines and protocols from different institutions (e.g., World Bank, 1990; 2004; IFC, 2012; Brookings et al., 2015; UNHCR et al., 2015; UNHCR, 2018).

4. Climate change resettlement capacity (CCRC) framework

4.1. Overview

Fig. 1 presents the CCRC framework. The framework consists of two dimensions that are highly relevant in assessing a place's capacity to resettle climate change migrants: assets and conditions. Assets capture the availability of the necessary inputs (resources) for viable livelihoods for resettled people and communities at their resettlement places. Conditions capture the factors that can assist or constrain the resettled people and communities in successfully translating assets into livelihood activities, strategies, and outcomes.

Together, assets and conditions form a system that determines a place's resettlement capacity, which in turn determines the livelihood prospects of the resettled people and communities. Assets and conditions can interact with each other both positively and negatively in many ways. Further, if one dimension is weak or absent, this seriously impairs livelihood restoration or improvement at the resettlement place, even if the other dimension is strong. For example, if limited livelihood resources are available to the resettled people, the livelihood outcomes (such as income or consumption) are likely to be bad at the resettlement place regardless of how good the conditions are. Thus, the combined effect on livelihoods of the assets and conditions – or the overall resettlement capacity of a place – is mainly a result of the interaction between the two dimensions (the solid downward arrow in Fig. 1), which is stronger than each dimension's direct effect (the dashed arrows). Depending on the context of the study, the two dimensions can either be added or multiplied, resulting in an overall additive or compounded model, respectively.

The framework is hierarchical: the assets and conditions are further disaggregated into 11 subdimensions (five and six for assets and conditions, respectively), and each subdimension, in turn, is represented by a set of general indicators (Table 1). For each generic indicator, we provide examples for specific measurable indicators (see Appendix A and C). The generic indicators are kept general and will be relevant in most contexts. We only provide examples of specific measurable indicators for three main reasons: the specific set of indicators will need to be context-specific; the assessment will in many cases be limited by data availability; and the selection of specific indicators may depend on the unit of analysis. These examples, however, illustrate how the generic indicators can be measured.

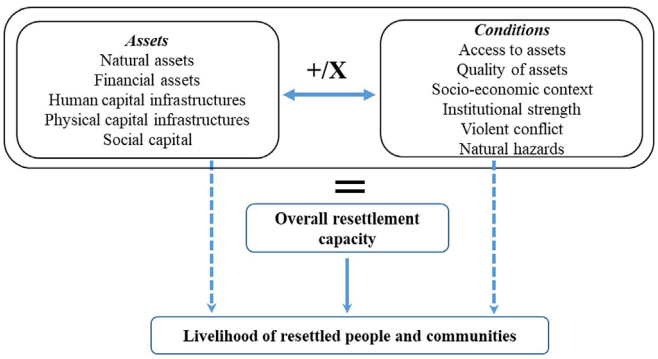


Fig. 1. Climate change resettlement capacity (CCRC) assessment framework. Note: the solid and dashed arrows indicate respectively stronger and weaker relationships; +, X, and = stand for addition, multiplication, and equality, respectively.

[3] Chambers and Conway (1992, p. 7) define livelihood as 'the capabilities, assets (stores, resources, claims, and access) and activities required for a means of a living' and sustainable livelihood as 'a livelihood that copes with and recovers from stress and shocks, maintain and enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and that contributes net benefits to other livelihoods at the local and global levels in the short and long-term'.

[4] As the framework focuses on *ex ante* evaluation of resettlement capacity it cannot include elements related to other parts of resettlement planning and implementation process (e.g., stakeholder involvement, addressing people's place attachment) or what happens after resettlement (e.g., resettlement outcomes).

Table 1
List of subdimensions and generic indicators relating to assets and conditions dimensions of the climate change resettlement capacity (CCRC) framework.

Dimension	Subdimension	Generic indicators	Measurement level	
			Individual or household	Grid, village, or district
Assets	Natural assets	Agricultural land (including pasture), forest and fish resources, subsoil resources, freshwater, and residential land		X
	Financial assets	Credit availability and employment opportunities	x	X
	Human capital infrastructures	Education and health facilities		X
	Physical capital infrastructures	Housing, energy (electricity), communication outlets, irrigation facilities, market centers, and modes of transport	x	X
	Social capital	Nature of networks, community participation, avenues for socialization, and institutions for help and support	x	X
Conditions	Access to assets	Property rights (natural and financial assets; human and physical capital infrastructures), distance (to natural and financial assets; human and physical capital infrastructures; social capital), and affordability (of natural and financial assets; human and physical capital infrastructures; social capital)	X	x
	Quality of assets	Quality of natural and financial assets, human capital and physical capital infrastructures, and social capital	X	x
	Socio-economic context	Social and economic factors	X	X
	Institutional strength	Voting, corruption, enforcement of laws and regulations, and regime type	x	X
	Violent conflict	Internal armed conflict (including one-sided violence), and international armed conflict	x	X
	Natural hazards	Geophysical, biological, and climatic, hydrological, and meteorological hazards	x	X

Note: X stands for optimal measurement level and x for the alternative level, if data at the optimal scale are not available.

4.2. Dimensions and subdimensions

4.2.1. Assets

Assets are the building blocks of people's livelihoods (DFID, 1999; Scoones, 2015). Additionally, assets help to undertake production, engage in labor-sharing arrangements,[5] and provide employment opportunities (Ellis, 2000). Assets can also function as a form of wealth or as safety nets during unexpected shocks (Walelign et al., 2017; Winters et al., 2009). Furthermore, assets include a spectrum of private and communal natural, physical, human, financial, and social capital (Bebbington, 1999; Winters et al., 2009). Having one or a combination of these assets is crucial for maintaining or improving one's livelihood (Li et al., 2017; Manlosa et al., 2019). The resettlement literature acknowledges the importance of assets in rebuilding the livelihoods of resettled people and communities (e.g., Sina, Chang-Richards, Wilkinson, & Potangaroa, 2019a).

People and communities inevitably lose part of their livelihood assets when they migrate in response to climate change hazards (Alam et al., 2017; Dietz et al., 2016; Forzieri et al., 2018). Furthermore, resettled people and communities may not be able to continue their previous livelihoods (in which they may have had many years of experience) at their resettlement places, as they may not have access to necessary assets (Rogers & Xue, 2015; Dias et al., 2016). Hence, restoring households' lost assets and providing them with new assets, in both short and medium terms, is crucial for securing sustainable livelihood opportunities (Dias et al., 2016; Kura et al., 2017).

Furthermore, a diversified asset portfolio is of major importance for a diversified livelihood (DFID, 1999; Li et al., 2017; Walelign et al., 2017) and is a common strategy to spread risks within a household. The strategy also enhances the prospects of viable livelihoods for resettled households and communities (Arnall et al., 2013; Asravor, 2018; Ellis, 2000). Hence, the more varied and more abundant assets are at the resettlement place, the more likely the migrants are to avoid the impoverishment risks identified by the IRR model (Cernea, 2000).

Thus, resettlement capacity assessments need to account for a spectrum of sub-assets to better reflect the resettlement capacity of resettlement places in terms of livelihood assets. For this reason, the CCRC framework draws on a broad definition of assets (e.g., Bebbington, 1999; Rogers & Xue, 2015; Arnall, 2019) and identifies five asset subdimensions (Table 1). These are natural assets, human capital infrastructures, physical capital infrastructures, financial assets, and social capital. For each subdimension, we have identified a number of generic indicators (Table 1) and examples of specific measurable indicators (Appendix A).

Natural assets: Natural assets support all livelihood activities (Gashu & Muchie, 2018; Winters et al., 2009). They encompass land (agricultural, residential,[6] and forest), subsoil resources, and water. Natural assets form the basis for primary livelihood activities (e.g., agriculture, extraction of forest products, and minerals) either directly or through wage employment; they serve as collateral for credit; and they support other livelihood activities and people's daily life (as fuel, drinking water, or oxygen, for example) (Jackson et al., 2016; Winters et al., 2009). Natural assets and natural asset-based resettlement have been posited as important components of enhancing people's willingness to be resettled (Peng et al., 2020), improving resettlement outcomes (Kura et al., 2017), and reducing risk of landlessness among resettled people (Cernea, 2000; Correa et al., 2011).

Financial assets: Financial assets in the form of credit or cash income are a means of establishing viable livelihoods. Such assets can be used to buy agricultural inputs, transport agricultural products to a market, or send a household member to a city where there are better wage employment or business opportunities. Financial assets can also be used in human capital investments (e.g., health, education), diversify household livelihoods, and improve a household's capacity to adapt to climate and other changes and its ability to repay debts (Asfaw et al., 2018). Securing financial assets at resettlement places can thus directly or indirectly help in reducing many of the resettlement risks, particularly joblessness, homelessness, increased morbidity, and landlessness.

[5] An arrangement whereby two or more households pool their labour to carry out agricultural work or other activities.

[6] Residential land was added as a generic indicator because some of the experts were concerned that the original generic indicators focused on rural settings. Although residential land is useful in both rural and urban settings, it is more relevant in semi-urban and urban areas.

Human capital infrastructures: Human capital infrastructures in the form of educational and health facilities broaden people's livelihood opportunities through human development (Winters et al., 2009). Educational facilities provide services for basic skills education (i.e., writing, reading, mathematics) and training to build skills and knowledge, and thus increase returns from livelihood activities. Additionally, education enables people to shift more easily from farm-based activities to other, more remunerative activities (Winters et al., 2009; Bhandari, 2013). The availability of health facilities reduces health-related shocks caused by sickness or death (Angelsen et al., 2014; Walelign et al., 2017). Thus, the availability of human capital infrastructures at resettlement places is important, enabling displaced people to gain new skills and knowledge in order to benefit from the livelihood opportunities, avoid intergenerational impoverishment (Bird, 2013; Reddy, 2015), and stay healthy (Angelsen et al., 2014; Walelign et al., 2017). In turn, these benefits decrease resettled people's risk of homelessness, morbidity, and food insecurity.

Physical capital infrastructures: Physical capital infrastructures are assets that broaden people's livelihood opportunities (Winters et al., 2009). They include housing, transport, communication outlets, energy, and irrigation facilities. Housing provides for one of three basic needs, namely shelter. Transport infrastructure provides improved access to inputs for livelihood activities, markets where outputs can be sold, and to employment opportunities (Barrett, 2008; Brashares et al., 2011; Faiz et al., 2012; Jayne et al., 2010; Walelign et al., 2019). Communication infrastructure (e.g., mobile networks, television, radio stations) can transform livelihoods through expanding and strengthening social networks, increasing people's ability to deal with emergencies, and enhancing the efficiency of livelihood activities (Chapman et al., 2003; Duncombe, 2014; Sife et al., 2010). A reliable energy source is a key input for many non-agricultural activities (Winters et al., 2009). Irrigation facilities in arid and semi-arid regions can substantially increase agricultural production, allow for year-long agricultural production, and increase people's resilience in adapting to climate variability and change (Buisson & Balasubramanya, 2019; Cao et al., 2019; Zheng et al., 2019; Zou et al., 2012). The availability of physical capital infrastructures facilitates resettlement processes and has been posited as one component of successful transitions at resettlement places, and in directly and indirectly mitigating the risks of homelessness, morbidity, and food insecurity associated with resettlement.

