NTNU – Trondheim
Norwegian University of
Science and Technology

Hydrological data for small hydropower plants

Irene Karlsson

Hydropower Development

Submission date:	June 2014
Supervisor:	Ånund Killingtveit, IVM
Co-supervisor:	Knut Alfredsen, IVM
	Kjetil Vaskinn, SWECO AS

Norwegian University of Science and Technology
Department of Hydraulic and Environmental Engineering

THE NORWEGIAN UNIVERSITY FOR SCIENCE AND TECHNOLOGY (NTNU)

Department of Hydraulic and Environmental Engineering

MSc Thesis

in

Hydropower Development

Candidate: **Irene Karlsson**

Topic: **Hydrological data for small hydropower plants**

1. Background

Small hydropower plants are often located in small rivers where there is no runoff data, since most runoff gauging stations have traditionally been placed in larger rivers. Until recently, it has been common practice to compute runoff data for small hydropower projects by scaling down data from nearby stations, often located in much larger catchments. Small hydropower catchments often have no lakes or reservoirs, which leads to faster runoff and more "peaked" hydrographs, compared to larger catchments. This may result in data that are not representative for the small catchments, if a scaling approach is used. In turn, use of such non-representative data may result in wrong design and disappointing results during operation, compared to what was expected in the planning phase.

In the last 10 years or so, consulting companies have become aware of the need for more accurate runoff data, and found that it pays to do measurements at the planned site, even for a shorter period. In some consulting companies, for example SWECO, it is now regular procedure to establish a runoff gauging station nearly for every project, and run the station shortly before and during the planning phase. Such data have proved to be of good value for the planning.

SWECO AS AS has established runoff gauging stations as part of the planning process for small hydropower for a large number of projects, resulting in a large volume of runoff data for many small rivers. These data could be very valuable, not only for hydropower planning, but also for other hydrological studies, and they could supplement NVE's data in small catchments and in locations where NVE have no stations. NVE has expressed interest in including these data into their database, thereby making the data series more easily available for other users. SWECO AS is willing to supply the data, and most of the clients who have paid for the data collection have also agreed to this idea. Some initial work was done in the summer 2013, the work done in the Thesis will have to build on this, and also use data series that were prepared then.

In this project the objective is to prepare for the transfer of SWECO AS's runoff data to NVE in an orderly and efficient way. Before this can be done, however, it is necessary to process and store the data, and to run checks on quality and to include other relevant information, like discharge measurements, inspection reports etc. During this process we also would like to do statistical analysis and comparison with existing data series in NVE's archive. It will be necessary to have a close contact with NVE during the preparation of data so than import into NVE's hydrological database can be done as efficient as possible.

2. Main questions for the thesis

The project will consist of the following topics (though not necessarily be limited to these):

- Identify and prepare an overview of available runoff data series collected by SWECO
- Prepare all data records for storage in HEC-DSS
- Collect information about each station and compute topographical and climatic parameters (Hint: Use NVE Low-flow application)
- Make a standardized description of each record (station) including all important information like location (GPS), map, photo(?), catchment characteristics, rating curve etc…
- Prepare method(s) for quality control for each record and run the quality control for selected stations
- Prepare flow-duration curves for selected stations and for other nearby (NVE) stations. Compare the local flow-duration curves to those based on scaling from larger catchments
- Analyze statistical properties of flow-duration curves and see if it can be related to topographic and climatic parameters
- Summary and recommendations
- Reporting and presentation

3. Supervision

Supervisor: Professor Ånund Killingtveit

Co-supervisor: Kjetil Vaskinn, SWECO AS AS

Professor Knut Alfredsen, NTNU

This specification for the thesis should be reviewed after about 6 weeks, and not later than 1/4. If needed, the text could then be modified, based on proposal from the candidate and discussions with the supervisor.

4. Report format

Professional structuring of the report is important. Assume professional senior engineers as the main target group. The report shall include a summary, offering the reader the background, the objective of the study and the main results. The thesis report shall be using NTNU's standard layout for Thesis work. Figures, tables, etc shall be of good report quality. Table of contents, list of figures, list of tables, list of references and other relevant references shall be included. The complete manuscript should be compiled into a PDF file and submitted electronically to DAIM for registration, printing and archiving. Three hard copies, in addition to the students own copies, should be printed out and submitted. The entire thesis may be published on the Internet as full text publishing. All documents and data shall be written on a CD thereby producing a complete electronic documentation of the results from the project. This must be so complete that all computations can be reconstructed from the CD.

Finally, the candidate is requested to include a signed statement that the work presented is his own and that all significant outside input has been identified.

The thesis shall be submitted no later than

Department of Hydraulic and Environmental Engineering, NTNU

Ånund Killingtveit

Professor

ACKNOWLEDGEMENTS

The author would like to express her gratitude to the supervisor, Professor Ånund Killingtveit, Department of Hydraulic and Environmental Engineering, Norwegian University of Science and Technology, for his help and guiding in this Thesis work. His advices and suggestions had a great role in preparing of this work.

Another gratitude is directed to two co-supervisers: Kjetil Vaskinn, Senior Engineer at Sweco Norge (Trondheim), and Professor Knut Alfredsen, Department of Hydraulic and Environmental Engineering, Norwegian University of Science and Technology, for their continuous help, guidance, support and valuable suggestions.

Guidance of these knowledgeable people became an invaluable experience and professional boost.

Finally, sincere thanks to all people who helped and encouraged directly or indirectly during this Thesis work.

ABSTRACT

During last years extensive development of small hydropower plants has taken place, and many of that plants are frequently located in small catchments. Mainly there is no runoff data for these small catchments, because runoff gauging stations have been established in comparably larger catchments.

For establishing runoff for small catchments it is common practice to downscale it from larger catchments – analogue catchments. For downscaling analogue stations should have nearly the same catchment characteristics, like area, lake percentage, elevation distribution, etc. Small hydropower catchments often don't have lakes, it means that small catchments have faster runoff response and more "peaked" hydrographs, comparably to larger catchments. In this case scaling approach will lead to wrong design and disappointing results during operation. Underestimation of runoff data will lead to additional spill of water, and overestimation will bring to wrong installed capacity and may be would not be efficient at all.

During past years consulting companies become very interested in more precise runoff data, even if it have been collected during not long time period. It has been decided to set a gauging stations near to projects and collect runoff data (even for short period). In the past 10 years SWECO AS company has collected runoff series for approximately hundred stations, which are located through all Norway. Collected runoff series are also very valuable for other hydrological computations, it could improve and adjunct NVE data for small catchment and supplement hydrological data where NVE has no stations. This study was made with permission of SWECO AS (Trondheim) and people who have paid for data collection.

The objectives of the Thesis is to store all available runoff data to the database in proper format (using HEC-DSS programm), collect necessary information about each station and compute topographical and climatic parameters (using NVE Low-flow application), make a standardized description of each record (station) including all important information like location (GPS), map, photo, catchment characteristics, rating curve etc. and check the quality of data.

In this project one of the objectives is to prepare runoff data series to transfer to NVE database in tidy and in the format that requested NVE.

During Thesis work one of the objectives is to make an comparable analysis between SWECO stations data and NVE analogue stations. Data from NVE analogue stations was provided by NVE staff. Besides, relationship between topographical and climatic parameters with flow duration curves of selected SWECO stations should be estimated.

ACRONYM

Etc.	Et cetera
m	meter
masl	meter above sea level
N	North
S	South
E	East
W	West
WMO	World Meteorological Organisation
NOK	Norwegian Kroner
NVE	Norwegian Water and Energy Directorate
p.a.	per annum/per year
PP	(hydro) Power Plant
Q	Discharge
Qmean	Mean/average Discharge
η	efficiency
mm	millimetres
MSc	Master of Science
km	Kilometres
km^2	Square Kilometres
s	Second
yr	Year
°	Degree
°C	Degree Celsius
%	percent

TABLE OF CONTENT

ACKNOWLEDGEMENTS 5
ABSTRACT 7
ACRONYM 9
TABLE OF CONTENT 11
LIST OF FIGURES 15
LIST OF TABLES 19
1. INTRODUCTION 21
1.1 Background 21
1.1.1 Importance of hydrological data 21
1.2 Objective of work 22
1.3 Scope of work 22
1.4 Limitation of study 23
1.5 Structure of thesis 23
2. STUDY AREA 24
2.1 Background 24
2.2 Location and Overview of Available SWECO AS Stations 25
2.3 Climate 28
2.4 Geology 29
2.5 Precipitation 30
2.6 Land Use 31
3. MATERIALS AND METHODS 32
3.1 Type of used equipment and methods 32
3.1.1 Water Level Logger 16/15 32
3.1.2 Flow Tracker 33

3.1.3 Moving Boat. Acoustic Doppler Current Profiler (ADCP) ... 34
3.1.4 Salt detection ... 35
3.2 Data collection and processing ... 37
3.2.1 Finding place for data Logger (by SWECO AS) ... 37
3.2.2 Data collection with Logger (by SWECO AS) ... 39
3.2.3 Stage discharge curve constructing with VFKURVE3 program ... 40
3.2.4 Extrapolation of Stage-Discharge curve ... 42
3.2.5 Storing and proceeding data in HEC-DSSVue ... 43
3.3 Data selected for all SWECO AS stations ... 45
3.4 Selection of SWECO AS stations for analysis ... 47
3.5 Selection of analogue NVE station ... 51
3.5.1 Meta-database format for transition to NVE database ... 52
3.6 Data quality control ... 53
3.6.1 Introduction ... 53
3.6.2 Accuracy of hydrological measurements ... 54
3.6.3 Types and sources of error ... 56
3.6.4 Main areas where quality control should be provided ... 56
3.6.5 Filling of Missed data ... 57
3.6.6 Effects of river ice ... 59
3.6.7 Uncertainty of the Rating Curve ... 59
3.6.8 Basic methods of quality control ... 60
3.6.9 Error correction application ... 62
3.6.10 Quality Control by SWECO AS ... 63
3.6.11 NVE Methods of Quality Control ... 65
3.7 Proposed quality control methods for selected SWECO AS stations ... 71
3.7.1 Introduction ... 71

3.7.2 Methods and findings 71

3.7.3 Recommendation and discussion 76

4. ANALYSIS 77

4.1 Introduction 77

4.2 Methods 78

4.3 Results and discussion 79

5. CONCLUSION AND RECOMMENDATION 100

5.1 Conclusion and recommendations 100

6. REFERENCES 102

7. APPENDICES 104

LIST OF FIGURES

Figure 2-1. Topographical map of Norway (GRID-Arendal, 1988) 24

Figure 2-2. The map of Norway counties. (Wikipedia) 25

Figure 2-3. Location of SWECO AS station. (Sweco, 2014) 26

Figure 2-4. Catchments Area Cumulative Frequency Curve. 27

Figure 2-5. Annual temperature of Norway for the period 1961-1990. (NMI) 28

Figure 2-6. Simplified bedrock map of Norway. (NGU) 29

Figure 2-7. Annual precipitations of Norway for the period 1961-1990.(NMI) 30

Figure 2-8. Forest Cover in Norway (www.enviromenment.no) 31

Figure 3-1. Water Level Logger 16/15 installation scheme. (www.globalw.com/products/wl16.html, 2014) 32

Figure 3-2. Major components of Flow Tracker. (www.sontek.com, 2007) 33

Figure 3-3. Flow Tracker Probe orientation to a river flow. (www.sontek.com, 2007)........... 34

Figure 3-4. The ADCP. (www.rdinstruments.com, 2008).. 34

Figure 3-5. ADCP’s different mount. (www.rdinstruments.com, 2008) 35

Figure 3-6. Description of proper place for Logger installation from the flow regime point. . 37

Figure 3-7. Description of narrow and wide river bed. 38

Figure 3-8. Description of proper riverbed for Logger installation. 38

Figure 3-9. Installation example of Logger. (www.globalw.com/products/wl16.html, 2014) 39

Figure 3-10. Inserting stage-discharge data into VFCURVE3 programm. (Reitan, 2013) 40

Figure 3-11. Appearance of stage-discharge curve and calculated parameters. (Reitan, 2013) 41

Figure 3-12. Rating curve extension (with measurements points), using Stevens method(Killingtveit and Sælthun, 1995) 42

Figure 3-13. “Raw” Logger data to be transferred to HEC-DSSVue. (Sweco, 2014) 43

Figure 3-14. Time series data entry into HEC-DSSVue. 44

Figure 3-15. Frequency duration curve of selected stations area 49

Figure 3-16. Location of selected SWECO AS stations. 50

Figure 3-17. Format of selected station data transferred to NVE database (example). 52

Figure 3-18. Explanation of errors. (WMO, 1994).. 54

Figure 3-19. Explanation of errors in linear regression. (WMO, 1994).................................. 55

Figure 3-20 River ice impact on stage.(Killingtveit and Sælthun, 1995) 59

Figure 3-21. Error screening with differential series (below picture). (Killingtveit and Sælthun, 1995).. 60

Figure 3-22. Accumulated deviation of mean values (increase in runoff last 25 years). (Killingtveit and Sælthun, 1995).. 61

Figure 3-23 Double mass analysis. (Killingtveit and Sælthun, 1995) 61

Figure 3-24. Detection of peaks. 64

Figure 3-25. HYKON Hydrological data control program. (NVE Hydrologisk, 2013)................ 66

Figure 3-26. HYKON Hydrological data control program (continue). (NVE Hydrologisk, 2013) 67

Figure 3-27. HYDAG Hydrological data control program.(NVE Hydrologisk, 2013)................ 68

Figure 3-28. Example of ice impact.(NVE Hydrologisk, 2013).. 69

Figure 3-29. Possible errors in data series. (Rees, 2008) 71

Figure 3-30. Detected stage drop in Bordalselva station... 72

Figure 3-31. Stage-discharge curve. 73

Figure 3-32. Checking goodness of data by duration curve.. 73

Figure 3-33. Detected gap in data... 74

Figure 3-34. Plotting of different analogue stations duration curve versus measured. (Sweco, 2014).. 75

Figure 4-1. Relation of NVE and SWECO mean runoff. 81

Figure 4-2. Relation of Q95 SWECO and NVE Q95 (1961-1990) 81

Figure 4-3. Long term plot of Q95. 82

Figure 4-4. Relation of Q95 and height gradient 83

Figure 4-5. Relation of mean runoff and height gradient 83

Figure 4-6. Relation of Q95 and effective lake percentage. 84

Figure 4-7. Relation of mean runoff and effective lake percentage. 84

Figure 4-8.Relation of Q95 and low vegetation percentage. 85

Figure 4-9. Relation of mean runoff and low vegetation percentage 85

Figure 4-10. Scaling factors of selected stations. 86

Figure 4-11. Height gradient of selected stations. 87

Figure 4-12. Low flow Q95 values for unique, scaled and long term scaled data 88

LIST OF TABLES

Table 2-1 Mean monthly precipitation on millimetres for largest cities of Norway. (NMI) 30

Table 3-1. The information collected for each station 45

Table 3-2. SWECO AS stations selected for analysis 48

Table 3-3. Selected SWEO stations with analogue NVE stations 52

Table 4-1. SWECO stations and corresponding analogue NVE station, scaling factors and ration. 79

Table 4-2. Mean runoff of SWECO and NVE Lavvann (1961-1990) 80

Table 4-3. Duration curves of measured SWECO data, scaled from NVE analogue station (from the same period) and scaled from NVE analogue station (long term) 90

1. INTRODUCTION

Dirty Data – Dumb Modellers! (Klemes, 1997)

1.1 Background

It is widely used saying about hydrological data, says: "Garbage in – garbage out". There is no matter how complicated data processing system is; if responsible staff or technically collection of data is made in not proper way, it means that error is unavoidable. There are a lot of examples when reason of erroneous data was in sufficient attention to staff, or providing not clear instructions. There was case when because of technician fail record data set with length of many-many hours was lost irreversibly.

Design of dams and spillways, irrigation systems, bridges and other hydraulic structures often suffer from a lack of the proper hydrological data. (Herschy, 1998) When the matter is about planning of small hydro, that problem increases, because no measurements have been done for certain catchments.

1.1.1 Importance of hydrological data

It's a well-known fact that hydrological observations are orderly procedure of calculating each process in water cycle. The forecasting of disasters as a flood or drought would be impossible without correct hydrological data. (Terakawa, 2003)

The importance of correct hydrological information cannot be overestimated. That information is used in:

- Assessing a country's water resources (as quality, quality of water and distribution of water in time)
- Assessing potential of water development
- Planning, designing and operating of water projects
- Providing information about water-related hazards as droughts and floods

(WMO, 1994)

1.2 Objective of work

The project will consist of the following topics (though not necessarily be limited to these):

- Identify and prepare an overview of available runoff data series collected by SWECO AS
- Prepare all data records for storage in HEC-DSS
- Collect information about each station and compute topographical and climatic parameters (Use NVE Low-flow application)
- Make a standardized description of each record (station) including all important information like location (GPS), map, photo, catchment characteristics, rating curve (incl. measured points) etc.
- Prepare method(s) for quality control for each record and run the quality control for selected stations
- Prepare flow-duration curves for selected stations and compare the local flow-duration curves to those based on scaling from larger catchments
- Analyze that difference on the basis of Q95 and mean flow values
- Analyze statistical properties of flow-duration curves and see if it can be related to topographic and climatic parameters
- Summary and recommendations
- Reporting and presentation

1.3 Scope of work

The following tasks have been carried out to meet the proposed objectives:

- Reviewing information related to the study area
- Collection, proceeding and storage of detailed data for approximately 100 gauging stations
- Preparation of all data records for storage using HEC-DSS programm
- Close cooperation with NVE and SWECO (interview with them about quality control and data proceeding, equipment proceeding, etc.)
- Literature review on methods of hydrological data quality control and data processing
- Literature review of existing low flow proceeding
- Preparation of meta database for transporting to NVE
- Finding of analogue NVE station, comparison with SWECO station
- Statistical analysis of Q95 and mean flow with topographical and climatic parameters of catchment properties
- Literature review on relationship between flow duration curve and topographical and climatic parameters.

1.4 Limitation of study

- There are no limitations in area of study, because SWECO AS stations are located through whole area of Norway.
- There are some limitations in analysis, because the period of observation of most SWECO AS stations is quite short (from 2-6 years) and it doesn't allow to make long term analysis (base flow index, etc.)
- The measurement data of most stations was not available, because of impossibility to access to SWECO archive for getting that.

1.5 Structure of thesis

The structure of thesis work organized with following chapters order:

Chapter 1: This chapter presents background, objective and scope of thesis and limitations of study.

Chapter 2: This part presents details about study area as climate, geology, precipitation, and overview of location of all SWECO stations.

Chapter 3: This chapter is most expanded one, it presents type of used equipment and data proceeding both by NVE and SWECO. It presents wrap up of selected data for all SWECO stations; it presents quality control by both organisations and proposed quality control by author and recommendations on that.

Chapter 4: This chapter presents statistical and comparable analysis between selected SWECO stations, analogue stations and Lavvann Low flow values.

Chapter 5: This part concludes results from analysis and quality control

Chapter 6: Present used sources of information

Chapter 7: This chapter includes all collected information about selected stations and results.