Social capital: Social capital strengthens a household's social bonds within the community, improves its status and access to help, and builds trust within the community (e.g., Abbay et al., 2018a; Abbay et al., 2018b). Particularly, social capital in the form of networks enables exchanges of resources, information, and financial assets, and is thus a critical component of livelihood security (Baird & Gray, 2014; Banerjee et al., 2013; Johny et al., 2017). Social capital in the form of community participation enables people to take part in and influence decisions in community affairs, such as the development of sustainable management of key community assets (Abbay et al., 2018b), and can be used to avoid and solve conflicts in the community arising from, for example, use of community resources (Apipalakul et al., 2015). Social capital in the form of institutions for help and support facilitates access to livelihood assistance, information, and safety nets during periods of stress and shocks (Linneroothbayer & Mechler, 2007; Hassan & Noor, 2015). Thus, availability of social capital at the resettlement place can help to reduce the risks related to community disarticulation, increased morbidity, food insecurity, and marginalization.

4.2.2. Conditions

To reestablish and improve livelihoods of resettled people, the available assets need to be transformed into viable livelihood activities, strategies, and outcomes. The transformation is mediated by a number of conditions that encompass social, economic, policy, and institutional factors that can enable and constrain the transformation (Ellis, 2000; Scoones, 2015). A resettlement place with good enabling conditions can promote asset accumulation and successful transformation of assets into livelihood activities by resettled people and communities (Correa et al., 2011) and thus improve resettlement outcomes (Kim, 2016; Tan, 2017) and mitigate the impoverishment risks of resettlement, particularly homelessness, landlessness, and loss of access to common property resources or assets (Cernea, 2000; Correa et al., 2011). Therefore, it is important to consider a number of enabling and constraining factors when assessing the resettlement capacity of potential resettlement places (Table 1). Based on the literature on livelihoods and resettlement, we identified six condition subdimensions. These include access to assets, condition of the assets, socio-economic conditions, institutional strength, and exposure to violent conflicts and natural hazards (Table 1) (for examples of measurable indicators, see Appendix C).

Access to assets: Access to assets embeds different types of property rights (e.g., laws, customs, conventions) that describe who controls and has access to assets (Ribot & Peluso, 2009). In addition to its institutional aspect, access to assets has a physical aspect (e.g., distance to assets) and an economic aspect (e.g., price and costs of owning and accessing assets). Secured access to a set of assets and their services is pivotal for people's successful engagement in livelihood activities, for broadening household technology options and livelihood opportunities, and for improving household technology adoption and welfare (Wossen et al., 2017; Zezza et al., 2011). Choosing a resettlement place that has regulated access to assets and with reasonable asset costs and distances for accessing assets is important for reestablishing the livelihoods of resettled people and communities, and for overcoming resettlement risks, particularly homelessness, landlessness, and increased morbidity.

Quality of assets: Quality of assets determines the potential of assets and the services they provide to maintain, improve, and support the livelihoods of resettled people and communities. For instance, land in good physical condition (e.g., fertile soil, gentle slope) enhances the return from farm-based activities. Similarly, health and educational services of good quality promote improved human capital. Assets with good conditions promote the accumulation of assets, and the maintenance and expansion of livelihood opportunities for resettled people and communities, as well as helping them to overcome resettlement risks, particularly increased morbidity, community disarticulation, and food insecurity. By contrast, assets of low quality hinder these processes (Gray, 2011; McNamara & des Combes, 2015; Lindegaard, 2018).

Socio-economic context: Socio-economic context encompasses the prevailing social and economic aspects of people's quality of life. Good social and economic conditions (e.g., high gender equality, low poverty rates) advance good community integration, create a conducive climate for viable livelihoods, and promote accumulation of livelihood assets (Molarius et al., 2007). In this way, good social and economic conditions in resettlement places can facilitate livelihood reconstruction (Arnall, 2019), and help in reducing resettlement risks, particularly homelessness, increased morbidity, community disarticulation, and food insecurity.

Institutional strength: Institutional strength captures the capacity of formal and informal institutions to enforce laws, protect human rights, ensure security, and deliver public services. Strong and good institutions are the main tools for designing and implementing sound policies that seek to improve people's living standards, develop public infrastructure and public services, promote existing livelihood strategies, and broaden livelihood opportunities (DFID, 1999; Ellis, 2000). Thus, the availability of strong

institutions increases a place's capacity to resettle people and communities through empowerment and enforcement of the rule of law (Sipe & Vella, 2014; Connell & Lutkehaus, 2017; Sina, Chang-Richards, Wilkinson, & Potangaroa, 2019b).

Violent conflict: Violent conflicts are social shocks that disrupt the normal life of people and communities. They hinder livelihood maintenance or improvement by restricting people's normal daily movements and access to assets and can at worst cause severe destruction of personal, household, and community assets. Violent conflict also weakens institutions, destroys public infrastructure, and denies people access to important public services, which in turn affect people's educational attainment, health status, and other aspects of their lives (Brück & Schindler, 2009; Justino, 2011). Thus, violent conflict can result in negative livelihood outcomes through lower incomes, a high incidence of poverty, food insecurity, and low resilience (Justino, 2011; Brück, d'Errico, & Pietrelli, 2019; Brück & d'Errico, 2019). Rebuilding and improving the livelihoods of displaced people and resettled communities in resettlement places affected by violent conflict is a daunting task, and the process of resettlement itself may worsen existing conflicts and tensions (Connell & Lutkehaus, 2017; Getahun et al., 2017; Rigaud et al., 2018). Thus, resettlement in conflict-affected areas should be avoided at all costs, and potential resettlement places need to be carefully screened for their suitability based on the prevalence and risk of violent conflicts.

Natural hazards: The natural disaster subdimension captures the slow and rapid onset of natural shocks due to geophysical hazards (e.g., earthquakes, volcano eruptions); climatic, hydrological, and meteorological hazards (e.g., flooding, drought, sea level rise); and biological hazards (e.g., disease outbreak, infestation). Natural hazards have already affected the livelihoods of millions, claimed many lives, and destroyed billions of US dollars' worth of private and public assets (Correa et al., 2011; Francescutti et al., 2017; Xu et al., 2016). Natural hazards also cause resource scarcity and lead to grievances that may result in violent conflict (Xu et al., 2016). If people are resettled in areas prone to natural hazards, they will remain vulnerable and less resilient to climate-related and other natural hazards as well as to social disasters, and these hazards will most likely impede the reconstruction of their livelihoods. To avoid these repercussions, potential resettlement places need to be carefully assessed for exposure to current and future natural hazards with due consideration to changes in climate-related hazards.

5. Validation

5.1. Survey

We conducted an expert survey in June–September 2019 to validate the CCRC framework. The survey was designed to acquire an expert judgment on the structure of the framework and relevance of its components (i.e., its dimension, subdimension, and generic indicators) and to identify missing ones. The experts were asked to rate each component of the framework using a 5-point unipolar Likert scale, ranging from "extremely relevant" to "not at all relevant", with an option to opt out of providing an answer if the expert was unable to make an assessment of a particular element. The survey data were analyzed by counting the experts who indicated that a specific component was either extremely, very, moderately, slightly, or not at all relevant. The experts suggested the addition of residential land and air quality in the framework, and hence we added residential land as a generic indicator to the natural capital subdimension and air quality as a specific measurable indicator to the quality of natural capital generic indicator. These were the only relevant elements recommended by the experts for addition to the CCRC framework, and since they were included in it only after the survey, we cannot provide expert assessment results for residential land.

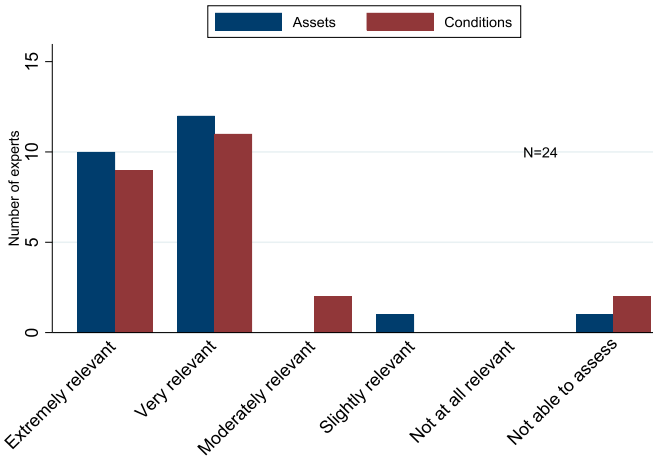


Fig. 2. Expert assessment of the asset and condition dimensions of the climate change resettlement capacity (CCRC) framework.

Most of the experts were selected using targeted and snowball sampling: an initial set of relevant experts was chosen among the participants at the Nordic Geographers Meeting in Trondheim, Norway (June 2019), and World Forum on Climate Justice in Glasgow, Scotland, UK (June 2019), and these experts then suggested additional experts. A total of 24 experts participated in the survey, which was conducted using an online cloud source solution, Survey123, for ArcGIS. The experts had an average of 12 years (range 1–40 years) of research or professional experience in one or more fields relating to climate change, resettlement, livelihoods, migration, and disaster management. The experts have work and field experience across the world, allowing the validation to pertain to many countries.

Snowball sampling can result in similarity biases as the survey participants may suggest experts with similar experiences or backgrounds. This, however, does not seem to have been the case as the responses for most elements cover most answer alternatives. As it was challenging to find relevant experts willing to participate in the survey, our sample size is relatively small. The sample size, however, falls in the recommended range for the approaches adopted in our study.[7] With these shortcomings in mind, the expert evaluation provided us with a valuable assessment of the overall structure of the framework and the relevance of its different components.

5.2. Results

The survey results show that most of the experts (22 and 20 of the 24 experts) rated assets and conditions, respectively, as either extremely relevant or very relevant for assessing the resettlement capacity of places (Fig. 2).

Regarding the asset subdimensions, most of the surveyed experts rated the subdimensions as either extremely relevant or very relevant (ranging from 18 to 21 of the 24 experts for natural assets and physical capital infrastructures, respectively) while the remaining experts rated them as moderately relevant, with the exception of natural and financial assets, which were rated as slightly and not at all relevant by one expert, respectively (Fig. 3). Of the generic indicators, the indicator for subsoil resources was

[7] Creswell (2007) suggested a range between 20 and 30 to be adequante sample size for valid results.

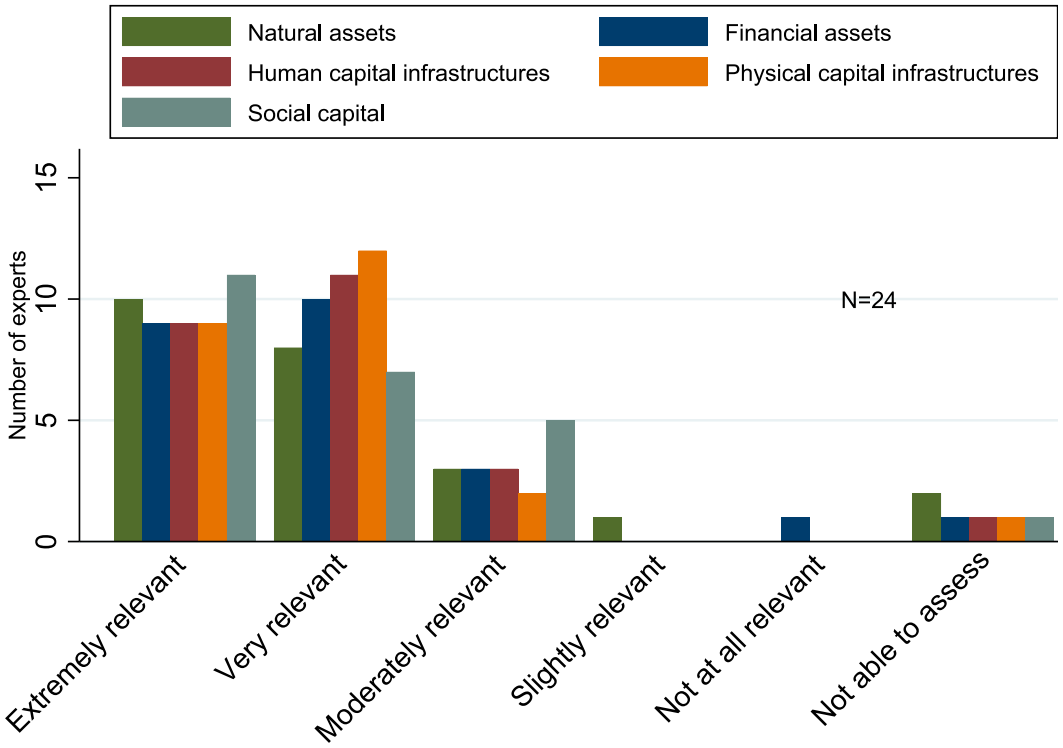


Fig. 3. Expert assessment of the asset subdimensions of the climate change resettlement capacity (CCRC) framework.

considered extremely relevant or very relevant by 5 of the 24 experts (the lowest share for all generic indicators), while 23 of the 24 experts considered health facilities and housing either extremely relevant or very relevant (the highest share) (Appendix B).

Regarding the condition subdimensions, most of the experts considered the condition subdimensions as either extremely relevant or very relevant (ranging from 20 to 24 of the 24 experts for quality of assets and violent conflict, respectively), while the remaining experts rated them as moderately relevant, with the exception of natural hazards, which was rated as slightly relevant by one expert (Fig. 4). Similarly, most experts rated the generic indicators in the condition subdimensions as either extremely relevant or very relevant (ranging from 12 to 21 of the 24 experts for regime type and climatic, hydrological, and meteorological

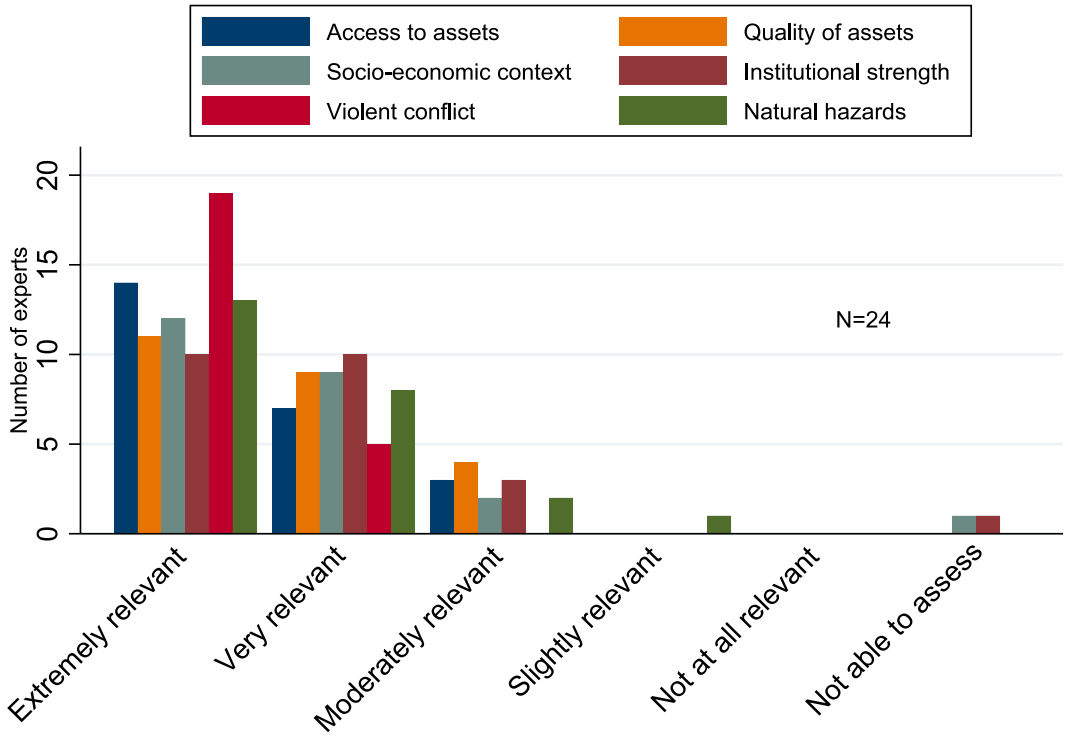


Fig. 4. Expert assessment of the condition subdimensions of the climate change resettlement capacity (CCRC) framework.

hazards, respectively). The only exception was voting, which was rated as either extremely relevant or very relevant by 10 experts (Appendix D).

6. Illustration

We illustrate the application and adaptation of the CCRC framework through a case study on two climate-vulnerable regions of Ethiopia (Afar and Somali). The pastoral communities in the Afar and Somali regions are highly vulnerable to weather-related shocks, have experienced recurrent droughts in the past, and have limited capacity to cope with the consequences of climate change that is predicted to worsen in the decades to come (Mekuyie et al., 2018). Therefore, there may be a need to resettle the most exposed communities in the future. As the Government of Ethiopia seeks to resettle people within the region they live in (Hammond, 2008), it is useful to identify which areas of the Afar and Somali regions have the highest capacity to resettle people and communities.

6.1. Data and indicator processing

We collected data for 107 preliminary indicators (see SM1 in Supplementary Material for a list) that span all the CCRC framework's 11 subdimensions. For indicators that measure the prevalence of a phenomenon (e.g., flood, conflict), we used longitudinal data starting from the year 2000. For the others, we used the latest available data. We normalized most indicators with population size to maintain comparability. The indicators come from 24 different data sources, such as datasets provided by international organizations, institutions in Ethiopia and other countries, and individual projects and studies (see SM2 in Supplementary Material). The unit of analysis is a 5 km grid cell, the grid spanning the two regions entirely. As the data came in different formats and resolutions, comprehensive data processing was undertaken prior to the analysis (see SM3 in Supplementary Material for details).[8]

6.2. Indicator screening and selection

Using pairwise correlations and conceptual screening, we identified highly correlated indicators. The revealed redundancy was then reduced by excluding indicators or aggregating them, decreasing the number of indicators to 78 (see SM2 in Supplementary Material). The standardized Cronbach alpha for the remaining indicators is 0.85, suggesting that our data has good internal consistency (Streiner, 2003; Tavakol & Dennick, 2011). The final list of indicators was grouped into 10 (rather than 11) subdimensions as we merged the indicators for the institutional strength and socio-economic contexts subdimensions.[9]

6.3. Index construction

To accommodate the hierarchical nature of the analytical framework, and following Cutter et al. (2014), Cutter and Derakhshan (2020), and Scherzer et al. (2019), we used a hierarchical minimax additive index construction approach. The approach was implemented as follows: we (i) min–max scaled the indicators, summed them within each subdimension, and divided each subdimension by the number of indicators to get its average score; (ii) min–max scaled the subdimension scores and summed them to get the dimension (asset and condition) scores;[10] and (iii) summed the dimension scores to get the overall resettlement index (see SM4 in Supplementary Material for details). Thus, the scores for the asset and condition dimensions can range from 0 to 5 (as both include five subdimensions, each ranging from 0 to 1). The overall resettlement capacity index can range from 0 to 10. The resettlement capacity scores are unitless and cannot be interpreted in absolute terms; rather, they must be interpreted in comparative (relative) terms across the included grid cells. For further analysis, we identified five resettlement capacity categories based on quintile groups (i.e., 5 groups of equal size) and mapped them (Fig. 5).

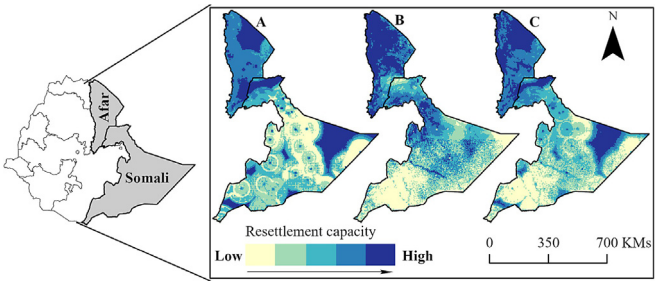


Fig. 5. Geographic distribution of scores for the asset (A) and condition (B) dimensions and the overall climate change resettlement capacity (C), based on five groups of equal size.

6.4. Results

The average overall resettlement capacity score is 4.7 with the standard deviation of 0.6 and minimum and maximum values of 3.1 and 7.4, respectively. The mean asset and condition resettlement capacity scores are 1.3 and 3.4, respectively. On average, the grid cells in the Afar region have higher scores than the Somali region (5.4 vs. 4.5 for the overall score and 1.7 vs. 1.2 and 3.7 vs. 3.3 for the assets and conditions, respectively, see SM5 in Supplementary Material). The grids with the highest resettlement capacity scores for the overall index, and for the asset and condition dimensions, are all located in the Afar region, while the ones with the lowest scores are in the Somali region. Fig. 5 shows the geographic distribution of the resettlement capacity scores across the study area and reveals that the places with the highest resettlement capacity in terms of overall scores are concentrated in northern and western Afar, eastern Somali, and along the border of the two regions (Panel C).[11]

7. Issues in applying the framework

7.1. Holistic approach and contextual adaptation

Any effort to apply the CCRC framework should include the two dimensions (assets and conditions), ideally all subdimensions, and as many relevant generic indicators as possible; they should be treated as a system in which each component interacts with the others to determine the resettlement capacity of places. Our illustration included indicators that spanned almost all generic indicators and all subdimensions and both dimensions (see also Walelign et al., 2021). Such a holistic approach is crucial as reconstruction of livelihoods at resettlement places is always a multi-dimensional

[8] Some indicators had few missing values, which were imputed using poly. regression function in 'spatialEco' package (Evans et al., 2021)

[9] After the removal of the redundant indicators only three indicators with limited spatial variation were left for the institutional strength subdimension.

[10] Values for indicators and subdimensions that were negatively associated with resettlement capacity were reversed so that all indicators have a positive impact on resettlement capacity score (see SM1 and 2 in Supplementary Material for a list of the reversed indicators and subdimensions).

[11] The results of the case study are only illustrative and do not necessarily reflect the actual resettlement suitability. See Walelign et al., 2021 for details.

process involving a number of physical, economic, social, political, and institutional aspects (Sina et al., 2019b; Cernea, 2000; Correa et al., 2011; Sina et al., 2019a). The CCRC framework seeks to preserve this complexity, accounting for the interaction between the dimensions and subdimensions, and acknowledging that their combined effect is greater than an individual component's effect in determining the overall resettlement capacity of resettlement places.