2. STUDY AREA

2.1 Background

Norway is a constitutional country. Its territory includes the western part of the Scandinavian Peninsula, the Arctic archipelago of Svalbard, and the sub-Antarctic Bouvet Island. The total area of Norway is 385,252 km^2 with population of 5,109,059 people. Norway shares its longest border with Sweden in East, with Finland and Russia to the north-east, and the Skagerrak Strait to the south, and with Denmark on the other side. Norway has mutual border with Russia by Barents Sea, with Greenland, the Faroe Islands, Iceland by Norwegian Sea, with Denmark and with United Kingdom by North Sea. Norway has broad coastline, which is broken by huge number of fjords and thousands islands. Most area of territory is mountainous with a great variety of flora and fauna. Location of Norway lies between latitudes 57° and 81° N, and longitudes 4° and 32° E. (Wikipedia)

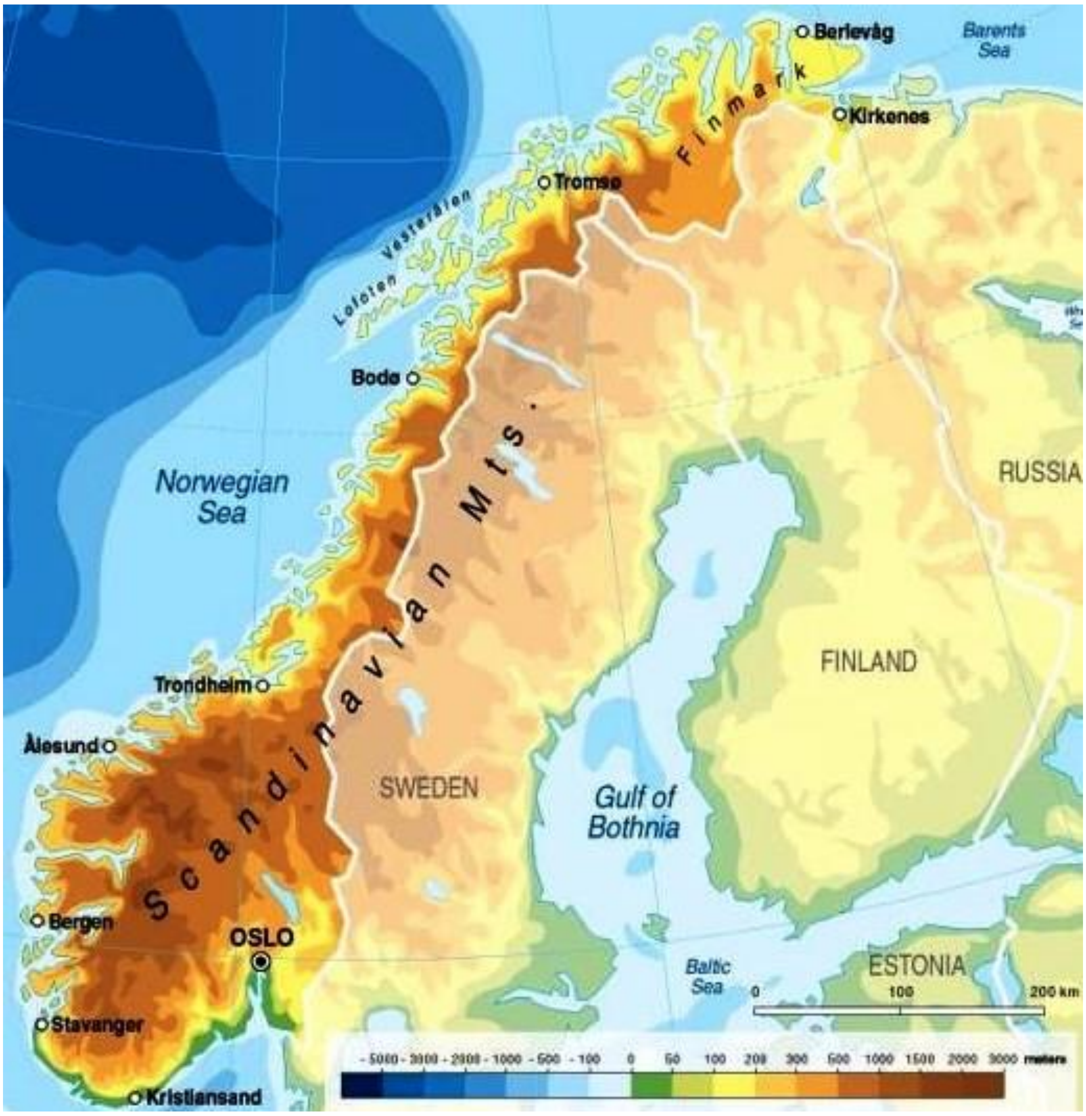


Figure 2-1. Topographical map of Norway (GRID-Arendal, 1988)

2.2 Location and Overview of Available SWECO AS Stations

During planning phase SWECO AS has established almost hundred runoff gauging stations for small hydropower projects obtaining large volume of runoff data for many small rivers. Observed stations number is 87. All that stations has different period of observation (from 1 to 8 years observation), some of them have been already stopped but some of them are in use till now.

Location of SWECO AS stations is scattered evenly through whole Norway, but more densely near to coast line. The most "densely equipped by stations" counties are Nordland, there are 32 stations, Møre og Romsdal - 13 stations, Troms – 5 stations, Hordaland - 11 stations, Sør-Trøndelag – 9 stations, Sogn og Fjordane - 8 stations, Nord-Trøndelag – 7 stations, Rogaland - 2 stations.

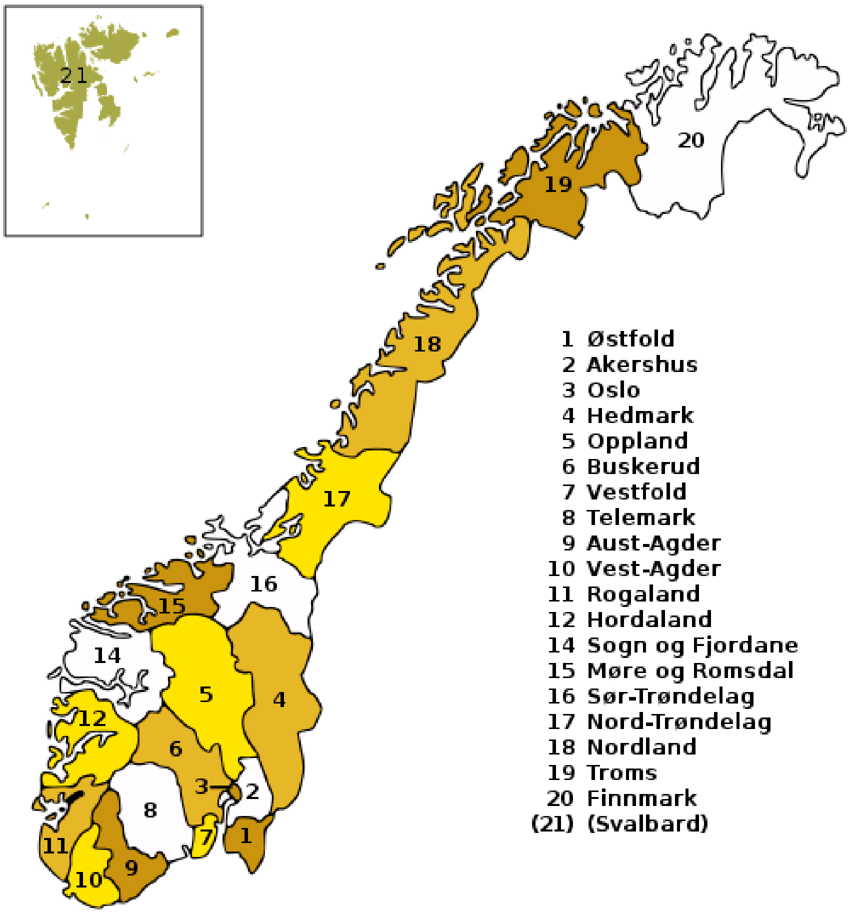


Figure 2-2. The map of Norway counties. (Wikipedia)

WL Logger 16/15 equipment was used for most stations for obtaining runoff values. Detailed information about operation and proceeding of that equipment is described in "Materials and Methods" chapter.

Location of all SWECO AS stations is shown on Figure 2-3.

Figure 2-3. Location of SWECO AS station. (Sweco, 2014)

Catchment sizes where have been established runoff gauging stations varies in a huge range. For example the area of smallest catchment (Norddalselva station) is approximately 0.1 km^2 and the biggest (Krutåga station) catchment area is 173,6 km^2. But the most catchments are relatively small in size. For proving that, cumulative frequency curve of available stations was established.

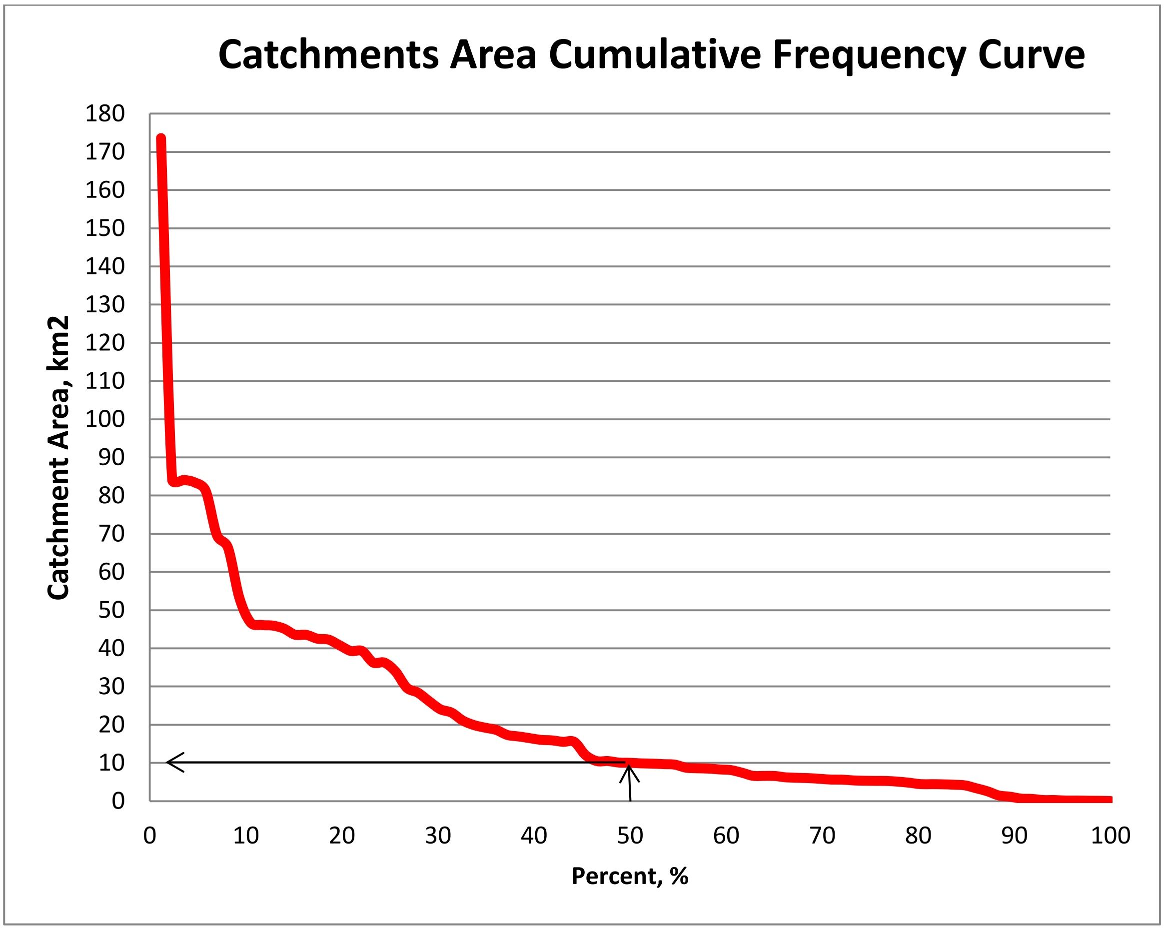


Figure 2-4. Catchments Area Cumulative Frequency Curve.

On the figure shown above it is evident that 50% of observed catchments area hardly achieve to 10km^2, it means that most catchments are small. Small catchments have faster runoff response and more "peaked" hydrographs, compared to larger catchments. That study would be very valuable for planning small hydropower plants, because planning small hydropower on the basis of scaling from large catchments will lead to erroneous data.

2.3 Climate

Climate of Norway has a great variation. It covers 13 degrees of latitude and has huge variation in amount of received solar energy per annum, e.g. there is midnight sun in summer and absolutely no sunshine during winter.

During winter season average temperature alters a lot. For example from Vest-Agder to Nordland mean temperature during winter could be above freezing point. From the other hand inland areas obtain very low temperatures. The coldest area in Norway is Finnmark Plateau, mean monthly temperature decreases up to 15°C! The most lowest temperature, which have been registered on 1st January in 1886 on Finnmark Plateau at Karasjon was -51,4°C!

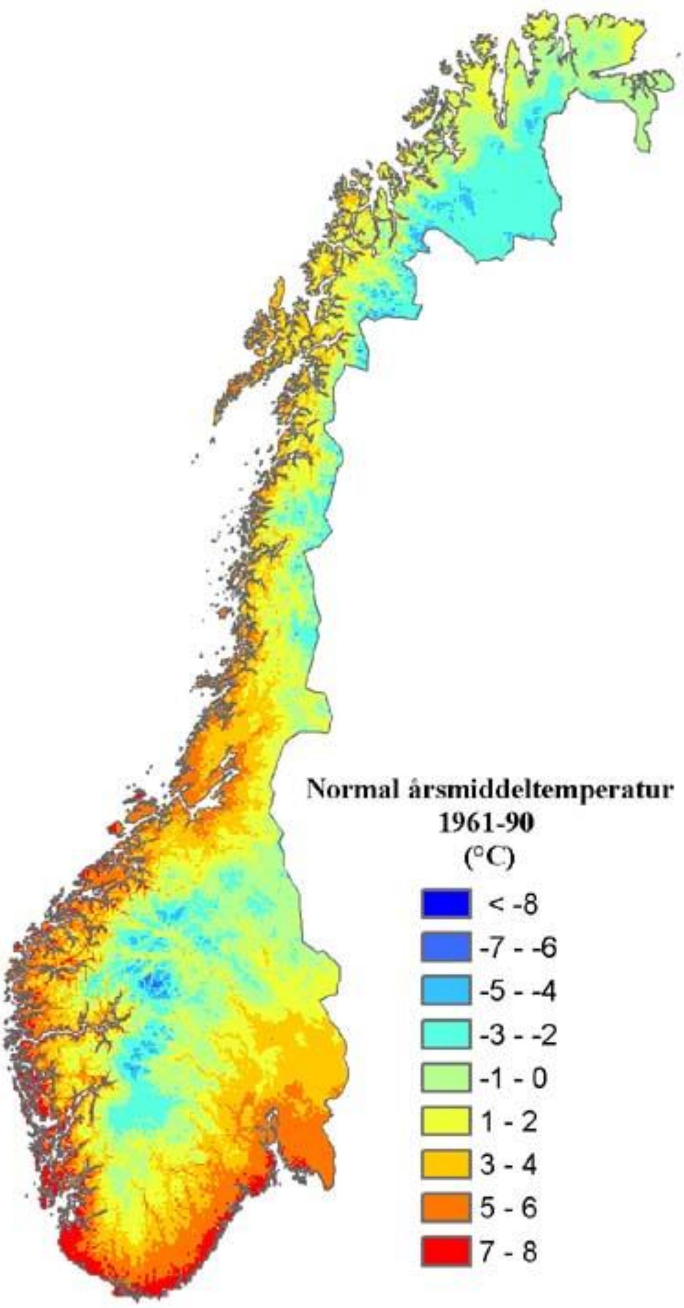


Figure 2-5. Annual temperature of Norway for the period 1961-1990. (NMI)

During summer the warmest regions in Norway are the southern part of Østlandet and the coastal areas of Sørlandet. The highest ever recorded temperature is 35,6 °C, it was observed on June 20-th on 1970 in Nesbyen (Buskerud). Since there are midnight sun during summer months Northern Norway can observe temperatures above 30 °C. Because of very low temperatures during winter and very high temperatures during summer, some regions of Norway could observe very high temperature difference. The biggest difference ever observed is incredible - 83,8 °C! (NMI)

2.4 Geology

From geological point of view Norway is a typical hard rock country, part of "Baltic Precambrian Shield". Approximately 2/3 of the bedrock is Precambrian and next 1/3 is Caledonian (Paleozoic).

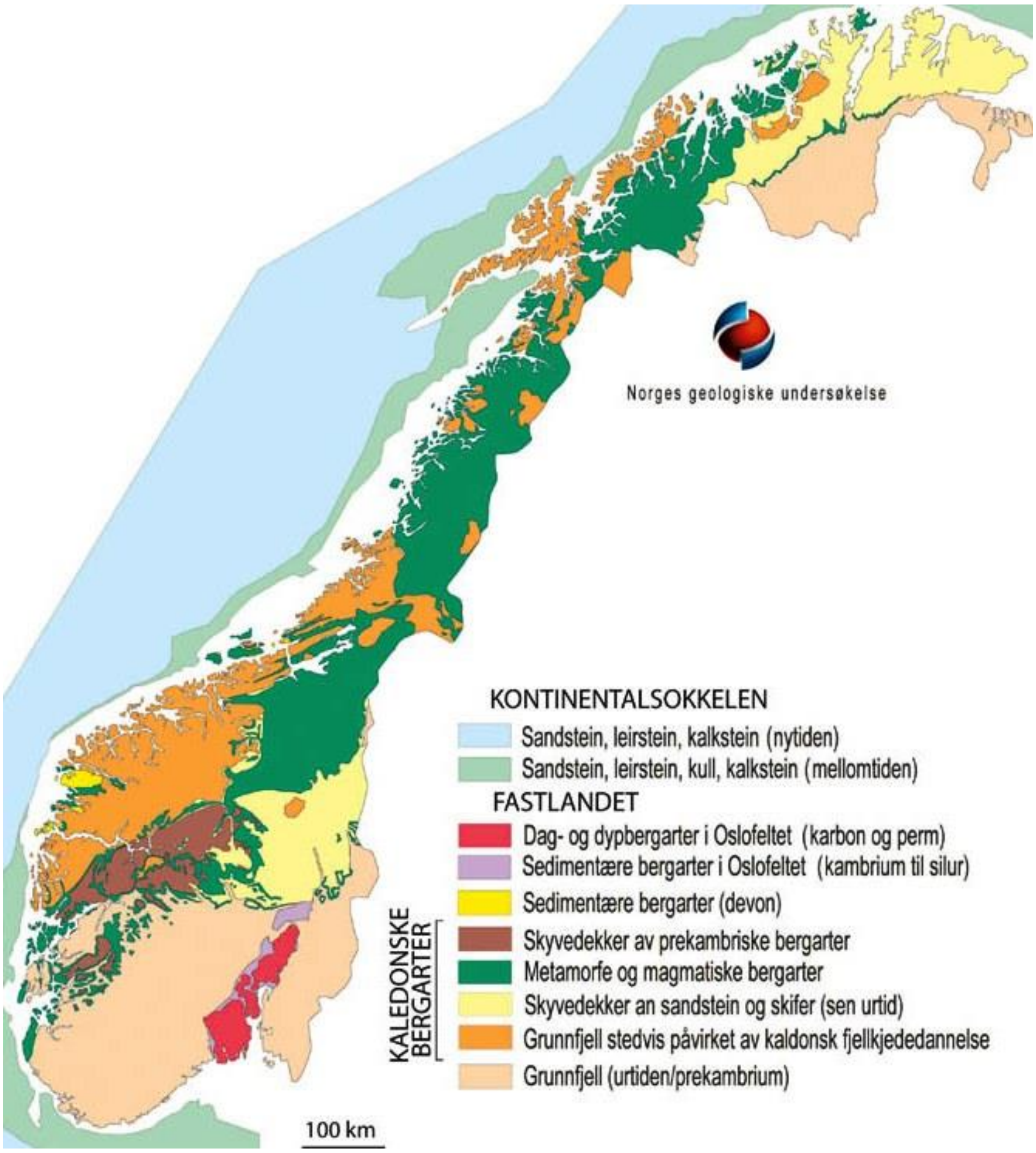


Figure 2-6. Simplified bedrock map of Norway. (NGU)

The most part of land consists from granite and gneiss rock. Although on the low elevation there is widely spread mica schist, phyllite, marble and greenstone. The most of rocks have a good quality (from an international engineering point of view), but from the other hand difficult rock conditions also present in Norway. Example of those difficult conditions could be faults and weakness zones, water inflow, unfavorable rock stresses, etc. The shown figure illustrates simplified bedrock map of Norway. (B.Nilsen and A.Thidenlann, 1993).