Some of the CCRC framework's components are context-specific, in which case the framework needs to be adapted. The adaptation process may involve the accommodation of concepts, as concepts may change in content and even in directionality when used in different settings (Holand & Lujala, 2013). For example, institutional strength can be conceptualized in terms of either informal institutions or formal institutions depending on which types of institutions dominate, or in terms of both in societies in which such institutions coexist. Ethnic diversity is an example of an element that may change directionality: ethnically homogeneous communities can potentially be very suitable when they are to accommodate people from the same ethnic group, yet potentially even disastrous if they are used to resettle people from other ethnic groups. Furthermore, specific components of the CCRC framework may be irrelevant in certain contexts. For example, agricultural land is relevant for assessing the resettlement capacity of rural areas, but less relevant if the objective is to assess urban areas only. By contrast, some components – the presence of armed conflict, say, or exposure to climate-related hazards – are likely to be relevant for assessing resettlement capacity in most contexts. In our case study, we made three simple adaptations: we reduced the number of 'conditions' subdimensions from six to five; we only included indicators for the most relevant natural hazards (i.e., drought and flood); and, for violent conflicts, we only considered internal conflicts as international conflicts are rare in Ethiopia.[12]

7.2. Unit of analysis

The CCRC framework can be applied to resettlement capacity assessments using different units of analysis, such as grid cells of different sizes or administrative units at various levels. In the case study, we used grid cells as our unit of analysis, but another option would have been to use the lowest administrative unit, the *kebele*, in Ethiopia. The choice of a relevant unit of analysis is an important step in the resettlement capacity assessment process as it determines the extent of the assessment's spatial disaggregation. For example, if the unit of analysis is the country, the assessment will not provide information on specific locations or regions within a country but would enable comparisons between the included countries. An assessment using subnational units (a ward, for example) or small grid cells could identify specific locations with better prospects for resettlement in the country. A gold standard approach is not available for the choice of unit of analysis; the choice depends on many factors, including the purpose and setting of the assessment, spatial variation in indicator values,[13] and what data are available and at what resolution (Arsenault et al., 2013; Walelign et al., 2021). This also means that the optimal size for the unit of analysis may differ across the framework's components, and it may therefore be wise to consider different spatial scales for different components in order to improve the quality of overall resettlement capacity assessment, as shown in previous studies using such an approach (for soil property modeling, for example, see Miller et al., 2015). In the case study, we chose the 5-km grid cell as our unit of analysis as most of the included indicators were available at that resolution or better. This resolution also provides sufficient detail to identify relatively small areas for further, localized resettlement capacity assessments.

7.3. Data availability, processing, and analysis

Application of the CCRC framework requires data at continuous (both absolute and relative), dichotomous, or ordinal level. The data can be historical, current, or predictive depending on the purpose of the study, the nature of the specific indicator, and data availability. Data availability often depends on the unit of analysis and scale (many variables only exist for the country level or highest administrative levels). As resettlement capacity is highly multidimensional, assessing resettlement capacity requires data on several indicators that encompass a wide variety of different aspects. The best basis for such an assessment would be to collect data through a purposely designed, large-scale interdisciplinary census or survey. As funding for such an approach often is an issue, the second-best alternative is to use existing maps, satellite images, geo-referenced databases, surveys, databases, and other sources. Assessments based on such data, as in our illustration, can then be used to identify potential areas for resettlement, which can then be targeted for purpose-designed data collection efforts and field visits.

As data are often available at a different scale than that of the analysis, data processing is necessary to make the data on different indicators suitable for the purpose and scale of the study. This may include aggregation or disaggregation of data to the intended spatial unit. Another issue when using data from different sources is the mismatch between data formats. Hence, data processing will also involve the transformation of data to suitable formats, as in our case study (see Section 6.1 and SM3 in Supplementary Materials; also Walelign et al. (2021)). The data may also need to be standardized, using, for example, total population living or total land area in the unit of analysis as a denominator in order to make comparisons across locations of different sizes (Reckien, 2018). As the value ranges of the included indicators can vary a lot and are measured in different units (e.g., land in square meters per person, length of rivers per square kilometer), data need to be scaled before they can be added into the index. In our illustration, we used min–max scaling (see Section 6.3). In some cases, dasymetric techniques may need to be used to consider, for example, areas that cannot be inhabited, such as large lakes or deserts.

Once the available data are processed, they can be combined using data reduction approaches, such as principal component or factor analysis (e.g., Cutter & Finch, 2008; Fao, 2016), structural equation modeling (a combination of data reduction with regression modeling) (Fao, 2016), an additive approach (e.g., Cutter et al., 2014; Scherzer et al., 2019; Walelign et al., 2021), or a multiplicative approach (e.g., Welle & Birkmann, 2015). No approach is superior to another *per se*, and the choice depends on the purpose and the context of the study. For instance, the data reduction approach is good for generating one or more scores that contain the highest variation of the components of the framework, structural equation modeling for understanding causal relationships, a multiplicative approach for assigning larger effects when higher values of two or more components exist, and an additive approach for calculating the contribution of each component on the overall index. An attractive advantage of the additive approach, which was employed in our illustration, is its simplicity regarding interpretation and construction (Cutter et al., 2014; Walelign et al., 2021).

[12] The Ethio-Eritrean war that took place between 1998 and 2000 is the only international war in which Ethiopia has participated over the last 30 years.

[13] For example, if there is substantial spatial variation in indicator values over short distances, the unit of analysis needs to be small in order to capture the spatial heterogeneity in the data.

7.4. Predictions

Predicting future resettlement capacity is relevant under the increasing impact of climate change. Two approaches can be used to make such assessments within the CCRC framework. First, future suitability can be modeled by using specific measurable indicators calibrated to points of time in the future and using data such as projected population size and composition, exposure to climate change, productivity changes, and extent of desertification. Second, it is possible to generate a resettlement capacity index using current data and aimed at predicting a future based on plausible and constantly updated scenarios of change. In this approach, current climate change scenarios based on greenhouse gas emission trajectories and global socio-economic development trends (O'Neill et al., 2014; van Vuuren et al., 2011) can form a basis for such an index.

8. Conclusions

In this article, we have proposed a new framework, the climate change resettlement capacity (CCRC) framework, to guide assessments of resettlement capacity and identification of potential places for resettling people and communities displaced by climate change. The CCRC framework emphasizes the capacity of resettlement places to support the reconstruction of viable livelihoods. The framework was validated by experts, and its application was illustrated using a case study.

The proposed CCRC framework includes two main dimensions – assets and conditions – that are crucial for livelihood reconstruction. Assets encompass the resources available for forming the basis for rebuilding livelihoods at the resettlement place, whereas conditions reflect contextual factors that can both constrain and enable the successful translation of assets into livelihood activities, strategies, and outcomes. The CCRC framework identifies 11 subdimensions: 5 for assets and 6 for conditions. The subdimensions focus on key aspects of the two main dimensions. We also provide a set of generic indicators for each subdimension and examples of specific measurable indicators for each generic indicator as a first step in operationalizing the framework. Experts who were used to validate the dimensions, subdimensions, and initial selection of generic indicators found the identified elements highly relevant for assessing the resettlement capacity. The case study illustrates that the framework can be operationalized and that it can be applied to subnational units (see also Walelign et al., 2021).

The CCRC framework can be used in the following ways: (1) To guide research on displacement and resettlement induced by climate change; (2) To help policymakers when choosing the best places to resettle communities in the face of actual or anticipated displacements related to climate change, and to prevent resettlement in unsuitable areas; (3) To guide climate migrants to move to places with higher potential for livelihood reconstruction; and (4) To help international and national organizations and governments at national, regional, and local levels to channel infrastructural and public service investments to more suitable resettlement areas, further enhancing their resettlement capacity. The framework can also be used to assess resettlement places in programs not related to climate change as most of its components reflect what displaced and resettled people and communities need at the resettlement place to reconstruct their livelihoods irrespective of the cause of their displacement. However, studies that adapt the framework to other types of resettlement programs may need to include program-specific subdimensions and generic indicators.

The framework and accompanying resettlement capacity assessments should not be used to justify resettlement or to discourage *in situ* adaptation strategies. Resettlement should, in most cases, be used as a last resort when all feasible *in situ* adaptation strategies have been exhausted (Arnall, 2019; de Sherbinin et al., 2011; López-Carr & Marter-Kenyon, 2015; Wilmsen & Webber, 2015). If resettlement is found necessary, rebuilding the livelihoods of resettled people and communities should be the major aim of resettlement programs, resettlement should be voluntary, and other aims (such as the political motive of weakening opposition to parties in power) should not influence the planning and implementation of the programs. Crucially, the physical resettlement and measures to facilitate it are only one part of a resettlement process, and only partially determine its success. In addition, the host communities need to be included in the process and efforts made to secure their support for the resettlement and people who will be part of their communities (Kolstad et al., 2019; Lujala et al., 2020). Equally importantly, any resettlement program should take into account the cultural and emotional dimensions and seek to provide avenues that help the resettled people to feel attached to their new homeplace (Bonaiuto et al., 2016; Brown et al., 2019).

Further studies are needed to develop the CCRC framework and how it can be operationalized. First, future studies should examine, both conceptually and empirically, the relevance and implications of scale in assessing resettlement capacity. Second, future studies need to explore the interaction between the different components of the framework, for example, to determine to what degree they can be considered to be additive, or should multiplicative approaches be employed instead. Third, assessments of potential resettlement places need to be coupled with vulnerability assessments to identify the people and communities most in need of resettlement. Such a joint approach would enable the development of conceptual frameworks that can help to match vulnerable populations with most appropriate host communities to ensure that the resettlement provides opportunities for those who need to resettle and for those who receive them.

CRediT authorship contribution statement

Solomon Zena Walelign: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Päivi Lujala:** Conceptualization, Writing – review & editing, Funding acquisition, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The research was funded by the Research Council of Norway (grant no. 274702). We would like to thank the experts who participated in the survey, and Xi Jiao and colleagues at the Department of Geography, NTNU, for testing and commenting on the pilot survey. We also thank Susan L. Cutter, Carsten Smith-Hall, Sabrina Scherzer, Sosina Bezu, Arne Wiig, Ivar Kolstad, and Catriona Turner for useful discussions and suggestions on earlier versions of the paper and to the conference participants of a paper session at the inaugural World Forum on Climate Justice in Glasgow for their comments.

Appendix A. Generic indicators, justification, and examples for specific measurable indicators, asset dimension.