2.5 Precipitation

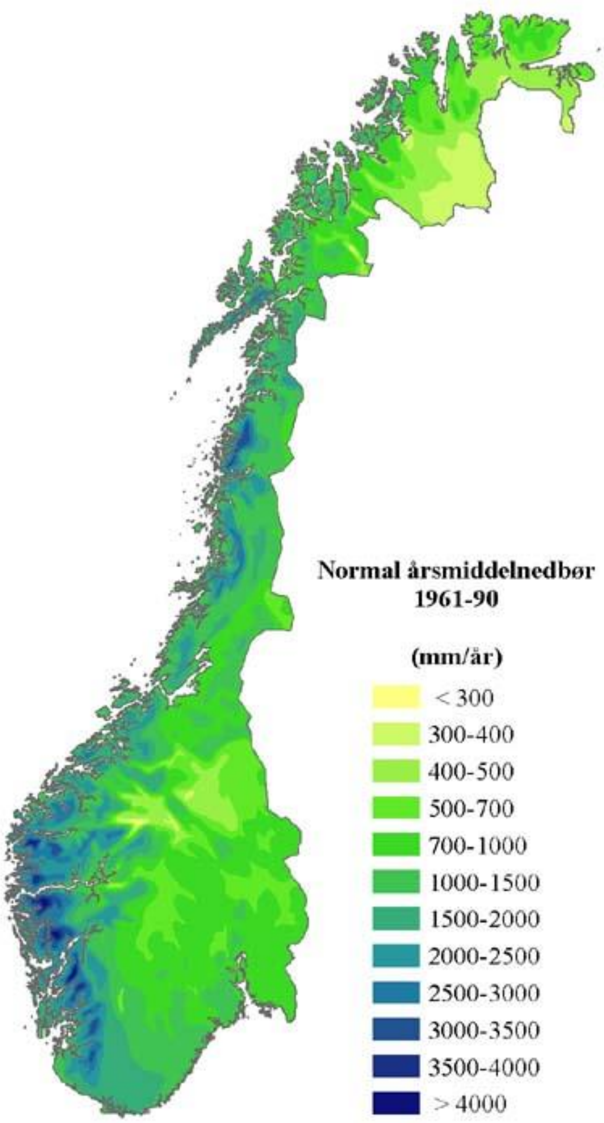


Figure 2-7. Annual precipitations of Norway for the period 1961-1990.(NMI)

There are three types of precipitation in Norway: frontal precipitation, orographic precipitation and showery precipitation. The better part of precipitations is frontal precipitation. It happens because of mixing between warm and humid air in south and cold and dry air in north. Orographic and showery precipitations happen because of rising of humid air with afterward cooling. The result of that cooling is abundant precipitation as rain or snow. Showery precipitation happens because of unstable vertical air flow. In most cases it occurs during summer months, when heating processes are very intense.

The richest place from the amount of observed precipitation is western coast of Norway. During autumn and winter months western coast register highest precipitation among whole country, but during summer the most wettest places are in eastern Norway. The Table shows mean monthly precipitation in millimetres for biggest cities of Norway.(NMI)

	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dec
Oslo	49	36	47	41	53	65	81	89	90	84	73	55
Bergen	190	152	170	114	106	132	148	190	283	271	259	235
Trondheim	63	52	54	49	53	68	84	87	113	104	71	84
Bodø	86	64	68	52	46	54	92	88	123	147	100	100
Tromsø	95	87	72	64	48	59	77	82	102	131	108	106

Table 2-1 Mean monthly precipitation on millimetres for largest cities of Norway. (NMI)

2.6 Land Use

Because of strong climatic condition land use aspects are not developed well in Norway. Approximately 3,3% of land is used as arable land, but some marginal areas are not in use or used as pastures. There are no land for permanent crops and permanent pastures.

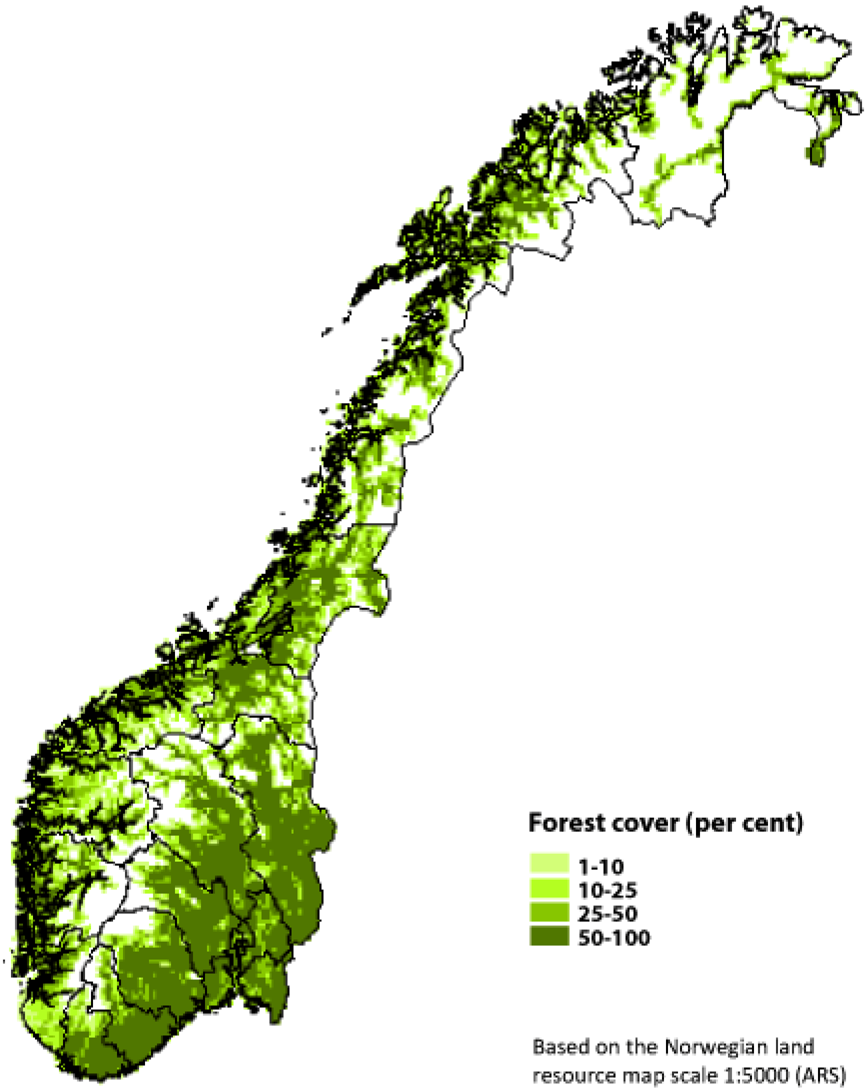


Figure 2-8. Forest Cover in Norway (www.enviromenment.no)

Approximately 38% of land area is covered by forest, 21% covered with conifer forest and 17% is covered with deciduous forest.

The remain 59% consists from mountains and heaths (46%), bogs and wetlands (about 6,3%), lakes and rivers (5,3%), urban areas (1,1%) (Wikipedia)

The introduction of above mentioned information about climate, geology and precipitation provides necessary information about variance of climatical and topographical factors in study area.

3. MATERIALS AND METHODS

3.1 Type of used equipment and methods

3.1.1 Water Level Logger 16/15

As mentioned above all runoff data was collected using Water Level Logger 16/15. The WL16, Water Level Logger, is a datalogger and submersible pressure transducer equipment. It has been used for remote monitoring and recording of water level or pressure data. Memory of the equipment is quite large; it can record over 81,000 readings. Water level variations available in 3 inch to 500 inch range. There are two alkaline batteries, which ensures properly work of each Logger for approximately one year, even if one of batteries will fail. There is also third battery, it will ensure that data is in secure.

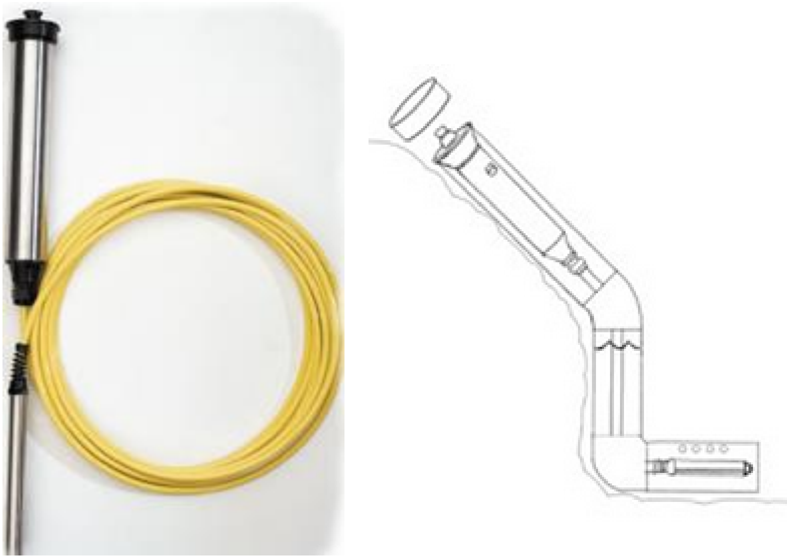


Figure 3-1. Water Level Logger 16/15 installation scheme. (www.globalw.com/products/wl16.html, 2014)

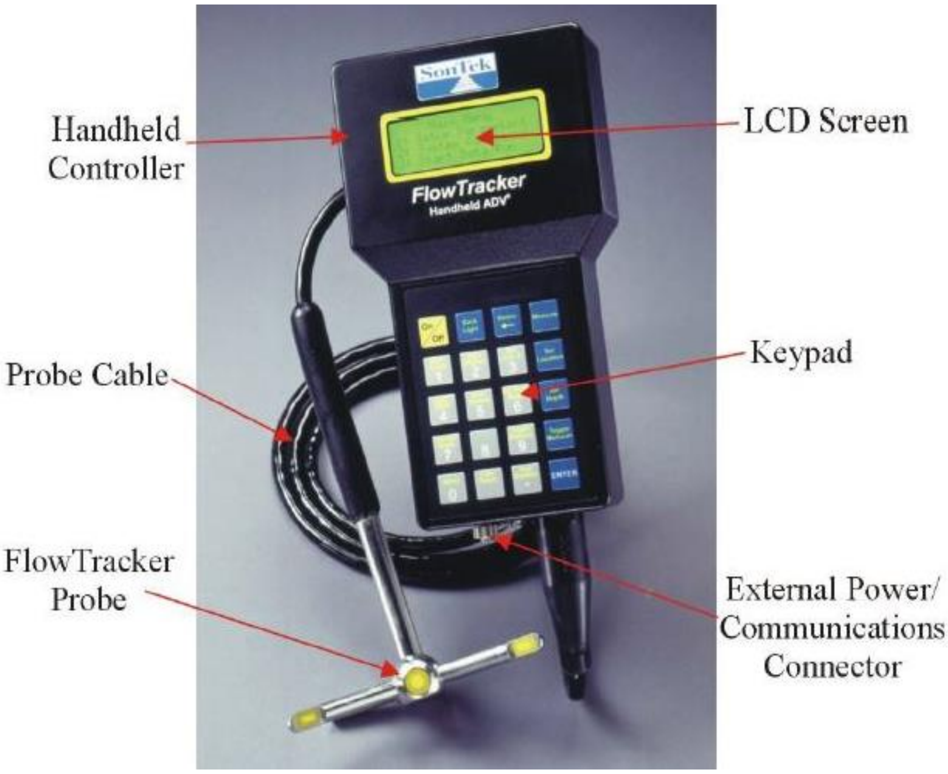
For easy upload of data all water Loggers has Windows and PDA software.

Logger is waterproof - it means that moisture will not leak into electronic parts and will not lead sensor failure. The most favourable advantages of water level Loggers is that: sensor does not need to be moved for downloading data and changing batteries.

The water Logger should be installed below the lowest expected water level. It is recommended to install the Logger into protective 2-inch PVC pipe (as shown on the Figure 3-1). The pipe should be buried or covered with rocks in order to be protected from vandalism. It is also advisable to fasten PVC pipe with staples into the river bank. Some small holes should be drilled into the PVC pipe (near the sensor) in order to reduce water velocity effects on sensor and ensure air supply. (www.globalw.com/products/wl16.html, 2014)

3.1.2 Flow Tracker

The Flow Tracker is equipment which is used for river discharge measurements, open channel flow measurements, measurements in large pipes, temperature, etc. Flow Tracker is handy in use, it is operated with simple keypad. While making river discharge measurement you should enter few parameters as location, water depth; those parameters are used with flow velocity data to compute current discharge in the river. It is possible to download data to a PC for further proceeding and archiving of data.



. **Figure 3-2. Major components of Flow Tracker. (www.sontek.com, 2007)**

The Flow Tracker has following appearance as shown on Figure 3-2 and consists from:

- Probe – The probe contains sensor (based on acoustic response), which measures velocity.
- Probe cable – The probe is mounted to a 200-cm flexible cable. The probe cable is impermeable and very sensible to noise.
- Handheld controller – The handheld controller is the main software, it has LCD screen, keypad, batteries. Handled controller is not water impermeable.
- Keypad – The Flow Tracker keypad with parameter buttons
- LCD screen – The LCD screen shows recorded data and further steps for correct exploitation.
- External power/communication connector – This waterproof cable is used for downloading collected data to a PC.

The correct orientation of Flow Tracker for discharge measurements is shown in Figure 3-3.

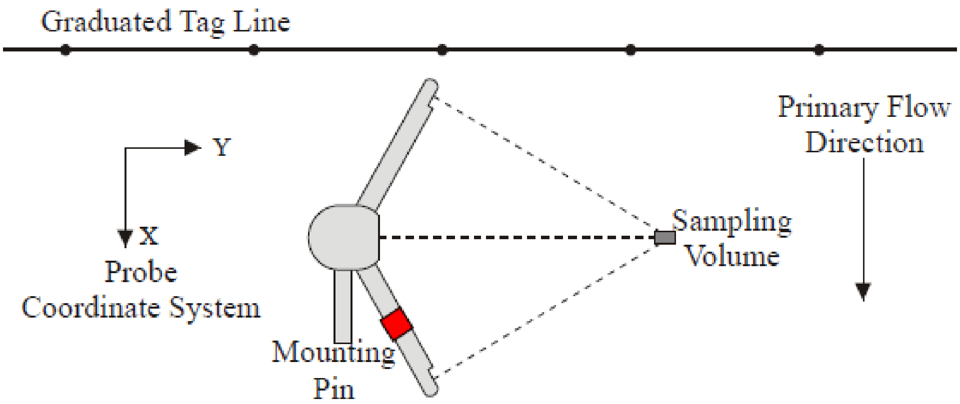


Figure 3-3. Flow Tracker Probe orientation to a river flow. (www.sontek.com, 2007)

The most important principle is that the tag line should be tied strictly perpendicular to the river flow and Flow tracker X-axis should be strictly perpendicular to the tag line. The red stripe of the Flow Tracker probe should be directed to river downstream. The Flow Tracker XYZ coordinate system is illustrated in Figure 3-3.

To make flow measurements with Flow Tracker it is necessary to divide entire river flow into sections. The width of each subsection should be less than 10% of total river flow.

It is necessary to do velocity records on each subsection with record of river depth in particular subsection. At last subsection Flow Tracker will calculate total discharge automatically.(www.sontek.com, 2007)

3.1.3 Moving Boat. Acoustic Doppler Current Profiler (ADCP)

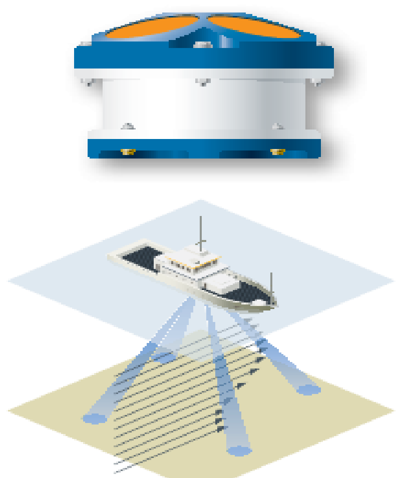


Figure 3-4. The ADCP. (www.rdinstruments.com, 2008)

The moving boat technique is a one of the method to make discharge measurements in large rivers. An Acoustic Doppler Current Profiler (ADCP) is a type of sonar that measures water current velocities over a range of depths.

The ADCP is widely used in irrigation monitoring, flood warning, environmental impact studies, oceanography, estuary, river, and stream flow current measurements.

A current meter with a vane is attached to the boat with a rod, it measures the velocity one meter below the surface. The ADCP send sound signals to the river bed through water body. Micro particles reflect that sound back to the ADCP, which is received by the sensor on the bottom of the equipment. Signals which are received later (incoming from deeper parts of river) recorded as deeper parts. ADCP combines that signals to a vertical profile of recorded velocities. Usually several crossings are done in order to reduce the uncertainty. The standard error is considered to be around 1 percent. The main disadvantages of this method is following limitations as river size, uneven velocity profile, huge sediment load, and expensive price (approximately 50 000 USD). (Killingtveit and Sælthun, 1995)

As seen from Figure 3-4, ADCP send signals to four directions at the same time. Knowing depths and velocities it is possible to calculate the discharge.

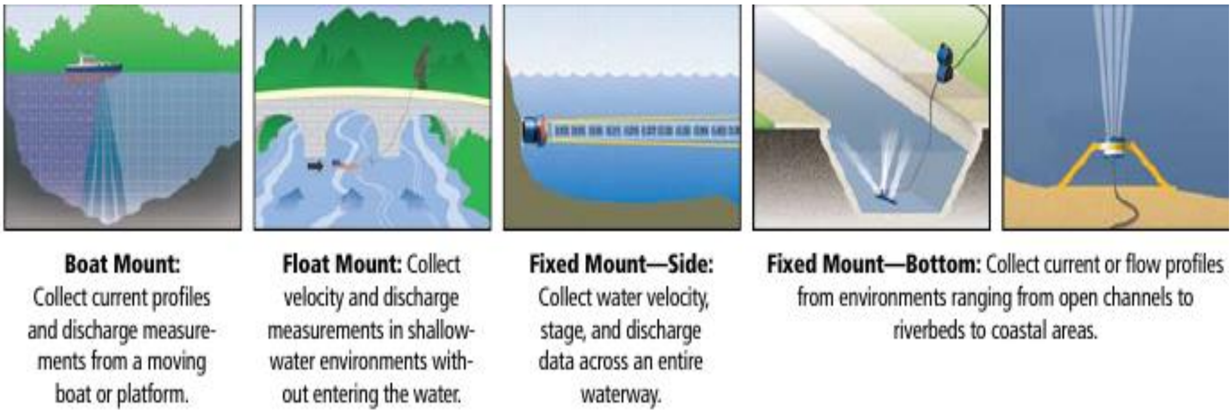


Figure 3-5. ADCP's different mount. (www.rdinstruments.com, 2008)

The ADCP is widely used for discharge measurements in rivers, open channels for industrial or ecological purposes (Figure 3-5). Measurements provided by ADCP are highly accurate and real-time. ADCP data is adopted into a flood warning system, to develop circulation patterns in lakes or reservoirs. (www.rdinstruments.com, 2008)

3.1.4 Salt detection

Salt dilution method is an alternative method for calculating discharge with using of artificial tracer as common salt. This method is widely used for measuring discharge in rapidly flowing water. The biggest advantage of salt dilution method is that there is no need for wading of the river, which sometimes could be very unsafe, particularly when river is very steep or have extremely high flow. Basis for discharge calculation via salt dilution method is mass balance principle.

Regular table salt (NaCl) is used because of 3 reasons:

- Table salt is cheap, almost always available
- Can be measured by electrical conductivity method
- Salt is not toxic agent (if proper concentrated)

There are two employed techniques: constant injection and bulk injection.

In case of constant injection, if the amount of tracer in river is known and concentration can be measured, using shown formula discharge can be estimated.

c = i / (q+i),

q - discharge

i - injection rate

c - measured concentration

Solving for q, we will come to:

q = I (1/c-1),

The bulk injection technique is based on injecting certain amount of tracer into the river flow.

$$\int_0^T i(t)\,dt = I$$

I-volume of tracer,

T-time when all tracers will reach to the measurement point,

i(t)- time varying at measurement point

Besides, regular table salt, there are other types of tracers also, like fluorescent tracers (rhodamine, which is difficult to use in turbid water) or radioactive tracers (has limit in their use). (Killingtveit and Sælthun, 1995).

3.2 Data collection and processing

3.2.1 Finding place for data Logger (by SWECO AS)

First of all it is very important to find a good place for installing Logger. There are some "rules of thumb" that SWECO used to follow.

1. **Flow condition.**

Sites were flow changes from subcritical to supercritical flow are acceptable. It is advisable to install the Logger in places where uniform flow is obtained. We should exclude any backflow water and huge waves, which would harm to Logger and lead to erroneous data. The examples of uniform and non-uniform flows are described in Figure 3-6. (Vaskinn, 2014)

Figure 3-6. Description of proper place for Logger installation from the flow regime point.

2. **Shape of river bed**

It is important to choose narrow river bed for installation of the Logger. Narrow river cross section with high banks will make visible even small changes in water level. Narrow section provides better discharge resolution. The example of narrow and wide river bed is shown in Figure 3-7. It is desirable that riverbed will have proper geometrical form with high banks, that will not let water to spill away from river bed. (Vaskinn, 2014)

Figure 3-7. Description of narrow and wide river bed.