Sub-dimension	Generic indicators	Examples of measurable indicators	Justification	Individual / Household	Grid/ village/ district
Natural assets	Agricultural land (including pasture)	Cultivated land per capita (pc); grazing land pc; fallow land pc; land suitable for agriculture but not yet in use pc	Provides input for all crop and livestock production; decreases the risk of landlessness and joblessness		X
	Forest and fish resources	Area of forest land pc; fish stock pc	Provide construction material and food, source for commercial fish and timber production; support other livelihood activities (e.g., crop, livestock production); decrease the risk of joblessness		X
	Sub-soil resources	Oil and gas reserves pc; high-value mineral reserves pc; other sub-soil reserves pc (e.g., stones, clay)	Provide input for extraction activities, wage employment, business opportunities, and construction materials; decrease the risk of joblessness		X
	Residential land	Residential land pc	Provides land for housing; decreases the risk of homelessness		X
	Fresh water	Volume of surface water pc, volume of ground water pc, annual rainfall/precipitation (amount)	Provides water for drinking, cooking, and other household necessities; source of services that support livelihood activities (e.g., crop, livestock production)		X
Financial assets	Credit availability	Number of (#) formal financial institutions (e.g., banks, microcredit institutions) pc; # informal financial institutions (e.g., rotational saving groups) pc; average level of borrowing (debt rate) per household	Provides capital for purchasing inputs for crop and livestock production, to start business, and for transport; decreases joblessness risk of resettlement	x	X
	Employment opportunities	# large size companies pc; # medium size companies pc; # micro and small size companies pc; # commercial farms pc	Provide employment and wage income; decrease risk of joblessness	x	X
Human capital inf.	Education facilities	# primary and secondary schools pc; # higher institutions pc, # teachers per pupil/capita	Improve human capital		X
	Health facilities	# clinics pc; # hospitals pc; # health practitioners pc	Improve human capital (in terms of health); decrease the risk of morbidity		X
Physical capital inf.	Housing	# housing units pc; # vacant houses pc	Provides shelter; decreases the risk of homelessness	X	x
	Energy (electricity)	Electricity grid density per km^2 of inhabited areas; % houses/ buildings/villages with electricity; % buildings/houses with solar panel	Provides energy for household and business activities	x	X
	Communication outlets	Mobile phone network stations pc; # radio and television stations pc; % households/adult population with mobile phone; % households with TV	Provides access to information (e.g., market information); facilitates knowledge sharing	x	X
	Irrigation facility	% agricultural land under irrigation; % agricultural land with potential to be irrigated	Increases agricultural production; decreases vulnerability to drought		X
	Market centers	# daily markets per km^2, % urban area of total area/inhabited area	Provide access to buy and sell agricultural and other livelihood inputs and products and business opportunities		X
	Modes of transport	Road density per $km^2$of inhabited area; navigable waterways density per km^2 of inhabited area	Provide access to market and employment opportunities		X

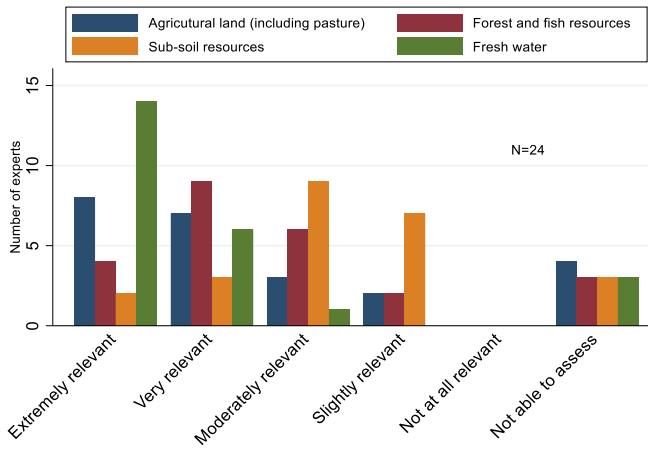
Appendix A (*continued*)

Sub-dimension	Generic indicators	Examples of measurable indicators	Justification	Individual / Household	Grid/ village/ district
Social capital	Nature of networks	# social groups pc (e.g., self-help groups); # people in social groups	Promote community integration; decrease risks of community disarticulation and marginalization	X	X
	Community participation	# meetings between local people and government; # meetings in the local community, # people attending local community meetings (on average)		x	X
	Avenues for socialization	# sport clubs pc; # religious places pc (e.g., churches, mosques); # places for sports pc; # meeting halls; # people attending social activities on average		x	X
	Institutions for help and support	# local NGO offices pc; # international NGO offices pc; # civic institution offices pc; # local civic institutions pc	Facilitate the resettlement process; promotes livelihood rebuilding		X

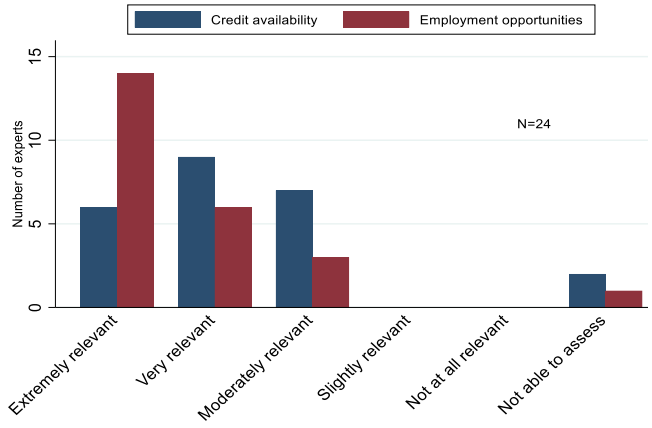
Note: X stands for optimal measurement level and x for the alternative level, if data at the optimal scale is not available.

Appendix B. Expert assessment of the generic indicators, asset dimension.

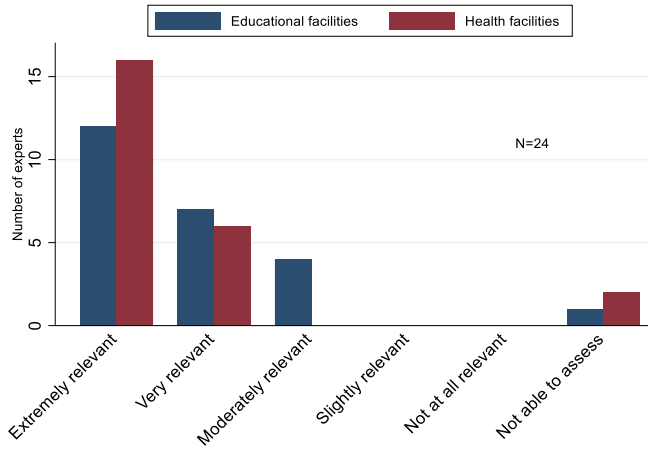
a) Natural assets



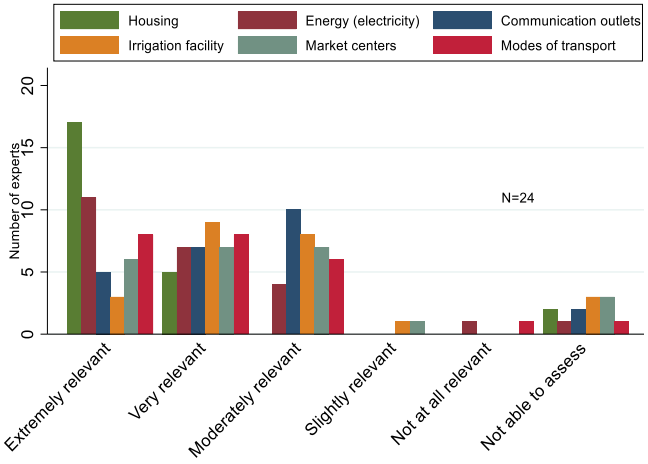
b) Financial assets



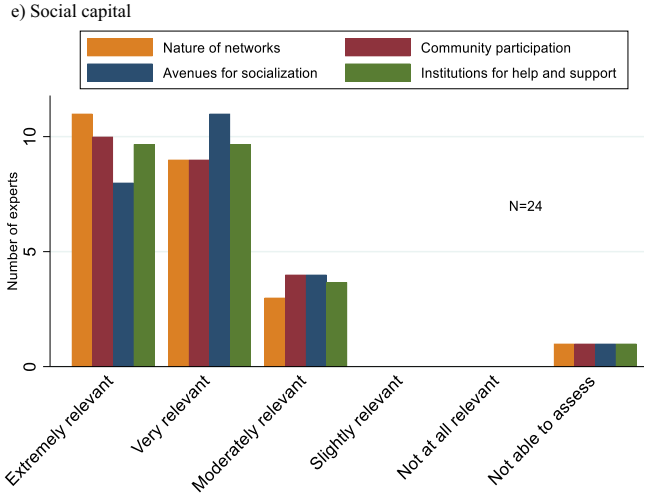
c) Human capital infrastructures



d) Physical capital infrastructures



e) Social capital



Appendix C. Generic indicators, justification, and examples for specific measurable indicators, condition dimension.

Sub-dimension	Generic indicators	Examples potential specific measurable indicators	Justification	Individual / Household	Grid/ village/ district
Access to assets	Property rights (natural and financial assets; human and physical capital infrastructures)	% households with land certificates; # court cases over ownership or use of resources/assets pc; prevalence of conflicts between people over property rights; perceptions over resource/asset security, # redistributive land policies	Enable/disable secured access to assets; decrease/increase risk of conflict over the use of resources, joblessness, and landlessness	x	X
	Distance (to natural and financial assets; human and physical capital infrastructures; social capital)	Distance to the nearest school; distance to the nearest health center; distance to urban centers; distance to religious places; distance to sport centers; distance to oil/ petroleum deposits	Hinders access to assets and services provided by them	X	x
	Affordability (natural and financial assets; human and physical capital infrastructures; social capital)	Cost of schooling per child; cost of visiting a health center per patient; interest rate; house rent per room; land rent per hectare; land price per hectare; membership fees for social organizations; entry fees for sport events	Influences ownership and access to assets and the services that are provide by the assets	X	x
Quality of assets	Quality of natural assets	Soil quality; slope; share of waste land/desert; rainfall/precipitation variability; normalized difference vegetation index (measure for greenness of vegetation); forest density per km^2; air quality; water quality	Influences viability of natural asset-based livelihood activities	x	X
	Quality of human capital infrastructures	Life expectancy; literacy rate; infant mortality; health burden (death and loss of health due to disease)	Affects human capital; decreases/increases risk of morbidity	X	x
	Quality of physical capital infrastructures	# Electricity outages per specified period; % tarmac roads of all roads; % improved housing; signal strength of mobile networks	Influences access to markets; reliability of electricity and other infrastructure	x	X
	Quality of financial assets	Wage rate; total capital of financial institutions; average loan per creditor; length of repayment period	Influences access to credit and other financial services	X	X
	Quality of social capital	Diversity of social organizations; # members in social organizations pc; # sport events per year; # religious service days per week; average number of employees in NGOs operating in the area; # people getting support by NGOs and civic institutions.	Influences access to and quality of social networks	x	X
Socio-economic context	Social factors	Ethnic diversity; religious diversity; crime rates	Decrease/increase the risk of community disarticulation	X	x
	Economic factors	Income inequality; poverty incidence; income level; economic growth; dependency ratio; population density; livestock density per km^2; land inequality	Influence community integration; decrease the risk of joblessness if good economic condition prevails	X	x
Institutional strength	Voting	% registered voters; voter turnout	Influences engagement in community affairs	X	X
	Corruption	# reported bribe cases pc; perceptions on corruption	Influences trust on institutions and officials	x	X
	Enforcement of laws and regulations	Share of decision per total number of cases per year; share of implemented policies per proposed ones per year	Affects security; influences the resettlement implementation process		
	Regime type	Level of democracy; stability of the regime	Influences planning and implementation of resettlement programs		

(*continued on next page*)

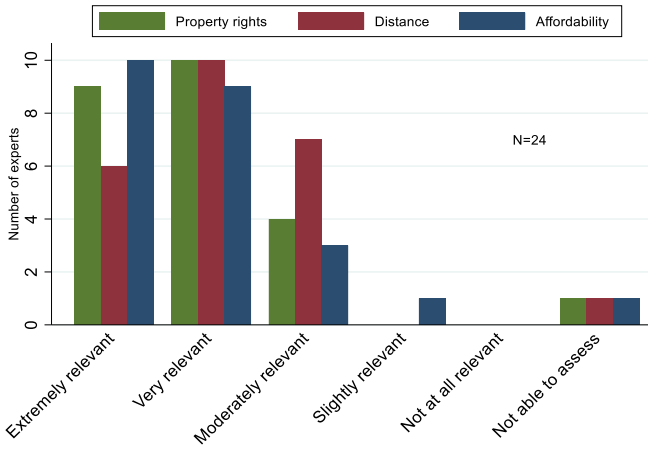
Appendix C (*continued*)