3. **River bed material**

Hence the Logger is going to be exploited for many years the base where the Logger should be installed need to be very hard and durable. It is desirable if river bed consists of sound bed rock, without cracks and fails as shown in Figure 3-8; although it doesn't happened all the time in nature. (Vaskinn, 2014)

Figure 3-8. Description of proper riverbed for Logger installation.

4. **Ice "fingertips"**

The place where the equipment should be fixed must be studied carefully on subject of ice "fingertips". In case if ice "paths" remains on the river banks, it means that in certain river bank present ice-jam problem, which will destroy data logger or will be a reason of wrong data as e.g. extremely high stages during winter months.

It is prudent to find places with good accessibility for maintenance, hence each station should be visited at least twice a year. (Vaskinn, 2014)

3.2.2 Data collection with Logger (by SWECO AS)

SWECO AS used to install WL Logger in 2 inches diameter PVC pipe to protect the sensor and the datalogger. The pipe could be buried in the soil, covered with rocks or fastened with large staples as shown in Figure 3-9. Sometimes logger should be hidden very well to prevent vandalism cases.

Figure 3-9. Installation example of Logger. (www.globalw.com/products/wl16.html, 2014)

Then, when SWECO AS staff found a place and installed Logger, first stage-discharge measurement should be made either by Flow Tracker or by other discharge measuring equipment. Despite the fact that Logger battery is enough for 2 years observation, SWECO AS staff use to visit Logger twice a year for observation of condition and status of the Logger. While visiting, SWECO AS staff downloads collected stage and temperature data from Logger into portable computer and stores it into SWECO AS data archive for further proceeding. Each time when working team visiting Logger they are doing stage-discharge measurement. To proceed a good stage-discharge curve for preliminary application they need at least 5 values of stage with corresponding discharge. After having run Logger for a long time they obtain enough measurements to create stage-discharge curve. SWECO AS uses VFKURVE3 program for constructing that curve.

Stages which are above or below observed measurements can be easily extrapolated using VFKURVE3. Construction of stage-discharge curve is described in following chapter.(Vaskinn, 2014)

3.2.3 Stage discharge curve constructing with VFKURVE3 program

SWECO AS used to handle to stage-discharge curve as one segment curve, it means that obtained parameters are the same for entire curve.

VFKURVE3 program locates in a program group in a special NVE application. In order to make extrapolation of stage-discharge curve via VFCURVE3 program it is necessary to establish parameters using formula:

$$Q=C_1(h-h_{01})^{b1},$$

where:

C_1 – constant;

h – actual stage;

h_{01} – the level for zero;

b1 – exponent (constant)

After choosing VFCURVE3 among other programs in application new window will appear, measured stage with corresponding discharge should be recorded in window as showed below in Figure 3-10. The coloured points are recorded measurements.

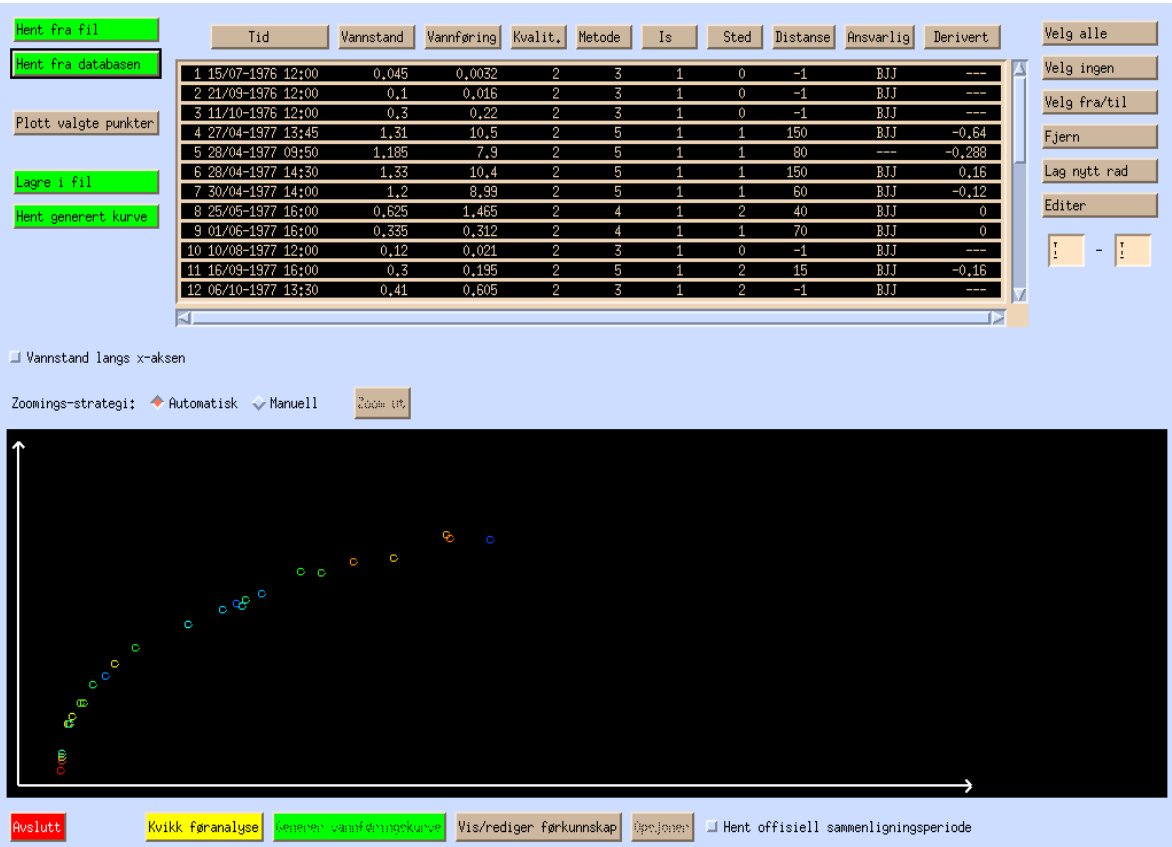


Figure 3-10. Inserting stage-discharge data into VFCURVE3 programm. (Reitan, 2013)

It is possible to pick up water flow measurements from database also. When data is chosen/entered, colour plot appears on the window as shown in Figure 3-10. It is possible to sort by different characteristics by pressing the buttons at the top of the table. After pressing "Analyze" button program runs simulation for certain measurements and creates stage-discharge curve. As seen from the Figure 3-11, program creates several curves: estimated mean curve, more probable curve, upper and lower probability curve for 95%, deviations, number of segments. Parameters of obtained formula are shown below in Figure 3-11. Here probability of wrong measurements should be close to 4 %.

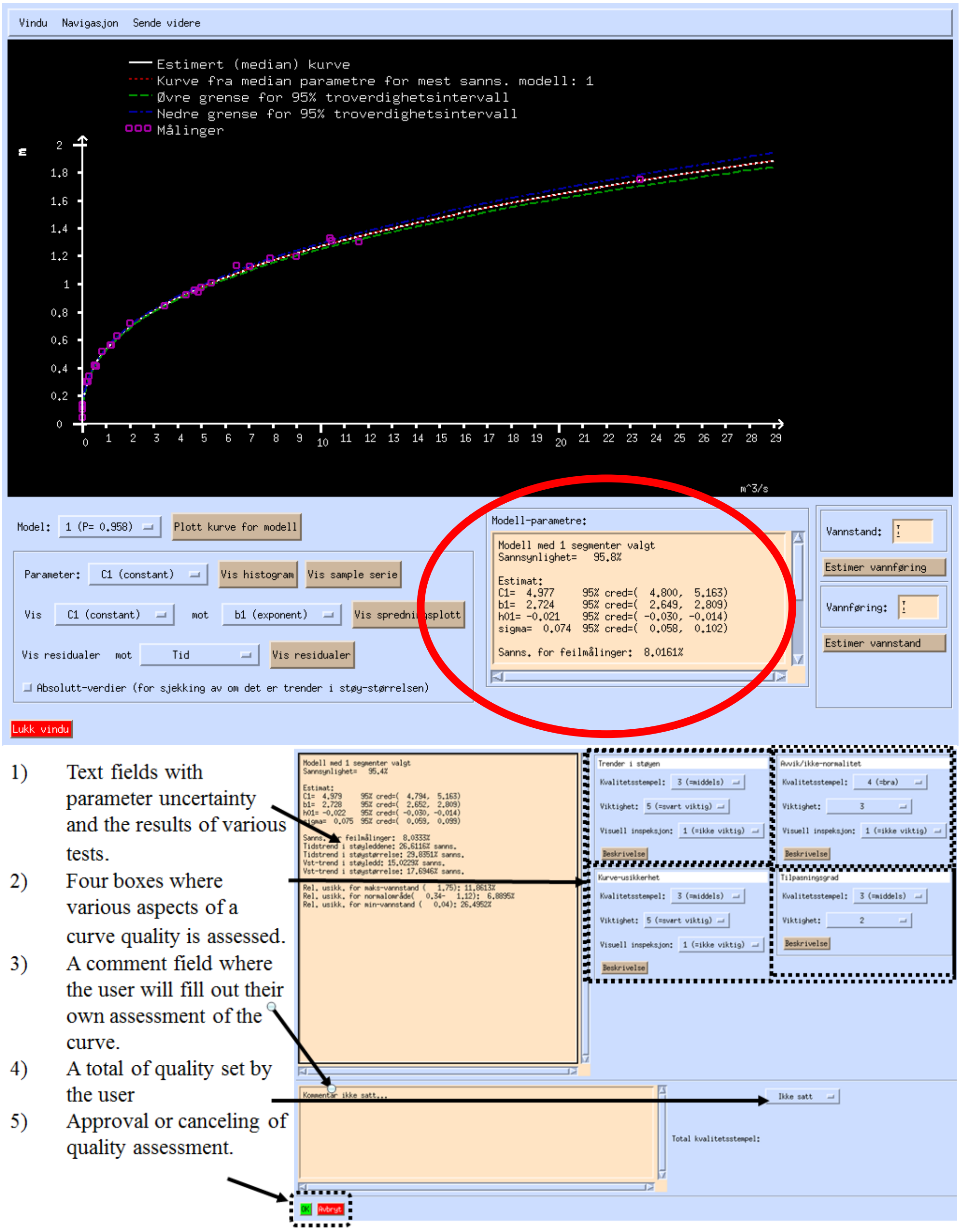


Figure 3-11. Appearance of stage-discharge curve and calculated parameters. (Reitan, 2013)

By taking the mouse over the plot area, it is possible to zoom in and examine whether the curve follows the measurements. After making this simulation it is necessary to do quality control by pressing 'quality assessment' button. Appeared window shows text fields with parameter uncertainty and the results of various tests. After obtaining this parameters and running quality control, stage-discharge curve can be easily extrapolated for measured discharges. (Reitan, 2013) Extrapolated discharges are stored in SWECO AS archive for further analysis.

3.2.4 Extrapolation of Stage-Discharge curve

It is not possible to make calibration for rating curve for its lowest or highest point, the only way is to extrapolate curve toward needed range. It is possible to make extrapolation at lower part of curve, if stage of zero discharge is estimated. Extrapolation toward highest values is possible, but will have some error.

There are some methods for rating curve extrapolation; they are based on description of channel geometry. Stevens method states that the mean velocity is easier to be extrapolate, than the discharge. The discharge will be:

$$q=A*V,$$

here A is known, and V is extrapolated

This method is based on the Manning or Chezy formulas, which says: (q) has linear relationship with $A*R^{2/3}$,

$q/(A*R)^{2/3}=MS^{1/2}$

q – discharge;

A – area;

R – hydraulic radius;

M and S are not dependent on stage. Stevens method is shown on Figure 3-12 (Killingtveit and Sælthun, 1995):

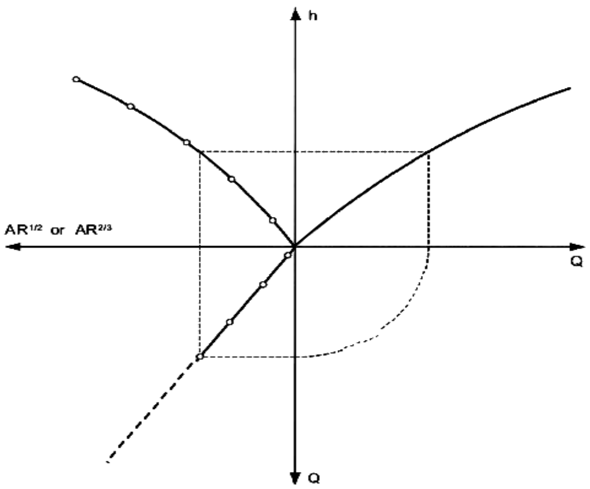


Figure 3-12. Rating curve extension (with measurements points), using Stevens method(Killingtveit and Sælthun, 1995)

3.2.5 Storing and proceeding data in HEC-DSSVue

After extrapolating discharges it is necessary to store obtained data in HEC-DSS format.

The HEC-DSSVUE (Visual Utility Engine) has been developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center and designed for efficiently store and extract scientific data. The data includes, but is not limited to time series data, textual data, etc.

Using HEC-DSSVue it is possible to make different plots, tabulations, change data files, etc.

Produced plots can be stored in different formats, as "jpeg", "png", etc. It is possible to enter other DSS files, rename, edit, delete or copy to other DSS files. HEC-DSSVue suggests over 50 mathematical functions to work on data. (HEC, 1995)

Figure 3-13 describes "raw data" downloaded from Logger (as Excel file) which to be transferred to PC and further to be stored in HEC-DSSVue format. As shown from below figure the unique number of Logger with station name is visible. On this example water level measurements have been recorded each 20 minutes. It is possible to extract hourly, daily or monthly date, even if primary date has 20 minute resolution.

Logger 34327	Femtevasselva					
Date	Time	Level (m)		Date	Time	Level (m)
31.12.2005	17:34	0,71		10.02.2006	10:54	0,83
31.12.2006	17:54	0,71		10.02.2006	11:14	0,83
31.12.2007	18:14	0,71		10.02.2006	11:34	0,83
31.12.2008	18:34	0,71		10.02.2006	11:54	0,83
31.12.2009	18:54	0,71		10.02.2006	12:14	0,83
31.12.2010	19:14	0,71		10.02.2006	12:34	0,83
31.12.2011	19:34	0,71		10.02.2006	12:54	0,83
31.12.2012	19:54	0,71		10.02.2006	13:14	0,83
31.12.2013	20:14	0,71		10.02.2006	13:34	0,83
31.12.2014	20:34	0,71		10.02.2006	13:54	0,82

Figure 3-13. "Raw" Logger data to be transferred to HEC-DSSVue. (Sweco, 2014)

Data in HEC-DSS is stored in blocks and each record should have its own unrepeatable "pathname". To create "pathname" window, press "Data Entry" and then "Manual Time Series". When new window (Figure 3-14.) will appear, empty fields should be filled in following way.

SWECO AS used to store data in HEC-DCCVue format in following way. It creates unique "pathname" for each station. This "pathname" consists from six parts:

A - name of county (fylke),

B - community (commune),

C - river (elva),

D - type of measurement (stage, discharge, temperature),

E- time resolution (e.g. 1 hour, 1 day, etc.),

F – comments, units – measurement units (e.g. m, m^3/s).

Keeping that convention makes data easy to work and operate.

For example, if we have following "pathname" in SWECO AS archive : /NORDLAND,HAMAROY/FEMTEVASSELVA/TEMPERATURE/08Jun2007-16Aug2012/1 HOUR// means that station located in Nordland county, Hamaroy community, river Femtevasselva, contains temperature measurements, which made from June 8-th, 2007 till August 16-th, 2012 with 1 hour resolution.

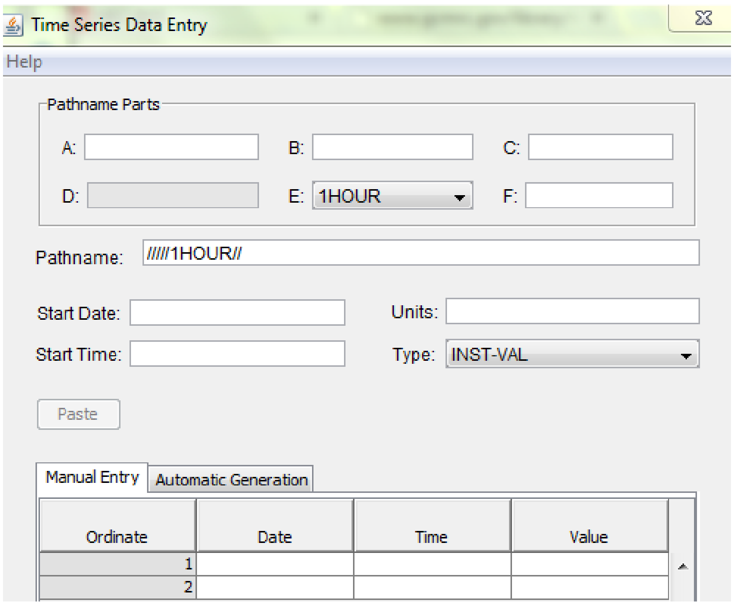


Figure 3-14. Time series data entry into HEC-DSSVue.

When each of mentioned "pathnames" are registered it is possible to copy measured data directly from Excel file.

Both stages, discharges, temperature should be recorded in HEC-DSSVue files in a proper format. At the end we will have window, where shown all measurements with pathnames, observation time, resolution time and comments. Using buttons on the upper part of control panel it is possible to create different plots, or see data in tabular appearance, or see data in Excel format. There is also available "Math Function" which can operate data with 50 mathematical functions. That includes a bunch of logarithmical functions, dividing, and trigonometry. "Time Conversion " function provides changing data interval, shifting, etc.

It is obvious that before transferring data to the consumer it is necessary to provide data quality control. The procedure of SWECO's quality control of collected data and their regulations regarding that will be present in chapter "Quality control by SWECO".

3.3 Data selected for all SWECO AS stations

For obtaining following information Lavvann Low Flow Application has been used via NVE webpage http://gis.nve.no/ge/Viewer.aspx?Site=Lavvann#. That is Geographical Information System online Tool (GIS). That calculates statistical characteristics based on catchment parameters and the official runoff map for normal period (1961-1990).

On the basis of the Logger location coordinates catchment outlet was chosen. Afterwile, catchment boundaries have been established on the basis of Lavvann map using "Generer Nedbørfelt" option. For generating catchment parameters "Genererer Feltparamentre" function should be pressed. It is possible to store information about each catchment parameters in specification in "pdf" format and "shape" file. "Shape" file is a folder which is downloaded from Lavvann, it contains a lump of specific files. That can be used in more advanced application of created catchment and their parameters, e.g. in GIS programm.

It is necessary to mention that catchment characteristics have been calculated for normal period (1961-1990yy.)

Besides, map of station location with coordinates, shape file and lavvanskart have been created. For better convenience all above mentioned information is placed in CD disc, which is attached to the Thesis. Enlarged topographic and climatic parameters of all SWECO stations are located in Appendix F.

There is Table 3-1, which shows information collected for each station:

Table 3-1. The information collected for each station

Original Name	Comment
Stasjonsnavn	Name of station
Koordinat UTM	Coordinates in UTM system
Y Coordinate geografical North	X Coordinates
X Coordinate geografical East	Y Coordinates
Middelavrenning 61-90, l/s/km2	Average runoff (for normal period, 1961-1990yy.) l/s/km2
Middelavrenning målt, m3/s	Measured average flow, m3/s
Middelavrenning justert	Measured average flow adjusted
OBJECTID	ID of object
ID	ID
VASSDRAGNR	Water way number
KLIMAREG	Climate region
REGION	Region
AREAL_KM2	Area, km2
AVRENNING	Drainage
HEIGHT_MIN	Minimum height

HEIGHT_10	Height 10%
HEIGHT_20	Height 20%
HEIGHT_30	Height 30%
HEIGHT_40	Height 40%
HEIGHT_50	Height 50%
HEIGHT_60	Height 60%
HEIGHT_70	Height 70%
HEIGHT_80	Height 80%
HEIGHT_90	Height 90%
HEIGHT_MAX	Maximum height
SJOPRO	Lake percentage, %
BREPRO	Glacier peentage, %
MYRPRO	Low vegetation percentage, %
SKOGPRO	Forest percentage, %
URBANPRO	Urban area percentage, %
EFFSJOPRO	Effective lake percentage, %
TAMSOMMER	Average summer temperature
TAMVINTER	Average winter temperature
CLF	Critical Low Flow
Q95	Q95 (the flow exceeded 95% of the time)
Q95WINTER	Q95 at winter
Q95SUMMER	Q95 at summer
BFI	Base Flow Index
GUID	Pathfile
ELVENAVN	Name of river
KOMMNR	Number of community
KOMMNAVN	Name of community
FYLKENAVN	Name of county
SHAPE_AREA (m2)	Area of catchment, m2
SHAPE_LEN (m2)	Length of catchment, m2

3.4 Selection of SWECO AS stations for analysis

When detailed information about each station has been collected, the selection of proper station has been done for providing suggested quality control and statistical analysis.

Selection of SWECO AS station for further statistical analysis was made on the basis of following rules and recommendations:

- Selected stations should not have missed data, or strange peaks.

Here is useful to mention that all SWECO AS stations have been passed through quality control by SWECO AS staff before the Thesis work is started. That is why there is no any station with missed or incontinuous data. The procedure about SWECO AS quality control on water flow measurements is described in chapter "Quality control by SWECO AS".

- Stations with observation time more than 3 years.

It was decided to use stations with observation time more than 3 years after screening of all available SWECO stations. Most of stations have observation time from 2 to7 years. The longest observation period between selected stations is 7 years.

- Stations which have available stage and discharge data.

Unfortunately the most part of discharge data was not available. Due to this criterion very many stations were refused in further analysis and quality control.

Basing on all above mentioned criteria 24 stations have been chosen. The most part of selected stations is located in Nordland county – 12 stations, in Hordaland county – 6 stations, in Møre og Romsdal county – 4 stations, in Sogn og Fjordane county – 2 stations.

For all selected SWECO stations following information have been collected and located in Appendix chapter:

- NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations
- Map of selected SWECO AS station terrain with coordinates
- Duration Curves for selected SWECO AS stations
- Stage-discharge curve for selected SWECO stations
- Hypsographic Curve for selected SWECO stations

Table 3-2 shows selected SWECO AS station for further analysis.

Table 3-2. SWECO AS stations selected for analysis

No	Stasjonsnavn	Koordinat UTM	FYLKENAVN	SHAPE_ AREA (m2)	SHAPE_ LENGTH (m)
1	Aurstadelva	32 V 357949 6887457	Møre og Romsdal	5258806,7	11037,9
2	Berge	33 V 61951 6833462	Sogn og Fjordane	12055998,6	15164,6
3	Bjåstad	32 V 380548 6806983	Sogn og Fjordane	8740879,0	14490,6
4	Breidalselva	33 V 460916 7426464	Nordland	4796368,7	15064,6
5	Breivikelva	33 V 468712 7431213	Nordland	5631389,8	11746,3
6	Forsland	33 V 415298 7326234	Nordland	36259143,4	35228,9
7	Heståga	33 V 488225 7422073	Nordland	5281608,5	14158,2
8	Kasseelva	32 V 323528 6878261	Møre og Romsdal	6584427,8	14762,7
9	Kjellingelva	33 V 471175 7438758	Nordland	2553036,5	13438,2
10	Krutåga	33 V 468727 7285912	Nordland	173632232,5	77411,7
11	Laupen	33 V 426249 7349646	Nordland	9803168,1	15522,3
12	Lille Gråttåga	33 V 485126 7420022	Nordland	6197025,5	13073,7
13	Savjords-Savåga	33 V 487533 7432244	Nordland	553590,4	3512,2
14	Selforssagåga	33 V 487243 7432658	Nordland	24048064,6	24949,4
15	Skorgeelva	32 V 430466 6939992	Møre og Romsdal	42275657,1	35782,7
16	Storfjelltjønna	33 V 408102 7240982	Nordland	9670534,8	20832,7
17	Erga	32 V 507318 6938389	Møre og Romsdal	93249,8	1865,4
18	Femtevasselva	33 V 540786 7520564	Nordland	83461057,0	61074,4
19	Bordalselv	32 V 357733 6640295	Hordaland	45170144,5	37490,9
20	Kverhusbekken	32 V 356392 6641474	Hordaland	5320425,9	11945,7
21	Skromme	32 V 358120 6641174	Hordaland	42522533,9	35728,2
22	Grøno	32 V 386543 6648002	Hordaland	66323778,1	54465,9
23	Middal	32 V 387291 6648021	Hordaland	46104475,8	41047,8
24	Strandåna	32 V 383606 6647882	Hordaland	4096522,6	8458,9

For better understanding of variability of selected catchments area frequency duration curve of selected stations area have been built. As seen from that figure curve become flat in the middle, that means that 20% of stations have area from 40-50km2, but later on curve drops down evenly. That means that most stations (more than 50%) have catchment area less than 10km2. The biggest area of selected stations is 173.6km2. Such huge catchment area variability makes analysis more interesting from variability point of view.

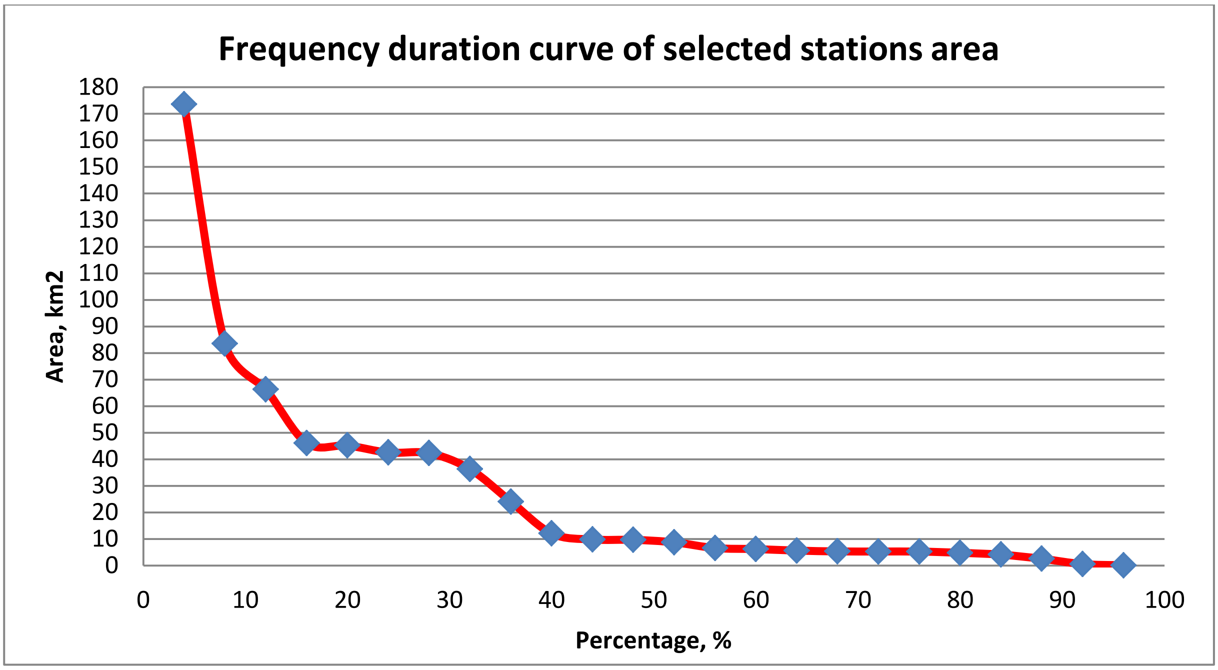


Figure 3-15. Frequency duration curve of selected stations area

For better understanding of location the map with selected SWECO stations is shown in Fig. 3-16. The red bullets are selected SWECO AS stations.

Figure 3-16. Location of selected SWECO AS stations.

3.5 Selection of analogue NVE station

For making comparable analysis with SWECO AS stations appropriate NVE stations have been selected. Selection of appropriate NVE station was made on the basis of following requirements:

- Corresponding NVE station should be located at the same climatic area as SWECO station.

This point is very important, because for example if one station is located near to coast line corresponding station should be located also near to the coast line and be located at the same climatic belt.

- The area of corresponding station should be proportional and rateable to the SWECO station

It has been decided not to settle any rule regarding corresponding station area, because frequency duration curve of selected stations area has a great variability. It means that the main demand to the corresponding station area is that it should be proportional and rateable to SWECO station.

- Corresponding NVE stations should not be regulated.

Regulated station means that it is located at the place where water flow can be regulated, for example dams, diversion waterways, reservoirs, and other hydrotechnical structures. For finding non-regulated stations screening of Lavvan map with indication of all water ways, tunnels, dams, regulated reservoirs have been done.

Finding of corresponding NVE stations was challenging, because most of stations are regulated, located at hydropower area. Other obstacle of finding appropriate station is that in many stations data from 2000 year is missed or not available, but SWECO stations measurements were done particularly at that period after 2000 year.

Based on all above mentioned conditions following corresponding NVE stations have been found for further comparison and analysis. As seen from Table 3-3 there are several SWECO AS stations that should be compared to one NVE stations. The explanation of that is SWECO stations located close to each other and have the same climatic parameters, area, etc.

For example Breidalselva, Breivikelva, *Heståga,* Kjellingelva, Lille Gråttåga, Savjords-Savåga, Selforssagåga stations are located on 100km2 area and could be compared with one NVE station which is located at the same place. For 24 SWECO AS water level measuring stations 10 corresponding NVE stations were selected.

Table 3-3. Selected SWEO stations with analogue NVE stations

Analogue NVE station number	Selected SWECO AS station name
94.19.0	Aurstadelva, Kasseelva
79.3.0	Berge, Bjåstad
163.6.0	Breidalselva, Breivikelva, *Heståga,* Kjellingelva, Lille Gråttåga, Savjords-Savåga, Selforssagåga
156.15.0	Forsland, Laupen
155.27.0	Krutåga
103.20.0	Skorgeelva
149.1.0	Storfjelltjønna
109.29.0	Erga
168.2.0	Femtevasselva
244.5.0	Bordalselv, Kverhusbekken, Skromme, Grøno, Rullestad, Middal, Strandåna,

3.5.1 Meta-database format for transition to NVE database

Meta-data base of selected stations was made on the basis of NVE data format requirements. It should include:

- Water levels
- Water discharges
- Stage-discharge curve
- Map of area, where station is located
- Lavvann low flow application
- Shape file

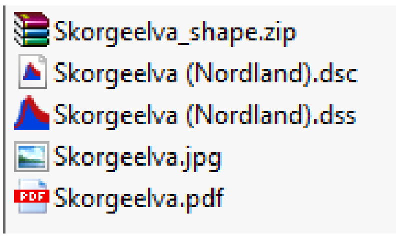


Figure 3-17. Format of selected station data transferred to NVE database (example).

All 24 selected stations have been transferred to NVE data base in the format shown in Figure 3-17.

3.6 Data quality control

Never assume that the data is ''settled in stone''(Zbigniew et al., 2000)

3.6.1 Introduction

While collecting any data into dataset, continuity and accuracy of that dataset is very important. Large amount of erroneous data can easily destroy the trust and reliance both of data supplier and users. Following factors play a role into establishing of the quality of data: network design, instrument performance, staff skills. (Herschy, 1998)

R.W. Herchy says: "Nowadays, developed methods and new computer-based processing systems had a positive impact on hydrometric data quality in many countries. None the less, an ongoing commitment to data validation is essential during a period when data acquisition is in a state of flux in many regions of the world. It should be recognized that ability to sense, record, transmit and process flow data untouched by human hand and, more crucially, unseen by human eye, may not represent unmitigated blessing". (Herschy, 1998)

Undoubtedly quality control should be applied through all dataset and be a part of processing line.

Quality control has following objectives:

1. To avoid uncertainties happened because of design and control of data collecting systems.
2. To find out error sources at sensor.
3. When find uncertainties, to correct or reject it. (Killingtveit and Sælthun, 1995)

Studies of hydrological changes have a great importance for water resources systems' designing and operation. All hydrological changes should be taken into consideration, otherwise water recourses systems (dams, reservoirs, etc.) will be in danger or will not serve their purpose properly or come very costly to projector.

In this Master thesis we will not discuss that changes in details but will describe it from the point of quality control of hydrological data.

There are very many changes in hydrological series could take place. Changes could be abruptly (step change) or gradually (trend) or may have more complex forms. For example abrupt changes could happen because of fast changes in catchment itself, for example construction of reservoir. Gradual changes could happen because of urbanization, climate variability. (Zbigniew et al., 2000)

3.6.2 Accuracy of hydrological measurements

In theory, it is impossible to obtain true hydrological values by measurements, because errors of measurements cannot be established completely. Uncertainties have a probabilistic character, which can be estimated as a range where the true value is expected to be with a certain probability. The width of the probability interval called "error band". Uncertainty estimation should also include carefully examining different sources of errors in measurements. (WMO, 1994)

3.6.2.1 Definitions of terms related to accuracy

The definitions of the terms related to accuracy given below based on terms in the WMO Technical Regulation and in the WMO Guide to Meteorological Instruments of Observation. (WMO, 1994)

World Meteorological Organisation has set the following terms, as:

- "Accuracy: The extent to which a measurement agrees with the true value. This assumes that all known corrections have been applied.
- Confidence interval: The interval which includes the true value with a prescribed probability and is estimated as a function of the statistics of the sample.
- Confidence level: The probability that the confidence interval includes the true value.
- Correction: The value to be added to the result of a measurement to allow for any known systematic error and thus to obtain a closer approximation to the true value.
- Error: The difference between the result of a measurement and the true value of the quantity measured." (WMO, 1994)

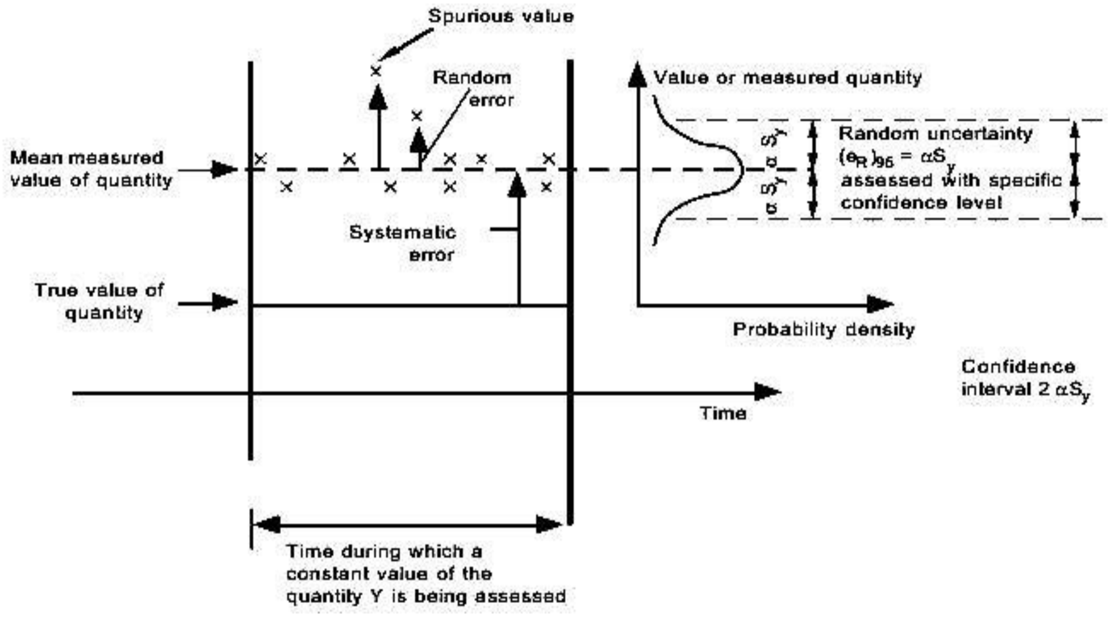


Figure 3-18. Explanation of errors. (WMO, 1994)

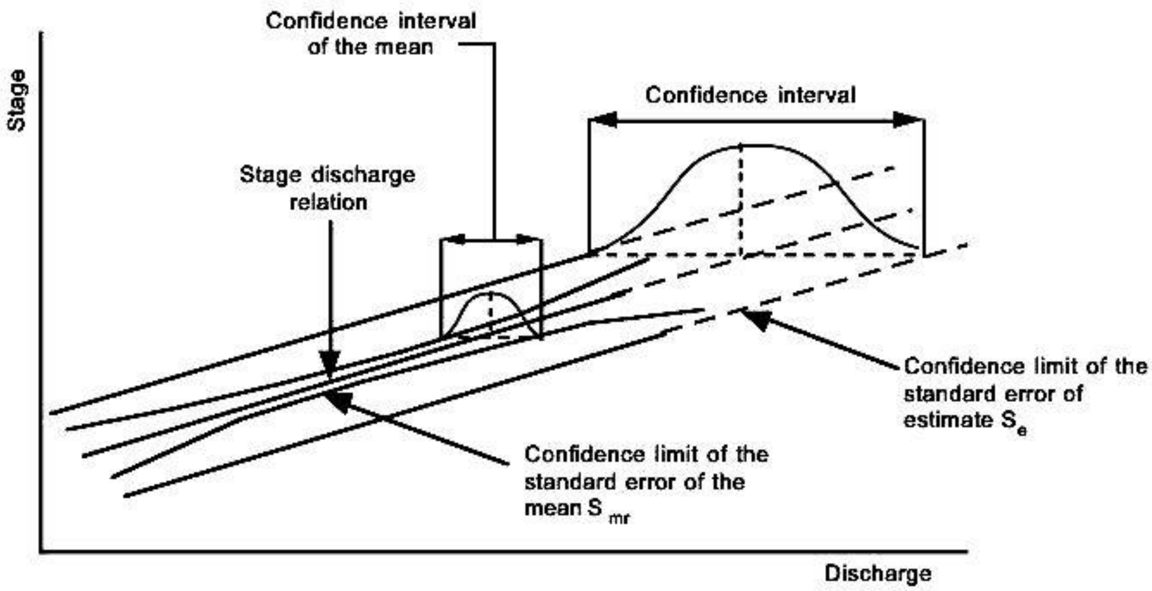


Figure 3-19. Explanation of errors in linear regression. (WMO, 1994)

The standard uncertainty is calculated from the following equation:

$$S_y = \left[\frac{\sum_{1}^{n} (yi - \bar{y})^2}{n - 1} \right]^{1/2}$$

where,

S_Y - standard deviation of observations

y¨ – arithmetic mean of the observations

N – number of observations

Standard error is calculated as:

$$S_e = \left[\frac{\sum (d)^2}{n - m} \right]^{1/2}$$

where,

S_e – standard error

d – deviation of observation

m – number of constants in regression equation

3.6.3 Types and sources of error

Spurious errors could be identified by statistical tests, described in ISO 5168. In many cases it depends on number of measurements.

Systematic error basically depends on equipment and cannot be reduced by increasing number of measurements, in case when equipment and conditions stay the same. Systematic error should be reduced by correcting, adjusting or even changing equipment. This type of errors occurs very random because of abstruse measuring conditions, like unsteady flow, bad location, etc.

Random errors cannot be excluded, albeit random errors' effect could be reduced by measurements repeating. (WMO, 1994)

Each equipment and measuring method has its own source of errors. Although there are a couple of typical sources of errors:

- Not correct establishment of reference point;
- Incorrect reading from the measuring equipment, because of e.g. bad visibility, waves, etc.;
- Interpolation error;
- Observation error (is the same as errors happened due to incorrect reading, but in this case because of observer;
- Hysteresis (when instrument gives different measures for the same value);
- Instability error occurs when measuring equipment cannot bear meteorological events;
- Out-of-accuracy error, occurs when equipment is abused; when minimum error is bigger than accuracy of measurements; (WMO, 1994)

3.6.4 Main areas where quality control should be provided

It should be evident, that quality control of data is more "computer-assisted" process, not a "computer-controlled" process and should include a lot of activities.

There are four evident areas, where quality control should be employed for reaching a good effect.

1. Hydrometric Field Practice and the Recording of Water Level

Hydrological data base accuracy somehow depends on measurement processes. In other words, the quality of the archived data is dependent on quality of observed water stage data. In most cases that is applicable for rivers with small streams. T.J.Marsh says: "The limited water depth places a premium on the accuracy of stage measurement - a very modest absolute error in the determination of water depth can result in substantial error in computed discharges, especially during periods of low flow".

Continuous measurements and station maintenance in addition with good field practice will lead to proper and true water lever record.

2. The checking of River Stage Data

There are many hydrological data-proceeding systems which work with automatically checking of stage data. They based on exclusion of water depths which are below or above established range. The strategy is following: it is necessary to set threshold value, which will be unique for each catchment. That effortless method will identify most erroneous data apart from data substantially systematic.

Beside above mentioned method there is also one method which is based on information about flow variability. Graphical plots of water levels, basically done prior conversion of depth to flow, should be studied on subject of ever recorded anomalies or gradually changing adjustments (influence of seasonal plants).