Sub-dimension	Generic indicators	Examples potential specific measurable indicators	Justification	Individual / Household	Grid/ village/ district
Violent conflict	Internal armed conflict (including one-sided violence)	# internal armed conflicts/genocides over a specified period; # affected people and victims over a specified period; # conflict/genocide years over a specified period	Destroys livelihood assets and social infrastructure; restricts free movement and exchange of information; increases the risk of morbidity	x	X
	International armed conflict	# international armed conflicts over a specified period; # affected people and victims; duration of conflict/genocide over a specified period			
Natural hazards	Geophysical disasters (e.g., earthquakes, volcano eruptions)	Frequency of geophysical disasters (GD); proportion of GD-affected area; # GD-affected people; # GD victims; economic damage pc; probability of GD occurrence; # active volcanoes; # inactive volcanoes	Destroy livelihood assets and public infrastructures; increase the risk of morbidity	x	X
	Biological disasters (e.g., disease outbreak, infestation)	Prevalence of livestock and human infectious diseases (e.g., malaria, trypanosomiasis); # major biological disasters (BD) over a specified period; # BD people affected; # BD victims	Claim human lives; destroy human capital; increase the risk of morbidity		
	Climatic, hydrological, and meteorological disasters (e.g., flooding, drought, sea level rise)	Frequency of climatic, hydrological, and meteorological disasters (CHMD); proportion of CHMD-affected area; # CHMD-affected people; # CHMD victims; economic damage pc; probability of CHMD occurrence; area permanently covered by sea level rise	Destroy livelihood assets and public infrastructures; increase the risk of morbidity		

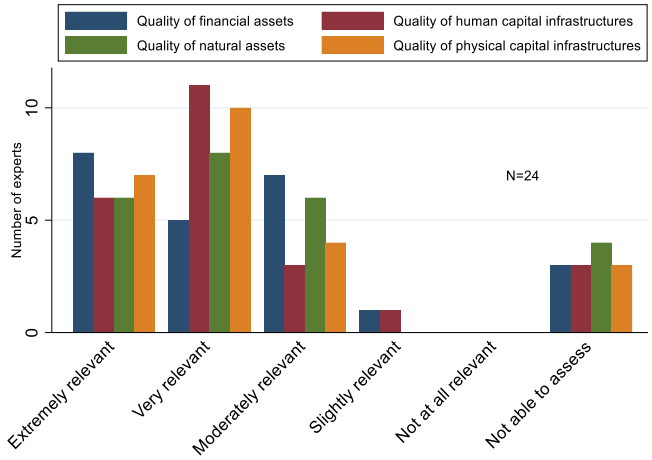
Note: X stands for optimal measurement level and x for the alternative level, if data at the optimal scale are not available.

Appendix D. Expert assessment of the generic indicators, condition dimension.

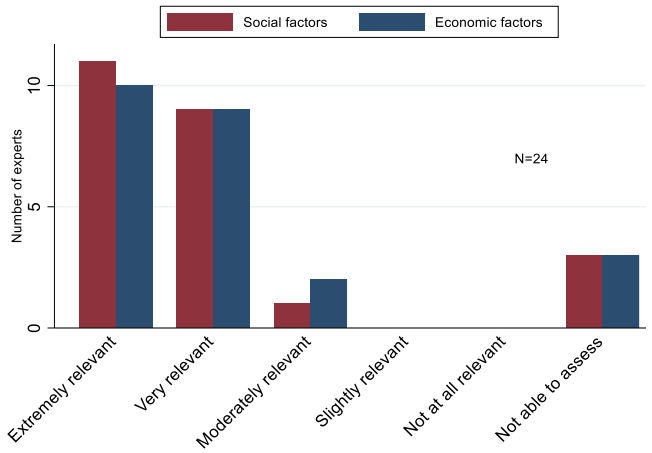
a) Access to assets



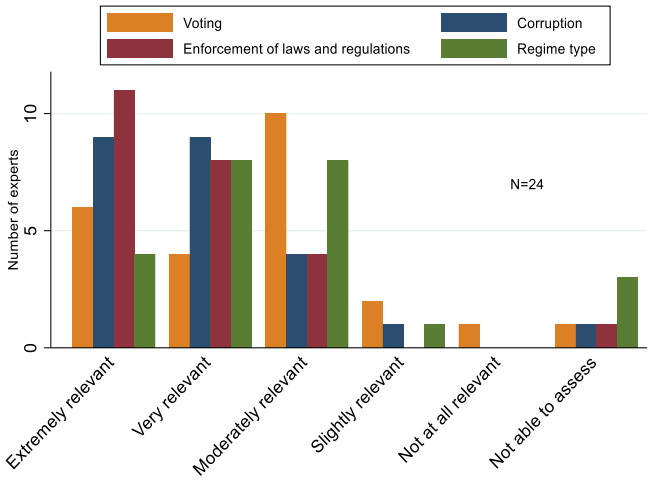
b) Quality of assets



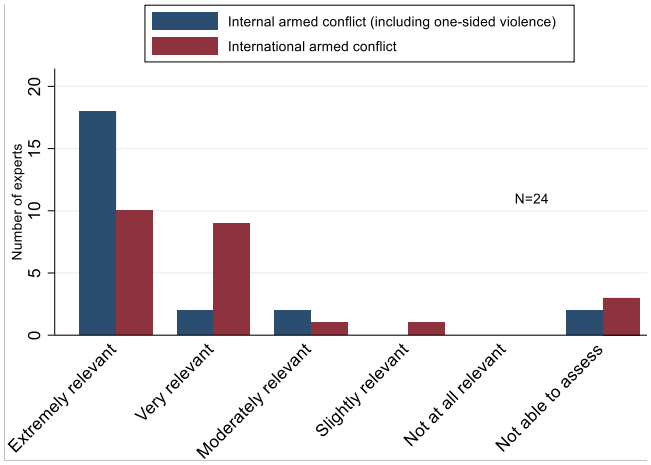
c) Socioeconomic context



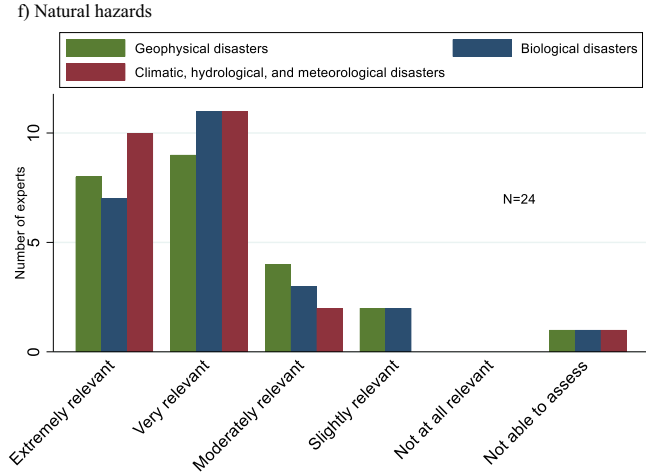
d) Institutional strength



e) Violent conflict



f) Natural hazards



Appendix E. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.worlddev.2021.105777.

References

Abbay, A. G., Rutten, R., Azadi, H., & Witlox, F. (2018b). How Social Status Contributes to Sustainable Livelihoods? An Empirical Analysis in Ethiopia. *Sustainability, 11*, 1–24.

Abbay, A. G., Rutten, R. P. J. H., & Graaf, P. M. D. (2018a). Social capital, geographical distance and transaction costs: An empirical analysis of social networks in African rural areas. *Review of Urban and Regional Development Studies, 30*, 202–224.

Agrawal, A., & Redford, K. (2009). Conservation and displacement: An overview. *Conservation & Society, 7*, 1–10.

Alam, G. M. M., Alam, K., & Mushtaq, S. (2017). Climate change perceptions and local adaptation strategies of hazard-prone rural households in Bangladesh. *Climate Risk Management, 17*, 52–63.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., ... Wunder, S. (2014). Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development, 64*, S12–S28.

Apipalakul, C., Wirojangud, W., & Ngang, T. K. (2015). Development of Community Participation on Water Resource Conflict Management. *Procedia - Social and Behavioral Sciences, 186*, 325–330.

Arnall, A. (2019). Resettlement as climate change adaptation: What can be learned from state-led relocation in rural Africa and Asia? *Climate and Development, 11*, 253–263.

Arnall, A., Thomas, D. S. G., Twyman, C., & Liverman, D. (2013). Flooding, resettlement, and change in livelihoods: Evidence from rural Mozambique. *Disasters, 37*, 468–488.

Arsenault, J., Michel, P., Berke, O., Ravel, A., & Gosselin, P. (2013). How to choose geographical units in ecological studies: Proposal and application to campylobacteriosis. *Spatial and Spatio-temporal Epidemiology, 7*, 11–24.

Artur, L., & Hilhorst, D. (2012). Everyday realities of climate change adaptation in Mozambique. *Global Environmental Change, 22*, 529–536.

Asfaw, S., Pallante, G., & Palma, A. (2018). Diversification Strategies and Adaptation Deficit: Evidence from Rural Communities in Niger. *World Development, 101*, 219–234.

Asiama, K., Lengoiboni, M., & van der Molen, P. (2017). In the Land of the Dammed: Assessing Governance in Resettlement of Ghana's Bui Dam Project. *Land, 6*, 80.

Asravor, R. K. (2018). Livelihood Diversification Strategies to Climate Change among Smallholder Farmers in Northern Ghana: Diversification Strategies to Climate Change. *Journal of International Development, 30*, 1318–1338.

Baird, T. D., & Gray, C. L. (2014). Livelihood Diversification and Shifting Social Networks of Exchange: A Social Network Transition? *World Development, 60*, 14–30.

Banerjee, A., Chandrasekhar, A. G., Duflo, E., & Jackson, M. O. (2013). The Diffusion of Microfinance. *Science, 341*, 1236498.

Barnett, J., & Webber, M. (2010). Accommodating Migration to Promote Adaptation to Climate Change. *World Bank Policy Research Working Papers #5270.*.

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy, 33*, 299–317. https://doi.org/10.1016/j.foodpol.2007.10.005.

Bebbington, A. (1999). Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty. *World Development, 27*, 2021–2044.

Bhandari, P. B. (2013). Rural livelihood change? Household capital, community resources and livelihood transition. *Journal of Rural Studies, 32*, 126–136.

Bird, K. (2013). The Intergenerational Transmission of Poverty: An Overview. In A. Shepherd & J. Brunt (Eds.), *Chronic Poverty*. Palgrave Macmillan, London: Rethinking International Development Series.

Black, R., Bennett, S. R. G., Thomas, S. M., & Beddington, J. R. (2011). Migration as adaptation. *Nature, 478*, 447–449.

Bonaiuto, M., Alves, S., Dominicis, S. D., & Petruccelli, I. (2016). Place attachment and natural hazard risk: Research review and agenda. *Journal of Environmental Psychology, 48*, 33–53.

Brashares, J. S., Golden, C. D., Weinbaum, K. Z., Barrett, C. B., & Okello, G. V. (2011). Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences, 108*, 13931–13936.

Brookings, Georgetown University, & UNHCR. (2015). *Guidance on protecting people from disasters and environmental change through planned relocation.* https://www.brookings.edu/wp-content/uploads/2016/06/GUIDANCE_PLANNED-RELOCATION_14-OCT-2015.pdf.