3. The Stage-Discharge Relation

A failure in estimating any changes in stage-discharge curve will seriously endanger the accuracy of a hydrological data.

Flow measuring structures should be studied on purpose of error source. There are some factors that will lead to erroneous data, e.g. upstream aprons, increasing of algae, non-modularity of station.

4. The Validation and Flagging of Achieved Flow Data

Hydrological data should be a combination of following three regimes:

a) Temporally; fluctuations in data time set should be studied to understand if they could exist in nature for entire period of time.
b) Spatially; Hydrological data from neighbouring catchments should be checked on subject, if they are homogeneous within examined period.
c) By comparison; hydrological data should be verified by other variables. For example while checking discharge it is rainfall or snow.

R.W. Herschy says: "No system will ever identify all possible errors; what is requires is a practical, efficient set of procedures designed to minimize the volume of significant errors on the river flow archive". (Herschy, 1998)

3.6.5 Filling of Missed data

It is common situation when data set has missed data. The reasons of that can be different, for example failure of sensor, errors in data storage or transfer, etc. Missing data should be filled before transferring it into database system.

There are many methods for estimating missed data on the basis of information from adjacent stations. Will count three of them:

1. Station-Average Method

Station-average method can be applied, if annual precipitation value of each adjacent station differs by less, than 10% from studied station (with missed data).(Dingman, 2002)

$$p_o = \frac{1}{G} \text{ x } \sum_{g=1}^{G} p_g$$

2. Normal-Ratio Method

In case, when annual precipitation at the stations differs more than 10% from studied station the normal-ratio method should be used. (Dingman, 2002)

$$p_o = \frac{1}{G} \text{ x } \sum_{g=1}^{G} \frac{P_o}{P_g} \text{ x } p_g$$

where,

p_o -Missing data

p_g -Observed values for corresponding day at adjacent stations

P_o -Annual average precipitation at the station with missing data

P_g -Annual average precipitation at the nearby stations

3. Inverse-Distance Weighting

In case annual average precipitation is not available, inverse-distance weighting method should be employed. The weights should be inversely proportional to distance (b=1) or to distance squared (b=2) and D is calculated as:

$$\text{D} = \sum_{g=1}^{G} d_g^{-b}$$

The missing value is calculating as:

$$p_o = \frac{1}{D} \text{ x } \sum_{g=1}^{G} d_g^{-b} \text{ x } p_g$$

4. Regression

If relatively few values are missed from whole data set it is possible to calculate p_o, following way:

$p_o = b_o + b_1 p_1 + b_2 p_2 + \ldots + b_G p_G$

here coefficients b_0, ..., b_G are calculated by common regression methods, using data when observations are done for all stations.(Dingman, 2002)

3.6.6 Effects of river ice

Undoubtedly, river ice has negative influence on measurements; it reduces the discharge at a given stage. That happens because of reducing of water free area, and formation of ice on the bottom of river. That problem could be solved following way.

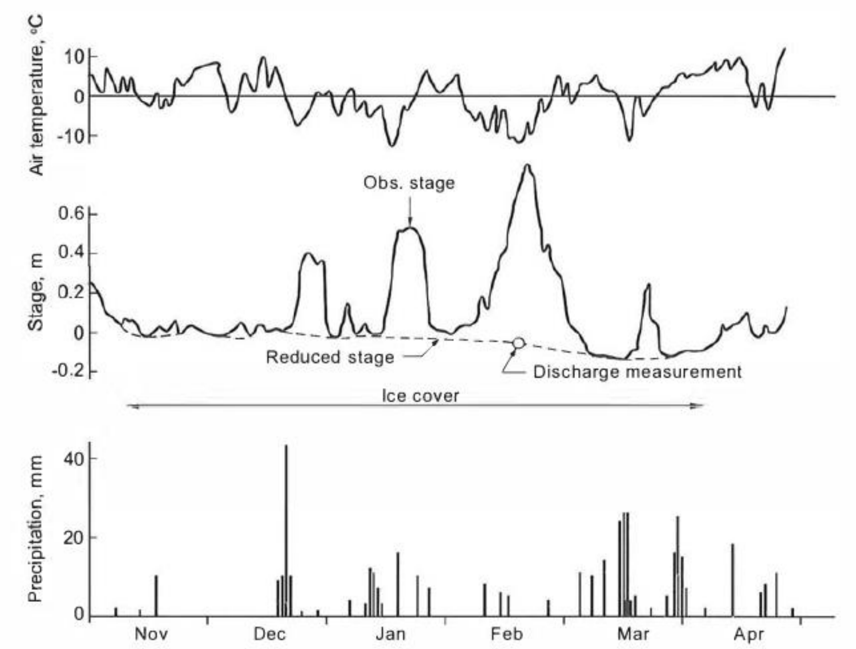


Figure 3-20 River ice impact on stage.(Killingtveit and Sælthun, 1995)

Corrections should be done on the basis of river flow records during winter months. But this method is not efficient, because in most cases winter.

The other option is interpolation based on information about temperature and precipitation. The interpolation is done on Figure 3-20. (Killingtveit and Sælthun, 1995)

3.6.7 Uncertainty of the Rating Curve

Rating curve built on the basis of error containing discharge measurements and stage undoubtedly will have error. One way to make error correction is to provide error analysis of nonlinear regression.

The other option of correcting, that error of stage-discharge curve parameters changes backward with the square root of the quantity of flow records.

For example, if 3 measurements can built a stage-discharge curve with the same error as the measurements (e.g. 5%), if we will raise the number of measurements by 9, the uncertainty will drop to around 2%.

Following limitations should be considered while operating mentioned method:

1. Should be applied to particular segment.
2. Flow measurements uncertainties are random and not systematic.
3. Uncertainties values growing at the ends of the curve.
4. Considered stage-discharge curve to be stable. (Killingtveit and Sælthun, 1995)

3.6.8 Basic methods of quality control

There are main pillars of quality control procedure:

1. Automatic error finding.

Automatic error finding is based on setting of highest and lowest threshold, which specifies uniquely for each catchment. Computer should detect data which is above or below established threshold, that suspicious data should be examined carefully with next step.(Killingtveit and Sælthun, 1995)

2. Graphical plotting.

This method is quite efficient. Graphical plotting should be made on finest time resolution of data base. Software should obtain all possibilities for better data screening (e.g. zooming). Differential series are more in handy than original series, because changes during observation period are more evident than original series. Example of that is on Figure 3-21, which represents error screening with differential series.

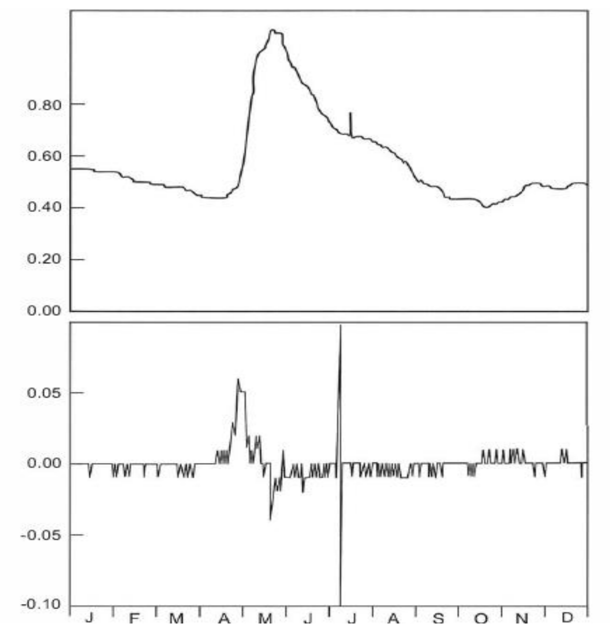


Figure 3-21. Error screening with differential series (below picture). (Killingtveit and Sælthun, 1995)

3. Trends and homogeneity check.

Systematic long term error is the reason of systematic shifts in trends. That error can be discovered by studying of long period of observations.

Following methods can be used:

- Plotting of smoothed means or accumulated deviation
- Trend analysis with linear regression

An example of accumulated deviation, as shown from Figure 3-22 there is increase in runoff last 25 years.

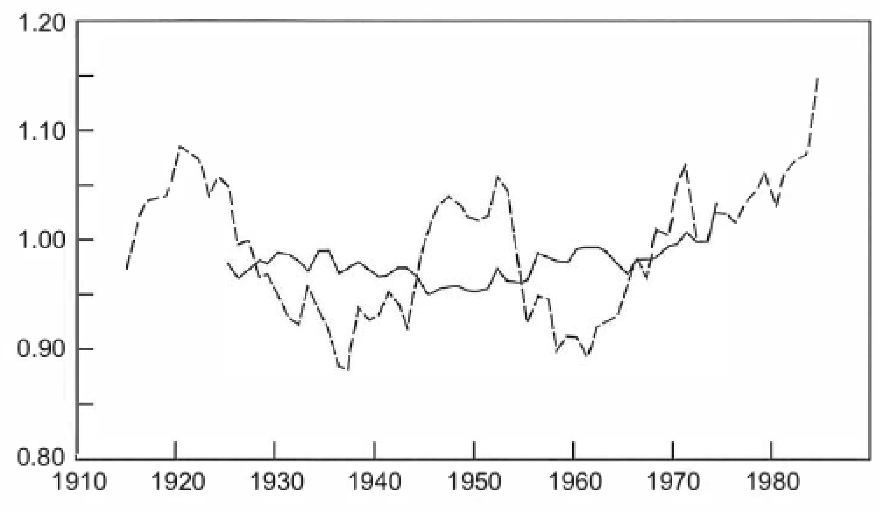


Figure 3-22. Accumulated deviation of mean values (increase in runoff last 25 years). (Killingtveit and Sælthun, 1995)

It is very important to know, that long term trends can be dictated not only by errors, other reason can be for example climate change, land use, water diversions. All mentioned activities can be a matter of long term trend change.

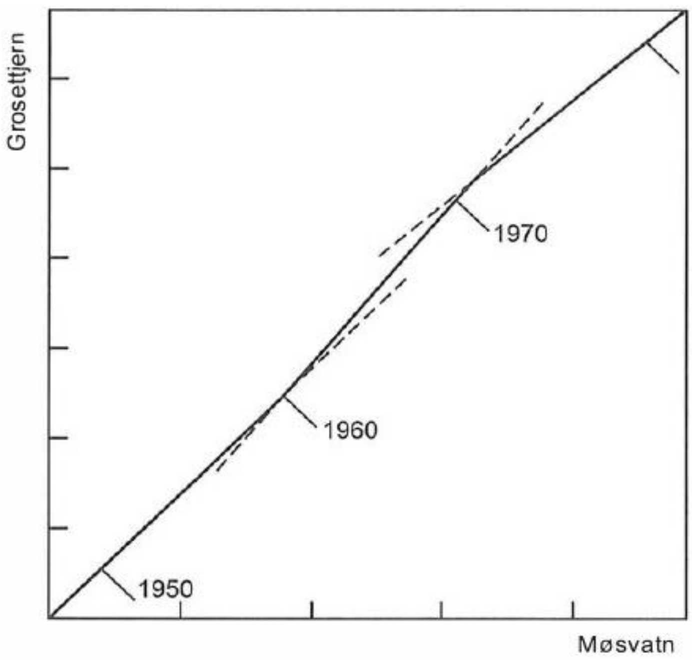


Figure 3-23 Double mass analysis. (Killingtveit and Sælthun, 1995)

The method for finding out effects from land use, data error, etc., is applying double mass curve analysis. Double mass tests are used basically for precipitation and runoff data, it based on plotting accumulated series against control series. Control series is data series which are taken from control gauging station (which usually have a good quality data). The output of double mass curve is line with continuous shape under 45^{o}; if there is parallel shift in the line, it means single major error occurs and trend change means continuous shift in the mean. Figure 3-24. Double mass analysis for stations.(Killingtveit and Sælthun, 1995)

If we have done double mass curve and got quite smooth line without shiftings, that doesn't mean that we have homogeneous series, because errors could remain during low flows and that wouldn't have visible influence on double mass curve.(Killingtveit and Sælthun, 1995)

3.6.9 Error correction application

There are two options to handle with errors in data: either to correct them, or to discard. While making some analysis it is more prefential to use uninterrupted data, in other words in case of errors it is more preferable to correct data and fill gaps to obtain continuous dataset for further analysis.

Although, there could be a situation, when virgin data is needed. It could happen that discarded data will found out as correct one.

To avoid such situations, it is advisable to keep following instructions:

- Keep original data
- Don't rely absolutely on automatic control and correction
- Tick corrected data

(Killingtveit and Sælthun, 1995)

3.6.10 Quality Control by SWECO AS

Quality control is a mandatory procedure applied to all stations measurements. All data should pass through quality control, before it is provided to the consumer or before taking part in calculations. When data is downloaded to the SWECO data-archive it is studied carefully on the purpose of possible errors. This procedure is performed by following steps:

- Eye-balling
- Ice Reduction
- Infilling Missed data

Checking data pattern by eye is very quick and easy method for establishing errors, whereas computer is not. Human eye and mind are very sensible to pattern changes and can recognize it easily. Experienced hydrologist at SWECO AS should be able to detect any suspicious changes in plot.

The example of suspicious behaviour of plot can be for example discharge peaks in winter months. It is very rare when flooding happened in winter, the explanation of that peak could be ice formations on the river bed and nearby measuring equipment. As shown on the below picture there are several peaks which happened in January and February months in Lille Grataaga station which is located in Nordland community. Such peaks are very rare in this region, basically in winter months. This is a classical case, when ice formation problem occurs. Usually peaks which happened because of ice don't last for a long time (one week or less). In this case when such a suspicious peak is detected it should be corrected according to nearest NVE station.

The correction should be done following way:

As was mentioned the nearest NVE analogue station should be found. Analogue station is found based on the following points:

- Proximity of catchment

- Climatological similarity

- Physiographical similarity (area, elevation range, etc.)

- Similarity of hydrological response (recession behaviour, BFI)

-Absence of artificial influences on catchment (regulation, sewage, irrigation)

It is necessary to study analogue station measurement period where SWECO has suspicious peaks. If NVE has not peaks during peaked period that data should be downscaled for short period of time, when peak was detected, to the SWECO catchment and replace high peak as shown in Figure 3-24.

If NVE analogue station has the same peaks as SWECO station, data should be marked for further investigations. That must be treated in following way.

The next step of making quality control is to check the information about air temperature and precipitation during mentioned period of time. For obtaining that information appropriate request should be sent to Norwegian Meteorological Institute. The report provided by the Institute contains quite detailed information about air temperature and precipitation. That report becomes a basis for a correction of erroneous data.

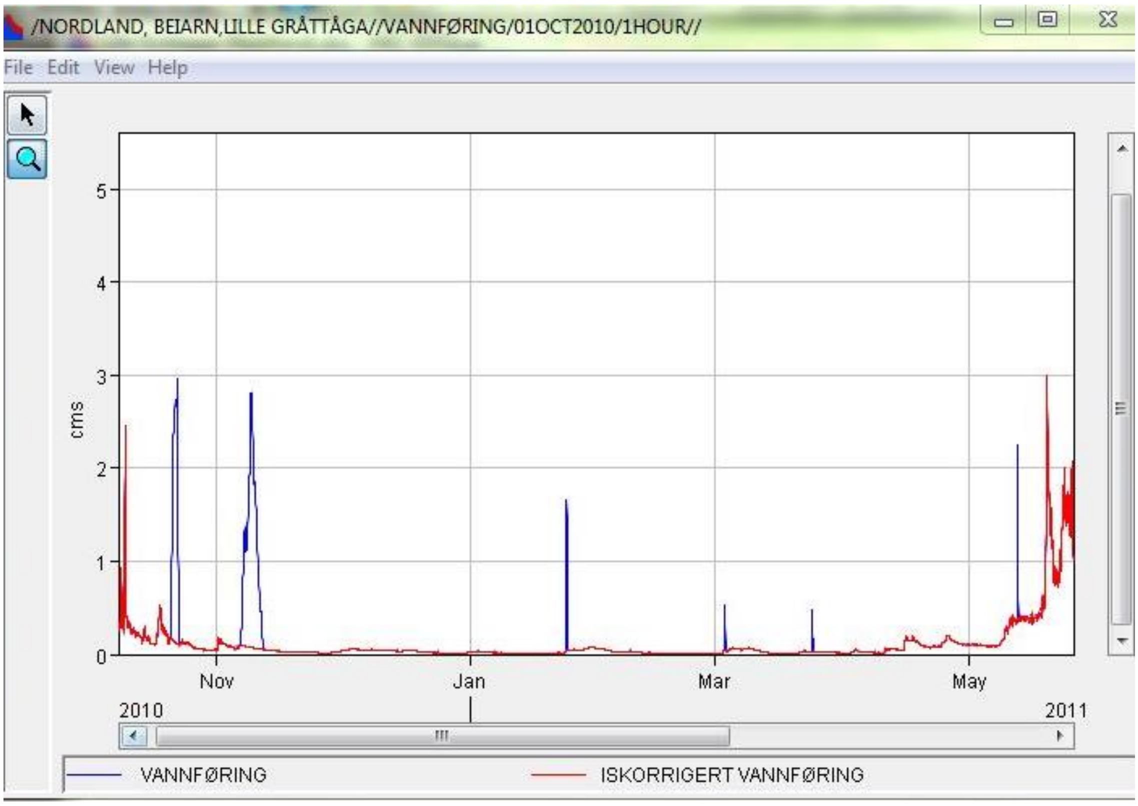


Figure 3-24. Detection of peaks.

Since all measurements have been done by WL Logger, it should be stated that all measurements have quite highly accurate water level measurements: ±0.1% full scale at constant temperature, ± 0.2% over 35 °F to 70 °F (1.37 °C to + 21.1 °C) range. (www.globalw.com/products/wl16.html, 2014)

In case of missed data following points should be taken into consideration:

- Nature of the site and catchment characteristics should be studied carefully
- Degree of data fluctuations at the site
- Number of missing data values
- Length of existing measurements record
- Hydrological conditions when the missing of data happened, how flow behaves (falling or peaking at the time)
- Knowledge and experience of person who corrects data

In case when number of missing values are few simple correlation between known data should be done. In case when missing values number is high scaling from nearby catchments should be done. (Sweco, 2014)

3.6.11 NVE Methods of Quality Control

Quality control procedures in NVE are not automatic and are carried out in two steps: the *Primary Control* on the basis of HYTRAN data series and *Secondary Control* of HYDAG_T daily mean series.

Primary concerns "fine data" meaning finer than daily resolution and tries to correct instrument errors, such as pressure sensor error, errors in float settings, errors in the shaft and errors due to maintenance of the stations, etc. This is done using particular software called HYKON and the chapter below describes how to use it. Secondary control concerns daily data (generated from fine data) and tries to correct gaps (missing data) and so called "ice-reduction", meaning guessing new values for periods when presence of ice causes errors in the observation.

3.6.11.1 Primary control of hydrological data (NVE)

Norwegian Water Resources Directorate has its own control of hydrological data.
Definition if terms:
HYKON: Program for primary control of data and secondary control of daily mean data;
HYDRA_II: NVE's proprietary hydrological database;
TIME: Temporary transaction archive for the last two years of data;
HYTRAN: Permanent transaction archive for uncontrolled data;
HYKVAL: Permanent archive for quality controlled data;
HYDAG_T: Temporary transaction archive for daily mean data;
HYDAG: Permanent archive for quality-controlled daily mean data.

There are two types of data control: primary data control and secondary data control. Primary Control of water levels is performed by using HYKON control program. This control shall ensure that the water level series reflects true water level in the river at the time of observation.
The point of primary control is to ensure that the recorded water level values reflect the actual water level in the river or lake at the time of registration.
Error may be due to a number of reasons and take the form of simple errors or mistakes of the more persistent nature.

HYKON Hydrological data control program works as following:
At first it is necessary to select measurement period to be controlled. It can be done following way:

- Primary either Secondary control type should be selected;
- River number should be entered into provided space;
- The main number of the station should be entered in the space provided;

- Click Search;
- Each measurement period stored on HYTRAN base will appear in the list. They are sorted by parameter, version and date. It is necessary to highlight the desired measurement period to be checked;
- Press Plotting button.

Checking and correction of values occurs in the plot module. In the module window you get up a plot summary. At the top of the module there are functions to store, calculate, add and remove series, discard series, etc. On the left there re functions to print and at the bottom there are functions to move data series in time, zoom, etc.