Brown, K., Adger, W. N., Devine-Wright, P., Anderies, J. M., Barr, S., Bousquet, F., ... Quinn, T. (2019). Empathy, place and identity interactions for sustainability. *Global Environmental Change, 56*, 11–17.

Brück, T., & d'Errico, M. (2019). Food security and violent conflict: Introduction to the special issue. *World Development, 117*, 167–171.

Brück, T., d'Errico, M., & Pietrelli, R. (2019). The effects of violent conflict on household resilience and food security: Evidence from the 2014 Gaza conflict. *World Development, 119*, 203–223.

Brück, T., & Schindler, K. (2009). The Impact of Violent Conflicts on Households: What Do We Know and What Should We Know about War Widows? *Oxford Development Studies, 37*, 289–309.

Brzoska, M., & Fröhlich, C. (2016). Climate change, migration and violent conflict: Vulnerabilities, pathways and adaptation strategies. *Migration and Development, 5*, 190–210.

Buisson, M.-C., & Balasubramanya, S. (2019). The effect of irrigation service delivery and training in agronomy on crop choice in Tajikistan. *Land Use Policy, 81*, 175–184.

Bukvic, A. (2018). Towards the sustainable climate change population movement: The Relocation Suitability Index. *Climate and Development, 10*, 307–320.

Bukvic, A., Smith, A., & Zhang, A. (2015). Evaluating drivers of coastal relocation in Hurricane Sandy affected communities. *The International Journal of Disaster Risk Reduction (IJDRR), 13*, 215–228.

Cao, X. C., Shu, R., Guo, X. P., & Wang, W. G. (2019). Scarce water resources and priority irrigation schemes from agronomic crops. *Mitigation and Adaptation Strategies for Global Change, 24*, 399–417.

Cernea, M. (1997). The risks and reconstruction model for resettling displaced populations. *World Development, 25*, 1569–1587.

Cernea, M. M. (2000). Risks, Safeguards and Reconstruction: A Model for Population Displacement and Resettlement. *The Economic and Political Weekly, 35*(21), 3659–3678.

Cernea, M. M. (2008). Compensation and benefit sharing: Why resettlement policies and practices must be reformed. *Water Science and Engineering, 1*, 89–120.

Chambers, R., & Conway, R. G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. Brighton: Institute of Development Studies.

Chapman, R., Slaymaker, T., & Young, J. (2003). *Livelihoods approaches to information and communication in support of rural poverty elimination and food security*. https://www.odi.org/publications/164-livelihoods-approaches-information-and-communication-support-rural-poverty-elimination-and-food.

Chen, Y., Tan, Y., & Luo, Y. (2017). Post-disaster resettlement and livelihood vulnerability in rural China. *Disaster Prevention and Management: An International Journal, 26*, 65–78.

Connell, J., & Lutkehaus, N. (2017). Environmental Refugees? A tale of two resettlement projects in coastal Papua New Guinea. *Australian Geographic, 48*, 79–95.

Correa, E., Ramirez, F., & Sanahuja, H. (2011). *Populations at Risk of Disaster: A Resettlement Guide*. Washington DC: The World Bank.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed). London: Sage.

Cutter, S. L., Ash, K. D., & Emrich, C. T. (2014). The geographies of community disaster resilience. *Global Environmental Change, 29*, 65–77.

Cutter, S. L., & Derakhshan, S. (2020). Temporal and spatial change in disaster resilience in US counties, 2010–2015. *Environmental Hazards, 19*, 10–29.

Cutter, S. L., & Finch, C. (2008). Temporal and spatial changes in social vulnerability to natural hazards. *Proceedings of the National Academy of Sciences, 105*, 2301–2306.

de Haan, L., & Zoomers, A. (2005). Exploring the Frontier of Livelihoods Research. *Development and Change, 36*, 27–47.

de Sherbinin, A., Castro, M., Gemenne, F., Cernea, M. M., Adamo, S., Fearnside, P. M., ... Shi, G. (2011). Preparing for Resettlement Associated with Climate Change. *Science, 334*, 456–457.

De Wet, C. (2012). The Application of International Resettlement Policy in African Villagization Projects. *Hum. Organ., 71*, 395–406. https://doi.org/10.17730/humo.71.4.0787k13246877275.

DFID (1999). Sustainable livelihoods guidance sheets accessed May 27, 2019 https://www.ennonline.net/dfidsustainableliving;.

Dias, N. T., Keraminiyage, K., & DeSilva, K. K. (2016). Long-term satisfaction of post disaster resettled communities: The case of post tsunami – Sri Lanka. *Disaster Prevention and Management: An International Journal, 25*, 581–594.

Dietz, S., Bowen, A., Dixon, C., & Gradwell, P. (2016). 'Climate value at risk' of global financial assets. *Nature Climate Change, 6*, 676–679.

Draper, J., & McKinnon, C. (2018). The ethics of climate-induced community displacement and resettlement. *Wiley Interdisciplinary Reviews: Climate Change, 9*, e519.

Duncombe, R. A. (2014). Understanding the Impact of Mobile Phones on Livelihoods in Developing Countries. *Development Policy Review, 32*, 567–588.

Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. New York: Oxford University Press.

Evans, J. S., Murphy, M. A., & Ram, K. (2021). *Package 'spatialEco' – Version 1.3-7: Spatial Analysis and Modelling Utilities*. https://cran.r-project.org/web/packages/spatialEco/spatialEco.pdf.

Faiz, A., Faiz, A., Wang, W., & Bennett, C. (2012). Sustainable Rural Roads for Livelihoods and Livability. *Procedia - Social and Behavioral Sciences, 53*, 1–8.

Fao (2016). *Analysing Resilience for better targeting and action: Resilience index measurement and analysis - II*. Rome: FAO.

Findlay, A. M. (2011). Migrant destinations in an era of environmental change. *Global Environmental Change, 21*, S50–S58.

Forzieri, G., Bianchi, A., Batista e Silva, F., Marin Herrera, M. A., Leblois, A., Lavalle, C., Aerts, J. C. J. H., & Feyen, L. (2018). Escalating impacts of climate extremes on critical infrastructures in Europe. *Global Environmental Change, 48*, 97–107.

Francescutti, L. H., Sauve, M., & Prasad, A. S. (2017). Natural disasters and healthcare: Lessons to be learned. *Healthcare Management Forum, 30*, 53–55.

Gashu, K., & Muchie, Y. (2018). Rethink the interlink between land degradation and livelihood of rural communities in Chilga district, Northwest Ethiopia. Journal of Ecology and Environment, *42*.