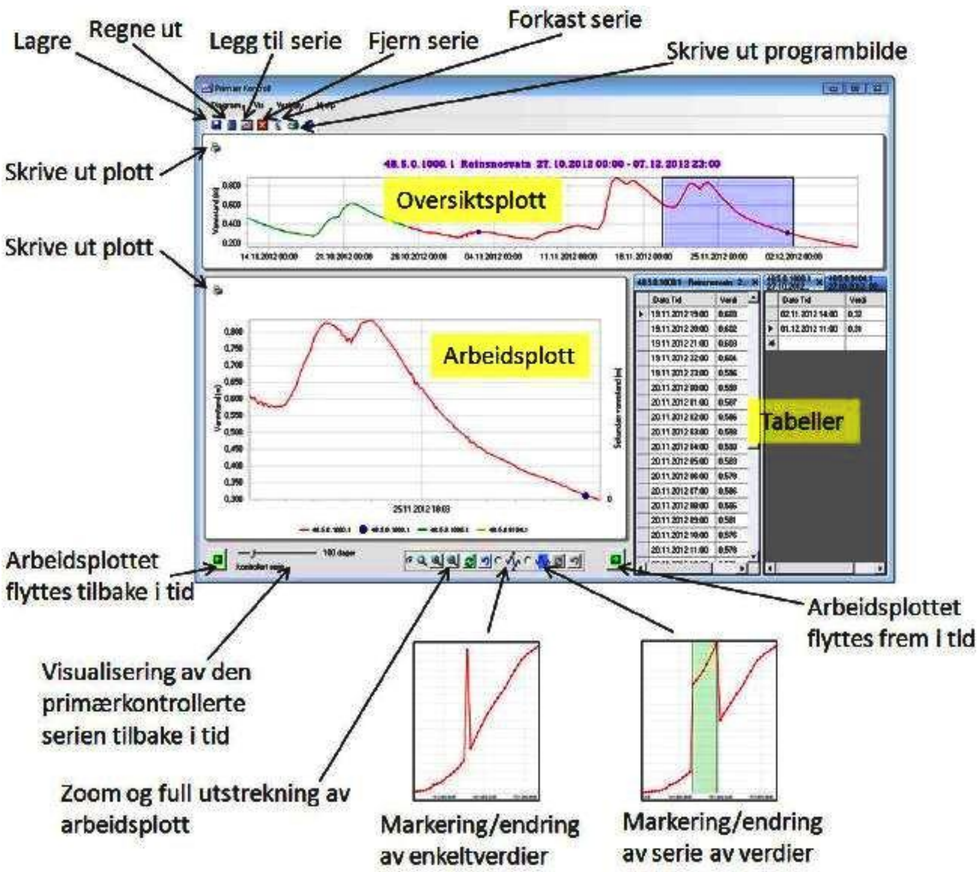


Figure 3-25. HYKON Hydrological data control program. (NVE Hydrologisk, 2013)

Evident wrong values ("pikes") are corrected or removed. This is also done with periods when the water level plot looks like a straight horizontal line caused by an instrument error (for example due to freezing in pipes or manholes). Individual values or ranges of values can be removed by highlighting the data, right click in the highlighted portion of the table (blue) and select either "missing value" that erases data completely or "delete" which interpolates over the data removed.

Drifting or incorrect water level over a long period is being checked by comparing data against the control points and the secondary water level at the station.

Correction of constant errors over a longer period of time is done by using "work out" module located in the upper plot module. Here it is possible either gradually or constantly change water levels. For changing the water level for example for 1 cm into some part of data series following procedure should be done:

- Mark the period during which the water level correction should be performed;
- Enter "y 0.01" in the first window function;
- Press Run;
- Click Save.

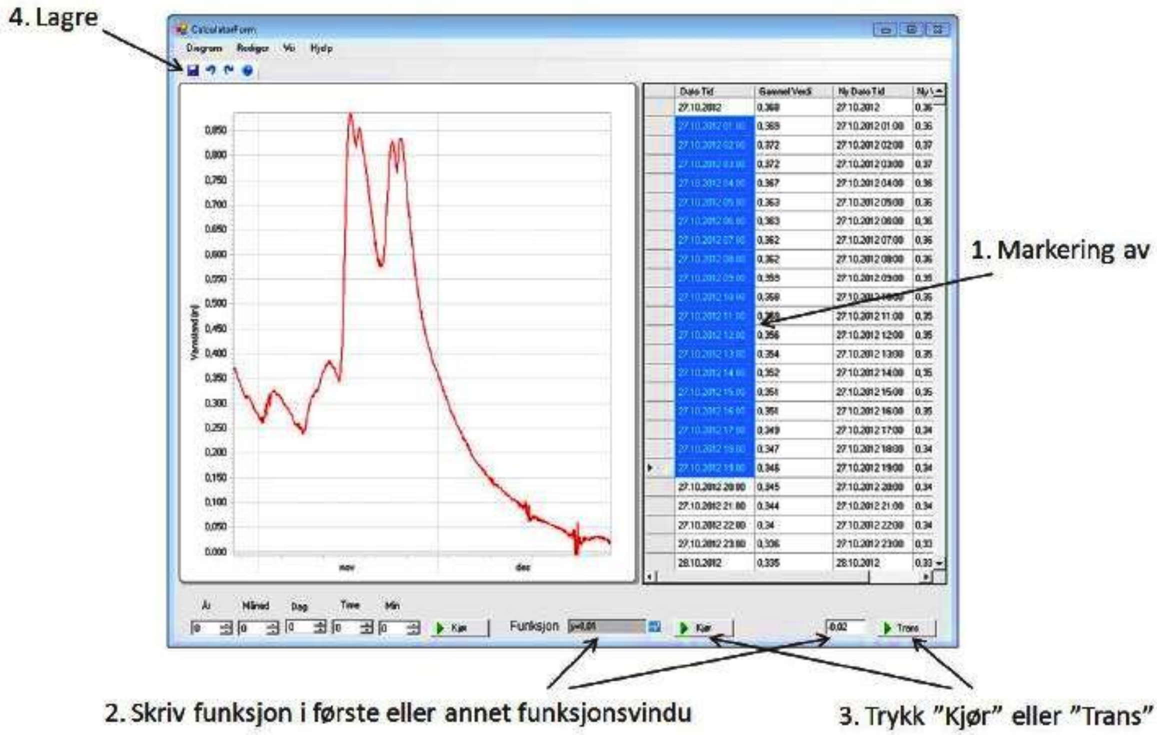


Figure 3-26. HYKON Hydrological data control program (continue). (NVE Hydrologisk, 2013)

To confirm and save water level series press "Save" in the upper plot module. The series transferred to HYKVAL (Permanent archive for quality controlled data). After that data is transferred to HYDAGT (Temporary transaction archive for daily mean data) and is ready for secondary control.

3.6.11.2 Secondary control of hydrological data (NVE)

The Hydrological Department at NVE is responsible for entering data in HYDRA II database.
Data quality checking routine consists of automate and manual procedures to detect possible errors in the data and correct these.
Secondary control is performed only on the generated daily data and performed with graphical control program KONDAG. For water level data mainly it is the ice reduction and completion of missing data.

For secondary control comparison stations are used; they should be located at the same water ways, have the same size of catchments and have the same height distribution. It is important to notice, that local conditions (coastal and inland climate is different) can have a major impact.

Plotting the daily data

This plot window, with many options on the left, shows the entire year observations of daily data.

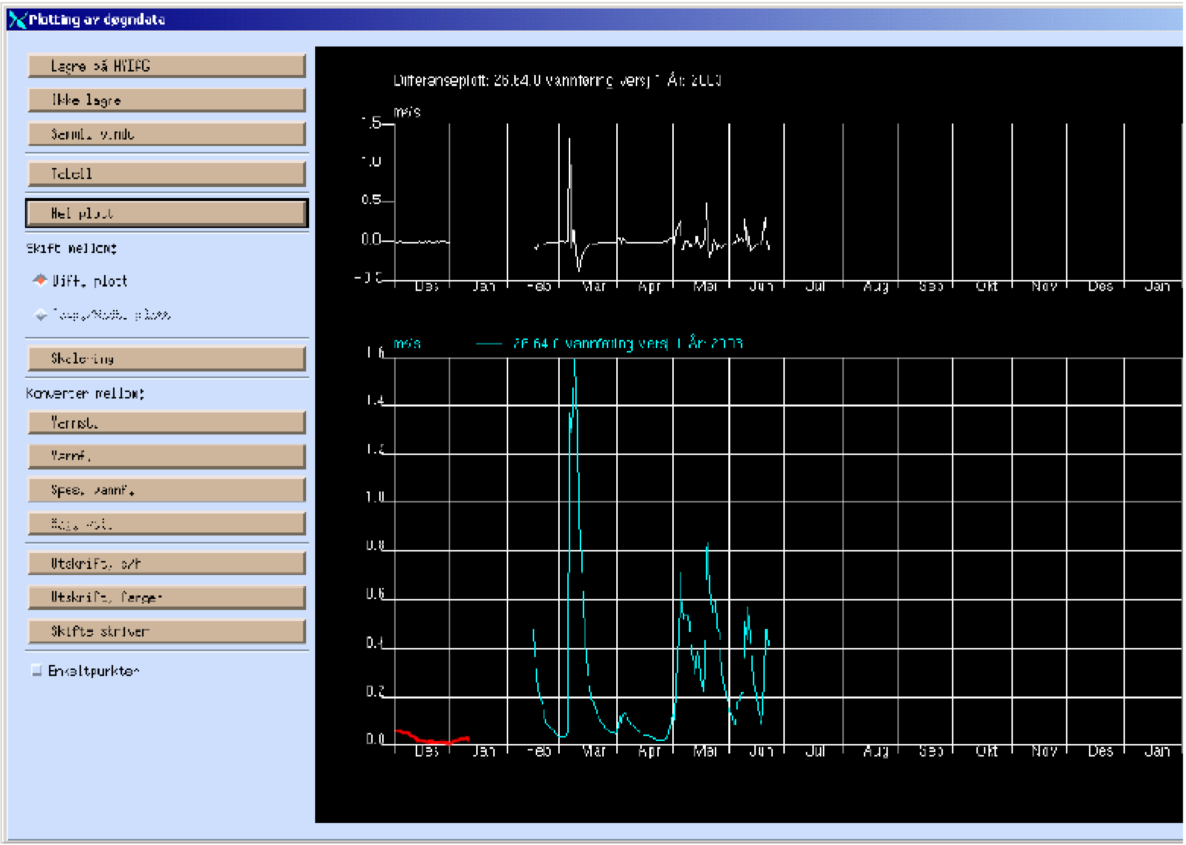


Figure 3-27. HYDAG Hydrological data control program.(NVE Hydrologisk, 2013)

Blue curve is developed by uncontrolled data on HYDAGT red curve is developed with data on HYDAG. If possible, also displays data for December last year and January of the following year.

If done corrections of yearly series are improved "Save on HYDAG", that stores data with corrections and notes on HYDAG. The improved series are not uncontrolled on HYDAGT and thus do not appear in the list of serials control.

Button "Do not save" erases any corrections and completions that are performed on yearly data base and data series are in the list of non-controlled series. After using these buttons you can start correcting new data series.

3.6.11.3 Ice correction by NVE

The ice reduction is performed to correct the observed water stages, which are influenced by ice problem in the river. There are following types of ice problems:

- Ponding due to changing conditions by controlling profile, formation of the bottom ice or ice dams;
- Reduced flow cross section due to bottom ice or ice cover;
- Increased friction and thereby decreased water velocity due to bottom ice, edge ice or ice cover;
- Change of water flow characteristics due to mixing of ice particles;
- Formation of ice pipes.

A water level rise in a cold period of time may be due to precipitation in the form of snow, and by its gravitational force press water out of lakes and marshes. Should not be ice corrected.

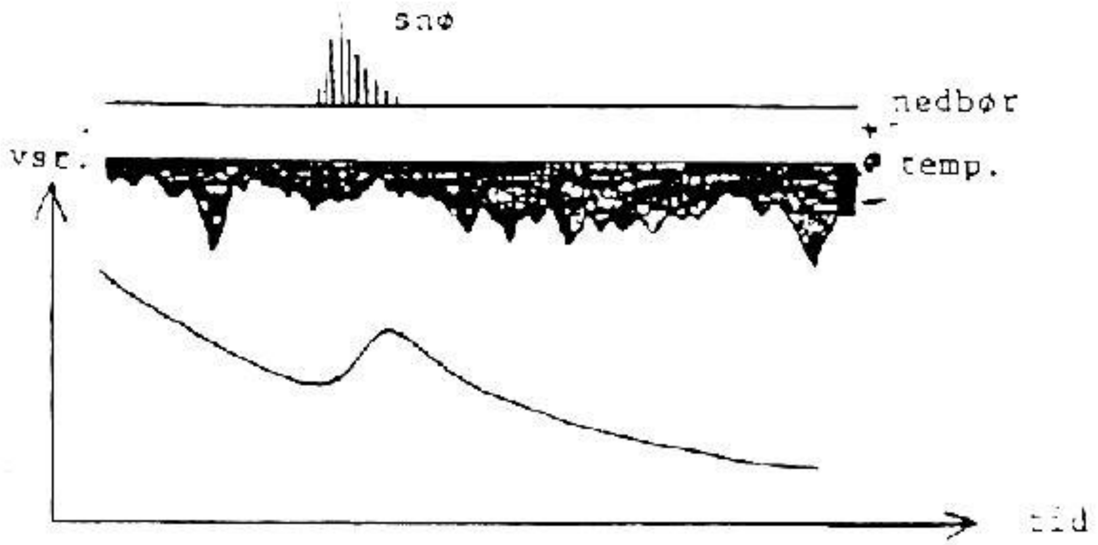


Figure 3-28. Example of ice impact.(NVE Hydrologisk, 2013)

Ice reduction methodology:

1. "Graphical"

Ice reduction is performed as correction routine using KONDAG;

The observed data during winter months is plotted either as water levels or as water flows or as specific flow.

Similarly, data from a comparison station with good data plotted in the same diagram. Precipitation and temperature data from a representative meteorological station is plotted as well. It considered the periods in which there has been no ice where congestion ie water stands are correct. It considered the periods in which there has been no ice where water levels are correct. On a graph it is visible when ice formations appears (water level is affected by ice).

2. "Scaling method"

Data for the ice impacted station is calculated by scaling the observed flow at a nearby station that is not ice impacted.

The scaling factor is calculated either on the basis of comparison of field area, comparison of normal drains or the comparison of flow during ice free periods.

3. "Model Method"

Water flow path through the winter is calculated by HBV model from observed precipitation and temperature data. The model can be adapted to the appropriate field when calibrated against observed data during the ice-free season.

"Scaling" and "Model Method" are not recommended for final ice reduction but can provide in many cases a good primary estimate, which should be proceeded further.

3.7 Proposed quality control methods for selected SWECO AS stations

3.7.1 Introduction

As mentioned above all SWECO stations data have been passed through quality control employed by SWECO. It was required initially not to change or improve data, because it should be transferred to NVE database in the format which SWECO provided.

"Methods and findings" chapter will consist from proposed additional methods that author consider to be important for data quality analysis and recommendations on existing methods, which have been employed to the stations.

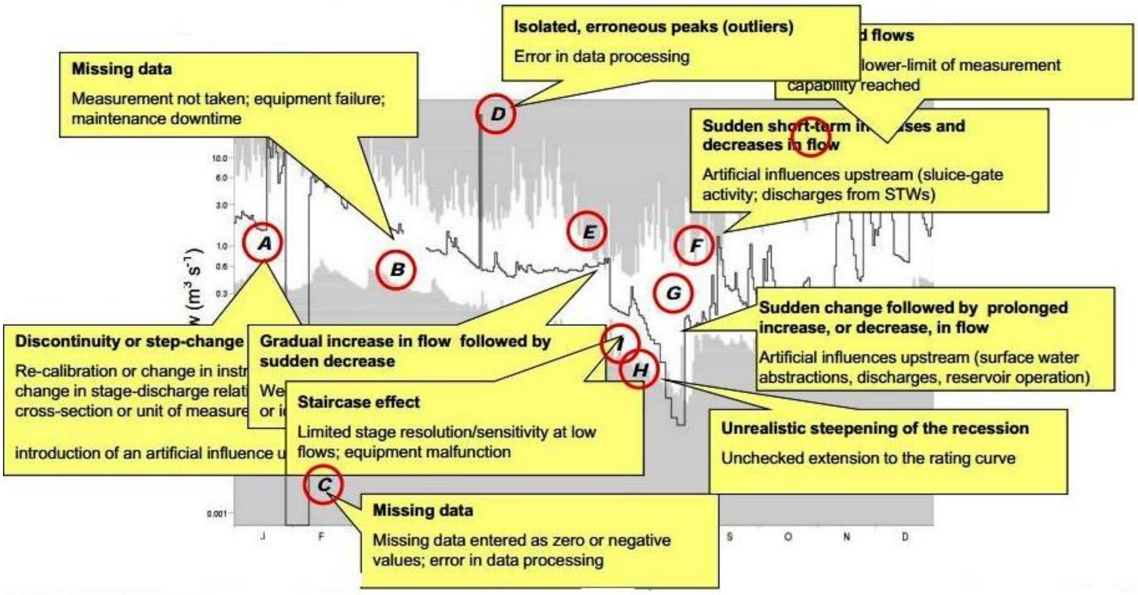


Figure 3-29. Possible errors in data series. (Rees, 2008)

All stations data have been studied on the purpose of possible erroneous data. Figure 3-29 shows possible errors that might occur in data series. Careful eye-screening was applied to selected stations. Both stage, discharge, temperature plots were eye-screened thoroughly.

3.7.2 Methods and findings

- It is very important to detect suspicious behaviour of data plots. In the figure below we can see visible drop of stage plot from Bordalselva station. The reason of that could be that measuring equipment was moved or have been damaged. Experience shows that vandalism cases could happen. It is very important to observe stage graphs also, because errors like this is not visible on discharge plots. In this case estimation or error correction cannot be done, and that part of measurements should be removed. The same procedure should be applied to discharge measurements also.

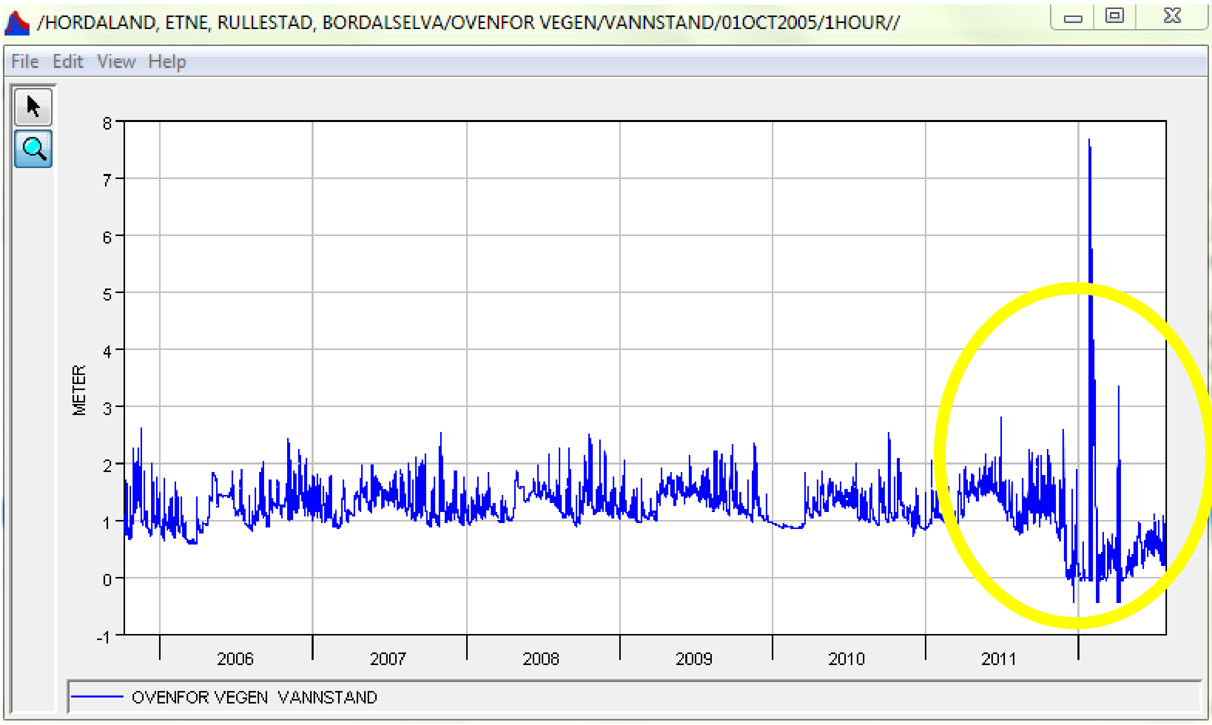


Figure 3-30. Detected stage drop in Bordalselva station.