Gebauer, C., & Doevenspeck, M. (2015). Adaptation to climate change and resettlement in Rwanda. *Area, 47*, 97–104.
Gemenne, F., & Blocher, J. (2017). How can migration serve adaptation to climate change? Challenges to fleshing out a policy ideal. *Geographical Journal, 183*, 336–347.
Getahun, K., Poesen, J., & Van Rompaey, A. (2017). Impacts of Resettlement Programs on Deforestation of Moist Evergreen Afromontane Forests in Southwest Ethiopia. *Mountain Research and Development, 37*, 474–486.
Gomersall, K. (2018). Resettlement practice and the pathway to the urban ideal. *Geoforum, 96*, 51–60.
Gray, C. L. (2011). Soil quality and human migration in Kenya and Uganda. *Global Environmental Change, 21*, 421–430.
Gromilova, M. (2014). Revisiting Planned Relocation as a Climate Change Adaptation Strategy: The Added Value of a Human Rights-Based Approach. *Utrecht Law Review, 10*, 76.
Hammond, L. (2008). Strategies of invisibilization: How Ethiopia's resettlement programme hides the Poorest of the Poor. *Journal of Refugee Studies, 21*, 517–536.
Hassan, N. M., & Noor, A. H. M. (2015). Do Capital Assistance Programs by Zakat Institutions Help the Poor? *Procedia Economics and Finance, 31*, 551–562.
He, L., Aitchison, J. C., Hussey, K., & Chen, Y. (2019). Building new houses or long-term recovery? A combination of quantitative and qualitative evidence from earthquake-displaced households in Sichuan, China. *Habitat International, 83*, 135–145.
Holand, I. S., & Lujala, P. (2013). Replicating and Adapting an Index of Social Vulnerability to a New Context: A Comparison Study for Norway. *Prof. Geogr., 65*, 312–328.
IFC (2012). Performance Standard 5: Land Acquisition and Involuntary resettlement accessed April 16, 2019 https://www.ifc.org/wps/wcm/connect/75de96d4-ed36-4bdb-8050-400be02bf2d9/PS5_English_2012.pdf?MOD=AJPERES&CVID=jqex59b;.
Jackson, M. C., Woodford, D. J., & Weyl, O. L. F. (2016). Linking key environmental stressors with the delivery of provisioning ecosystem services in the freshwaters of southern Africa: Environmental stress and ecosystem services. *Geo: Geography and Environment, 3*, e00026.
Jayne, T. S., Mather, D., & Mghenyi, E. (2010). Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa. *World Development, 38*, 1384–1398.
Johny, J., Wichmann, B., & Swallow, B. M. (2017). Characterizing social networks and their effects on income diversification in rural Kerala, India. *World Development, 94*, 375–392.
Justino, P. (2011). Violent Conflict and Human Capital Accumulation. *IDS Working Paper 2011*, 1–17.
Karanth, K. K., Kudalkar, S., & Jain, S. (2018). Re-building Communities: Voluntary Resettlement from Protected Areas in India. *Frontiers in Ecology and Evolution, 6*, 183.
Kim, I. (2016). Beyond Trauma: Post-resettlement Factors and Mental Health Outcomes Among Latino and Asian Refugees in the United States. *The Journal of Immigrant and Minority Health, 18*, 740–748.
Kolstad, I, Bezu, S, Lujala, P, Mahmud, M, & Wiig, A (2019). Does changing the narrative improve host community attitudes to climate migrants? Experimental evidence from Bangladesh. *CMI Working Paper WP, 2019*(3) https://www.cmi.no/publications/7065-does-changing-the-narrative-improve-host-community-attitudes-to-climate-migrants.
Kura, Y., Joffre, O., Laplante, B., & Sengvilaykham, B. (2017). Coping with resettlement: A livelihood adaptation analysis in the Mekong River basin. *Land Use Policy, 60*, 139–149.
Li, M., Huo, X., Peng, C., Qiu, H., Shangguan, Z., Chang, C., & Huai, J. (2017). Complementary livelihood capital as a means to enhance adaptive capacity: A case of the Loess Plateau, China. *Global Environmental Change, 47*, 143–152.
Li, Y., López-Carr, D., & Chen, W. (2014). Factors affecting migration intentions in ecological restoration areas and their implications for the sustainability of ecological migration policy in arid Northwest China. *Sustainability, 6*, 8639–8660.
Lindegaard, L. S. (2018). Adaptation as a political arena: Interrogating sedentarization as climate change adaptation in Central Vietnam. *Global Environmental Change, 49*, 166–174.
Linneroothbayer, J., & Mechler, R. (2007). Disaster safety nets for developing countries: Extending public–private partnerships. *Environmental Hazards, 7*, 54–61.
Liu, W., Xu, J., & Li, J. (2018). The Influence of Poverty Alleviation Resettlement on Rural Household Livelihood Vulnerability in the Western Mountainous Areas, China. *Sustainability, 10*, 2793.
Lo, K., & Wang, M. (2018). How voluntary is poverty alleviation resettlement in China? *Habitat International, 73*, 34–42.
Lo, K., Xue, L., & Wang, M. (2016). Spatial restructuring through poverty alleviation resettlement in rural China. *The Journal of Rural Studies, 47*, 496–505.
López-Carr, D., & Marter-Kenyon, J. (2015). Manage climate-induced resttlement. *Nature, 517*, 265–267.
Lujala, P., Bezu, S., Kolstad, I., Mahmud, M., & Wiig, A. (2020). How do host–migrant proximities shape attitudes toward internal climate migrants? *Global Environmental Change, 65*, 102156.
Manlosa, A. O., Hanspach, J., Schultner, J., Dorresteijn, I., & Fischer, J. (2019). Livelihood strategies, capital assets, and food security in rural Southwest Ethiopia. *Food Security, 11*, 167–181.
Mathur, H. M. (2015). Climate Change and Displacement: Learning from Resettlement in the Development Context. *Soc. Change, 45*, 118–130.
McLeman, R. A. (2011). Settlement abandonment in the context of global environmental change. *Global Environmental Change, 21*, S108–S120.
McNamara, K. E., & des Combes, H. J. (2015). Planning for Community Relocations Due to Climate Change in Fiji. *The International Journal of Disaster Risk Reduction (IJDRR), 6*, 315–319.
Mekuyie, M., Jordaan, A., & Melka, Y. (2018). Understanding resilience of pastoralists to climate change and variability in the Southern Afar Region, Ethiopia. *Climate Risk Management, 20*, 64–77.
Miller, B. A., Koszinski, S., Wehrhan, M., & Sommer, M. (2015). Impact of multi-scale predictor selection for modeling soil properties. *Geoderma, 239–240*, 97–106.
Molarius, A., Berglund, K., Eriksson, C., Lambe, M., Nordstrom, E., Eriksson, H. G., & Feldman, I. (2007). Socioeconomic conditions, lifestyle factors, and self-rated health among men and women in Sweden. *The European Journal of Environment and Public Health (EJEPH), 17*, 125–133.
Mueller, V., Gray, C., & Kosec, K. (2014). Heat stress increases long-term human migration in rural Pakistan. *Nature Climate Change, 4*, 182–185.
O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., ... van Vuuren, D. P. (2014). A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Climatic Change, 122*, 387–400.
O'Sullivan, M. (2016). The ethics of resettlement: Australia and the Asia-Pacific Region. *The International Journal of Human Rights, 20*, 241–263.
Owen, J., Muriuki, G., & Kemp, D. (2018). *Livelihoods, Food Security and Mining-Induced Displacement and Resettlement*. Brisbane: Centre for Social Responsibility in Mining (CSRM), The University of Queensland.
Owen, J. R., & Kemp, D. (2015). Mining-induced displacement and resettlement: A critical appraisal. *The Journal of Cleaner Production, 87*, 478–488.
Patnaik, S., & Prasad, C. S. (2014). Revisiting Sustainable Livelihoods: Insights from Implementation Studies in India. *Vision, 18*, 353–358.
Peng, W., López-Carr, D., Wu, C., Wang, X., & Longcore, T. (2020). What factors influence the willingness of protected area communities to relocate? China's ecological relocation policy for Dashanbao Protected Area. *Science of The Total Environment, 727*, 138364.
Reckien, D. (2018). What is in an index? Construction method, data metric, and weighting scheme determine the outcome of composite social vulnerability indices in New York City. *Regional Environmental Change, 18*, 1439–1451.
Reddy, A. B. (2015). Changes in Intergenerational Occupational Mobility in India: Evidence from National Sample Surveys, 1983–2012. *World Development, 76*, 329–343.
Ribot, J. C., & Peluso, N. L. (2009). A Theory of Access. *Rural Sociology, 68*, 153–181.
Rigaud, K. K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., ... Midgley, A. (2018). *Groundswell: Preparing for Internal Climate Migration*. World Bank.
Rogers, S., & Wilmsen, B. (2019). Towards a critical geography of resettlement. *Progress in Human Geography, 44*, 256–275.
Rogers, S., & Xue, T. (2015). Resettlement and climate change vulnerability: Evidence from rural China. *Global Environmental Change, 35*, 62–69.
Scherzer, S., Lujala, P., & Rød, J. K. (2019). A community resilience index for Norway: An adaptation of the Baseline Resilience Indicators for Communities (BRIC). *The International Journal of Disaster Risk Reduction (IJDRR), 36*, 101107.
Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies, 36*, 171–196.
Scoones, I. (2015). *Sustainable Livelihoods and Rural Development*. Warwickshire, UK: Practical Action.
Sife, A. S., Kiondo, E., & Lyimo-Macha, J. G. (2010). Contribution of Mobile Phones to Rural Livelihoods and Poverty Reduction in Morogoro Region, Tanzania. *The Electronic Journal of Information Systems, 42*, 1–15.
Sina, D., Chang-Richards, A. Y., Wilkinson, S., & Potangaroa, R. (2019a). A conceptual framework for measuring livelihood resilience: Relocation experience from Aceh, Indonesia. *World Development, 117*, 253–265.
Sina, D., Chang-Richards, A. Y., Wilkinson, S., & Potangaroa, R. (2019b). What does the future hold for relocated communities post-disaster? Factors affecting livelihood resilience. *The International Journal of Disaster Risk Reduction (IJDRR), 34*, 173–183.
Sipe, N., & Vella, K. (2014). Relocating a Flood-affected Community: Good Planning or Good Politics? *The Journal of the American Planning Association, 80*, 400–412.
Streiner, D. L. (2003). Starting at the Beginning: An Introduction to Coefficient Alpha and Internal Consistency. *Journal of Personality Assessment, 80*, 99–103.
Tadgell, A., Doberstein, B., & Mortsch, L. (2018). Principles for climate- related resettlement of informal settlements in less developed nations: A review of resettlement literature and institutional guidelines. *Climate and Development, 10*, 102–115.
Tan, Y. (2017). Resettlement and Climate Impact: Addressing migration intention of resettled people in west China. *Australian Geographic, 48*, 97–119.
Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53–55.
Tilt, B., & Gerkey, D. (2016). Dams and population displacement on China's Upper Mekong River: Implications for social capital and social-ecological resilience. *Global Environmental Change, 36*, 153–162.
Torri, M. (2011). Conservation, relocation and the social consequences of conservation policies in protected areas: Case study of the Sariska Tiger Reserve, India. *Conservation & Society, 9*, 54.
UNHCR (2018). Climate change and disaster displacement; key messages on the international protection accessed May 15, 2019 https://www.unhcr.org/5c0172f24.pdf.

UNHCR, SFS, International Organization for Migration (2015). A toolbox: Planning relocations to protect people from disasters and environmental change accessed May 3, 2019 https://reliefweb.int/sites/reliefweb.int/files/resources/Planned%20Relocations%20Toolbox%20-%20Final%20Version.pdf.

van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., ... Rose, S. K. (2011). The representative concentration pathways: An overview. *Climatic Change, 109*, 5–31.

Vanclay, F. (2017). Project-induced displacement and resettlement: From impoverishment risks to an opportunity for development? Impact Assess. *Project Appraisal, 35*, 3–21.

Walelign, S. Z., Cutter, S. L., & Lujala, P. (2021). Resettlement capacity assessments for climate induced displacements: Evidence from Ethiopia. *Climate Risk Management, 33* 100347.

Walelign, S. Z., & Jiao, X. (2017). Dynamics of rural livelihoods and environmental reliance: Empirical evidence from Nepal. *Forest Policy and Economics, 83*, 199–209.

Walelign, S. Z., Nielsen, M. R., & Jacobsen, J. B. (2019). Roads and livelihood activity choices in the Greater Serengeti Ecosystem, Tanzania. *PLOS ONE, 14*, e0213089.

Walelign, S. Z., Pouliot, M., Larsen, H. O., & Smith-Hall, C. (2017). Combining Household Income and Asset Data to Identify Livelihood Strategies and Their Dynamics. *Journal of Development Studies, 53*, 769–787.

Warner, K. (2010). Global environmental change and migration: Governance challenges. *Global Environmental Change, 20*, 402–413.

Welle, T., & Birkmann, J. (2015). The World Risk Index – An Approach to Assess Risk and Vulnerability on a Global Scale. *J. Extreme Events, 02*, 1550003.

Wilmsen, B. (2016). After the Deluge: A longitudinal study of resettlement at the Three Gorges Dam, China. *World Development, 84*, 41–54.

Wilmsen, B., Adjartey, D., & van Hulten, A. (2019). Challenging the risks-based model of involuntary resettlement using evidence from the Bui Dam, Ghana. *International Journal of Water Resources Development, 35*, 682–700.

Wilmsen, B., & Webber, M. (2015). What can we learn from the practice of development-forced displacement and resettlement for organised resettlements in response to climate change? *Geoforum, 58*, 76–85.

Winters, P., Davis, B., Carletto, G., Covarrubias, K., Quiñones, E. J., Zezza, A., ... Stamoulis, K. (2009). Assets, Activities and Rural Income Generation: Evidence from a Multicountry Analysis. *World Development, 37*, 1435–1452.

World Bank (1990). Involuntary resettlement accessed April 30, 2019 https://www.ifc.org/wps/wcm/connect/c41b5296-4485-43e3-a1d5-0876c39b1b19/OD430_InvoluntaryResettlement.pdf?MOD=AJPERES&CVID=jqeB1iA:.

World Bank (2004). *Involuntary resettlement sourcebook: Planning and implementation in Development Projects*. Washington, DC: The World Bank.

World Bank. (n.d.). *Understanding the context of involuntary resettlement*. http://pubdocs.worldbank.org/en/628991425483120559/resettlement-fact-sheet.pdf

Wossen, T., Abdoulaye, T., Alene, A., Haile, M. G., Feleke, S., Olanrewaju, A., & Manyong, V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *The Journal of Rural Studies, 54*, 223–233.

Xiao, Q., Liu, H., & Feldman, M. (2018). Assessing livelihood reconstruction in resettlement program for disaster prevention at Baihe county of China: Extension of the impoverishment risks and reconstruction (IRR) model. *Sustainability, 10*, 2913.

Xu, J., Wang, Z., Shen, F., Ouyang, C., & Tu, Y. (2016). Natural disasters and social conflict: A systematic literature review. *The International Journal of Disaster Risk Reduction (IJDRR), 17*, 38–48.

Yang, X., Zhao, H., & Ho, P. (2017). Mining-induced displacement and resettlement in China: A study covering 27 villages in 6 provinces. *Resources Policy, 53*, 408–418.

Zezza, A., Winters, P., Davis, B., Carletto, G., Covarrubias, K., Tasciotti, L., & Quiñones, E. (2011). Rural Household Access to Assets and Markets: A Cross-country Comparison. *The European Journal of Development Research, 23*, 569–597.

Zheng, H., Ying, H., Yin, Y., Wang, Y., He, G., Bian, Q., ... Yang, Q. (2019). Irrigation leads to greater maize yield at higher water productivity and lower environmental costs: A global meta-analysis. *Agriculture, Ecosystems & Environment, 273*, 62–69.

Zou, X., Li, Y., Gao, Q., & Wan, Y. (2012). How water saving irrigation contributes to climate change resilience—a case study of practices in China. *Mitigation and Adaptation Strategies for Global Change, 17*, 111–132.