Water temperature measurements are also very important, but not available at every station. Available information on water temperature will provide necessary information while doing ice reduction. In case if temperature data is absent, there is need to send data request for needed period to NMI, which will take additional time and will make quality control not rational.

- For estimation the goodness of obtained data the plot of done stage-discharge measurements should be done and careful look should be taken on which part of measured data by Logger is within done measurements.

For demonstration the case is taken from Skorgeelva station which is located in More og Romsdal community, station was run from 24-th August 2007 till 04-th May 2011. As was mentioned above SWECO used to do stage-discharge measurements when visit Logger (for maintenance or downloading data) and then extrapolate it for recorded stages.

This plot will provide the necessary information about which part of observed measurements has been extrapolated and which is located within measurement points. On the graph below measurements points are colored with red color and the green line is stage-discharge curve which is proceeded by smoothing of measurement points, blue line is extrapolated for observed stages during observation time.

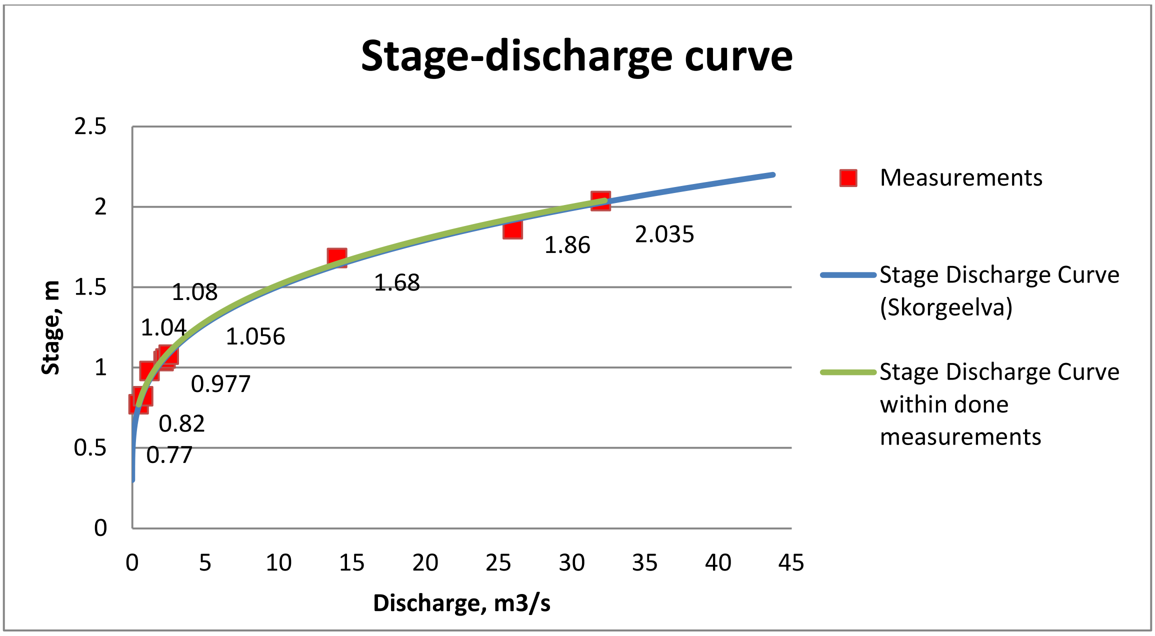


Figure 3-31. Stage-discharge curve.

As seen from the graph more than half of recorded stages are done within measurement points, where extrapolation has not been done. But from the point of exceedence of time this curve is meaningless.

Duration curve is made for demonstration of which part of measurements (from the point of time exceedence) is under extrapolation and which part is not. In this plot red curve is a duration curve which is done on the basis of smoothing of stage-discharge measurement points and blue curve is an extrapolated one.

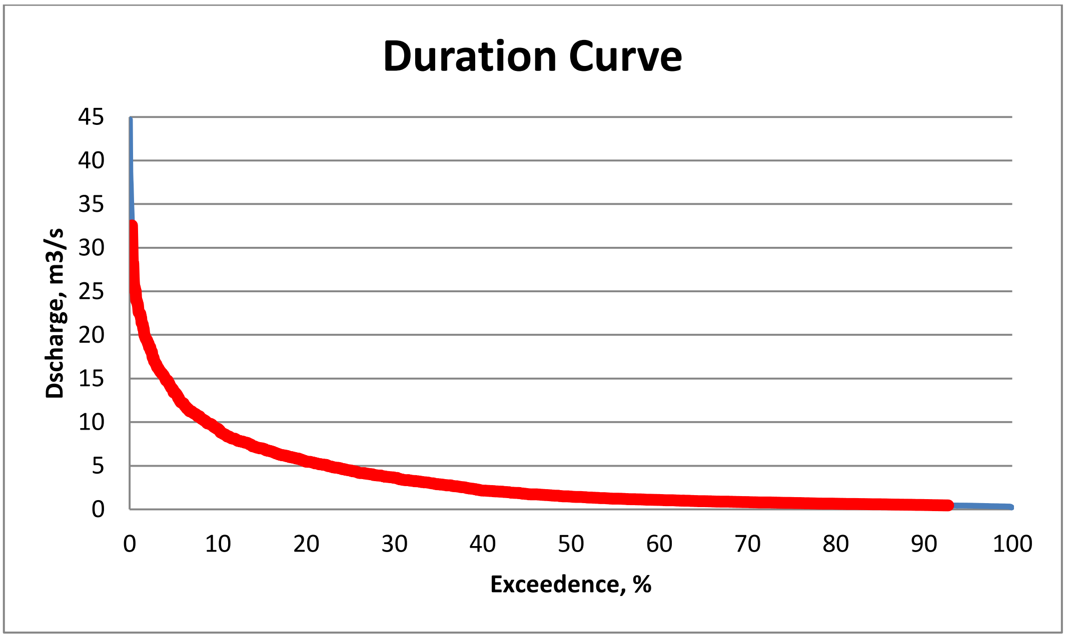


Figure 3-32. Checking goodness of data by duration curve.

It was established that 92.4% of all observed measurements are under non-extrapolated curve, it means that all observation have quite high quality. It is recommended to do such checking of data goodness for all stations - that will provide some information about data quality to the consumer. Proposed data quality check has not been performed for selected stations because of not available stage-discharge measurements.

- While eye-screening of selected stations there has been detected data gap in Forsladnd station. It locates in Nordland community and have been exploited from 01-st of September 2007 till 09-th October 2012. The Figure 3-33 shows recorded gap.

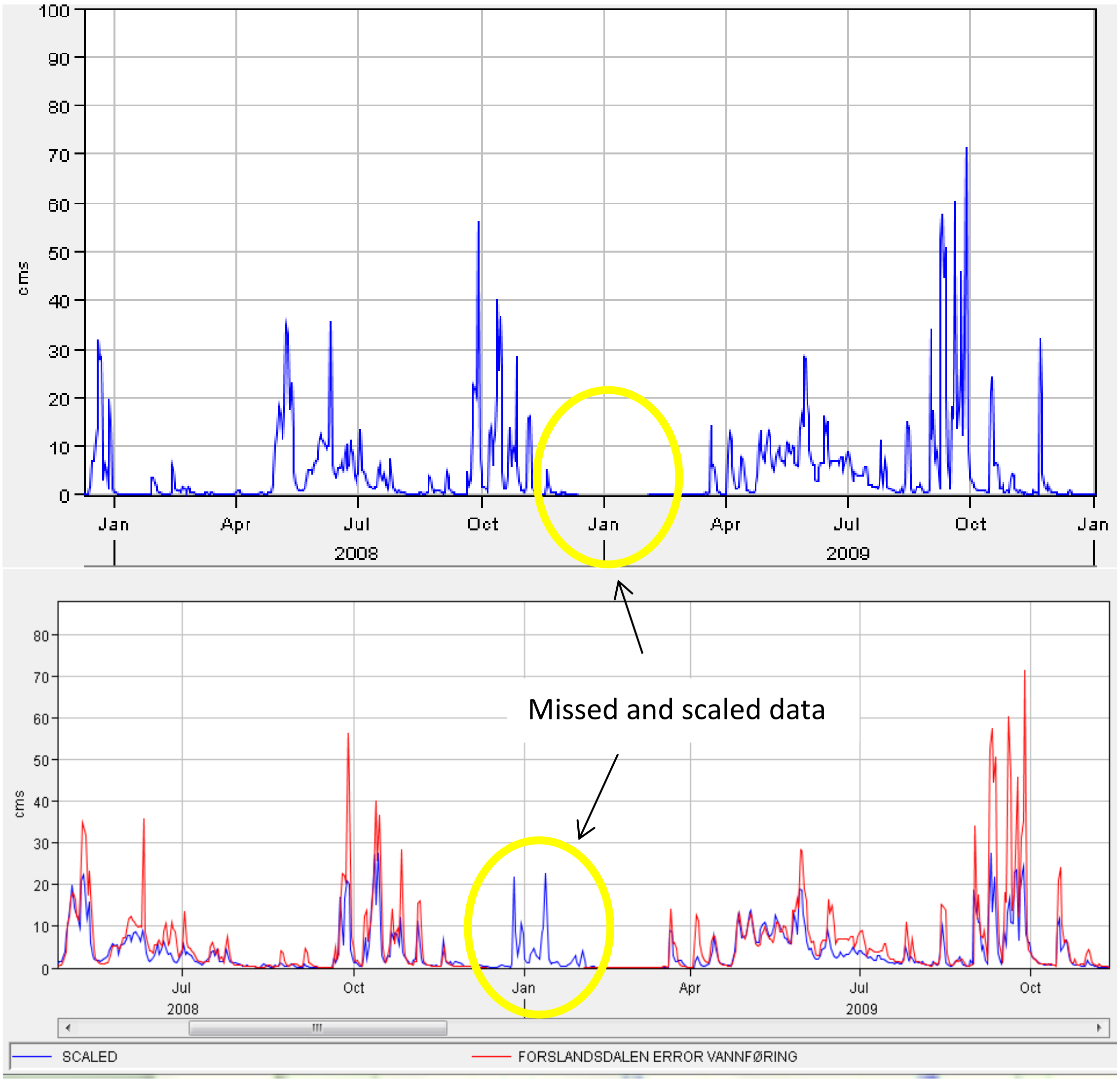


Figure 3-33. Detected gap in data.

For filing gap of that stations neighbouring NVE analogue station was found. Using scaling technique scaling was done of the basis of specific runoff and area of the stations. Scaling factor for this catchment is equal 0.72.

Plotting Forsland station data series with scaled data from analogue station,Figure 3-33 it is visible that analogue station "repeats" behaviour of current station hydrograph, but it has more expressed peaks.

It is visible on plot that in January precipitation event took place. This precipitation event is visible on analogue station also, for checking that it is necessary to look on precipitation data happened during that period of time. Nearby meteorological station was found (Tjotta (76530) and appropriate precipitation data was obtained via www.eklima.no website.

The precipitation event is also have been registered by meteorological station, that means that missing data gap can be removed with scaled data.

- It is important to find proper analogue stations for making scaling. As was mentioned before it is important to take into consideration a number of factors influencing on catchment selection (as area, size, lake percentage, climatic parameters). It is obvious that there is no ideally suitable catchment which will satisfy all mentioned points, although it is necessary to find better one. In the figure below there is a number of analogue stations duration curves scaled for SWECO catchments plotted versus SWECO unique duration curve. Y axis represents average flow for each analogue station in percentage. Black curve is a true measured duration curve for certain catchment. As seen from Figure 3-34 analogue stations duration curves shows different scenarios for the same period. Some curves are quite close to measured one, but some curves differ from measured curve. Figure 3-34 is an example of importance of choosing correct analogue station.

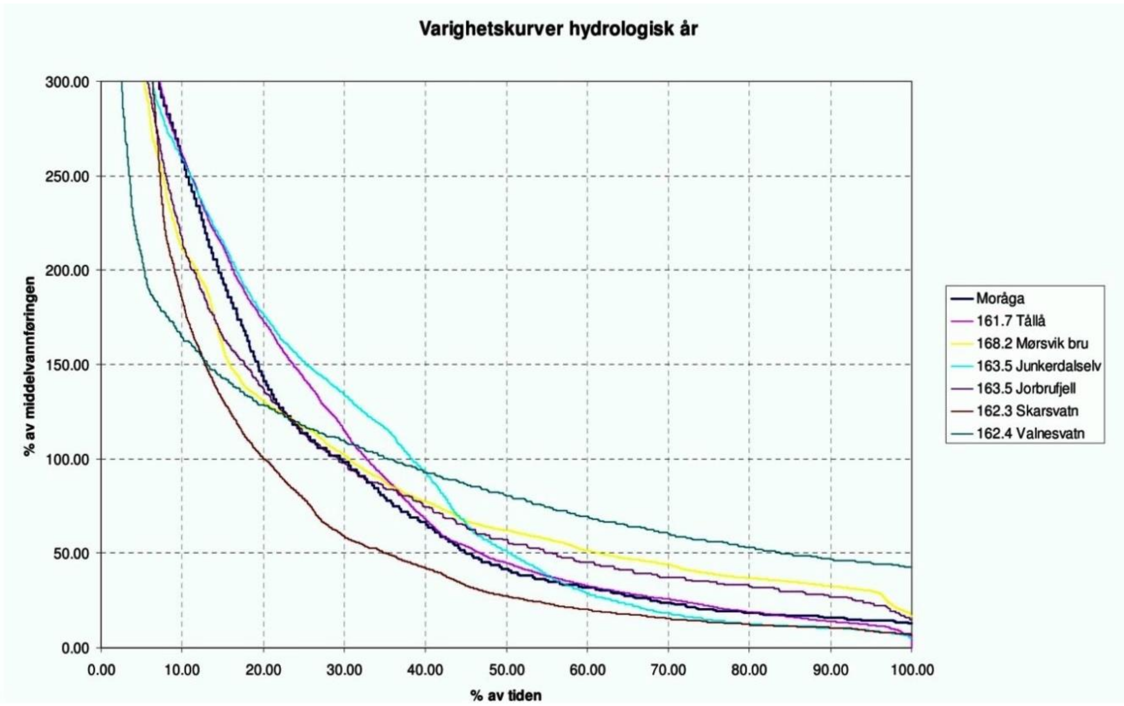


Figure 3-34. Plotting of different analogue stations duration curve versus measured. (Sweco, 2014)

3.7.3 Recommendation and discussion

Following points are found to be taken into consideration or to be improved:

1. For making quality control based on measurement points it is necessary to ensure that proper number of stage-discharge measurements have been done in order to obtain smooth and accurate stage-discharge curve. As was noticed during station exploitation time from 5 to 6 measurements are recorded. I would recommend to do more measurements in order to avoid probable errors which creates programm while doing stage-discharge curve. Moreover, I would recommend to do measurements of stages at different range. As shown in Figure 3-31 measurement points are "combined" together at the start of curve and very rare in between. More measurements would ensure goodness and accuracy of stage-discharge curve smoothing.

2. The next point which is recommended - to check observed peaks with precipitation data gained from meteorological stations. Sometimes analogue station could also show peaks at the same time by accident. To prevent erroneous scaling meteorological data should be taken in consideration.

3. Sometimes downscaling method is not optimal solution for correcting or infilling missed data. The reason of that analogue stations sometimes are very difficult to find (since selection of analogue station is based on many factors) and scaling factor could be very low. In this case downscaling should be done for short period correction, but if missed data period is quite long that means that it will affect data definitely.

4. It is important to observe not only recorded discharge data series but temperature and stage also. Sometimes observing these data series could detect some errors which are not visible while discharge screening. (Figure 3-30.)

4. ANALYSIS

4.1 Introduction

During last years development of small hydropower in Norway becomes more extensive. In most cases small hydropower plants are located in small catchments, where discharge measurements have not been provided and most of gauging stations are located in comparably big catchments. In this case for calculating runoff for small catchment it is common to scale it from the bigger catchments, which have almost the same characteristics, in other words the procedure is to downscale runoff from gauged to ungauged catchment. But in sometimes it could lead to overestimated or underestimated data, which in both cases could lead either to additional spill of water in hydropower plant or loose of potential production. It is important to have correct runoff data from environmental point of view also, because underestimating of environmental flow will lead to ecological disasters. (W. Marchand, 2013)

Studying and analysis of small catchments will lead to more accurate runoff, in other word - improvement of Q95 values, etc. Scaling of runoff series from analogue gauged station (with similar catchment characteristics, like size, lake percentage, etc.) to ungauged catchment will be shown in this chapter. The analysis is made to find out possible differences, when doing scaling from analogue stations and using small catchment unique measurements. For doing that 3 to 7 years period observation have been analysed.

It should be mentioned that some stations have been rejected from analysis. After more careful screening it appears that some stations shows extremely low runoff, the reason was unforeseen geological phenomena. Savjord-Savaaga and Selfors Savaga are located in karsteous area and size of catchment cannot be estimated, because water comes from underground. Kvernhusbekken and Hestaga stations have very short observation time, these stations cannot be used in statistics.

4.2 Methods

Important statistical figures of discharge series have been compared for 19 catchments. The main focus was on figures that have impact on power station production. Average flow is one of important issue.

Average specific runoff from actual SWECO measurements have been compared with average specific runoff from the same catchment calculated by Lavvann application. Lavvann is an online Geographical information System (GIS) tool, which calculates catchment statistics. The observations period used in NVE Lavvann application is normal period from 1961 till 1990.

Q95 from actual SWECO measurements were compared with Q95 values obtained through Lavvan. Since values varies from what was calculated by Lavvann application, two long-term hydrographs with Q95 values were presented to figure out changes in hydrographs within normal period and during recent years.

Regression equation and R2 values were established for arguing about relation between NVE Lavvann and SWECO calculations about mean runoff.

The deviations between calculated and observed values are discussed in Results chapter.

Flow-duration curves for selected stations have been prepared and compared with scaled duration curves from analogue station both for the same period as SWECO have done measurements (will be called as "short-term") and long term data available in NVE. Data from analogue station for scaling and comparison was taken within same period as SWECO stations observation and for long time period. Discussions about findings and difference between two obtained curves are shown in sub-chapter below.

Relation of flow duration curve with topographic and climatic parameters was made on basis of comparing mean flow and Q95 of selected stations and obtained catchment characteristics calculated via Lavvann Low Flow application and steepness of catchment.

4.3 Results and discussion

As have been mentioned in most cases it is not easy to find good analogue station, which will have the same catchment size. Mainly the best analogue station should have larger catchment area than treated one.

Scaling factors have been calculated on the basis of areas and specific runoff for certain period of time when SWECO measurements have been done. Specific runoff of NVE stations have been calculated for the same period. In this case scaling factors varies from 0.08 to 1.63 and the factor from measured to analogue station varies from 0.4 to 27.1. Ratios and scaling factors are shown in Table 4-1.

Table 4-1. SWECO stations and corresponding analogue NVE station, scaling factors and ration.

Analogue NVE station number	Area of NVE stations (km2)	Scaling factor F1A1/F2A2	No	Stasjonsnavn	Area of SWECO station (km2)	SWECO to NVE area ratio
94.19.0	76.16	0.08	1	Aurstadelva	5.26	14.5
79.3.0	30.08	0.49	2	Berge	12.06	2.5
79.3.0	30.08	0.32	3	Bjåstad	8.74	3.4
163.6.0	69.2	0.25	4	Breidalselva	4.80	14.4
163.6.0	69.2	0.24	5	Breivikelva	5.63	12.3
156.15.0	56.04	0.72	6	Forsland	36.26	1.5
94.19.0	76.16	0.13	7	Kasseelva	6.58	11.6
163.6.0	69.2	0.31	8	Kjellingelva	10.30	6.7
155.27.0	159.03	1.28	9	Krutåga	173.63	0.9
156.15.0	56.04	0.22	10	Laupen	9.80	5.7
163.6.0	69.2	0.41	11	Lille Gråttåga	6.20	11.2
103.20.0	44.4	0.85	12	Skorgeelva	42.28	1.1
149.1.0	95.2	0.17	13	Storfjelltjønna	9.67	9.8
109.29.0	85.85	0.39	14	Erga	26.50	3.2
41.8.0	27.5	1.02	15	Bordalselv	45.17	0.6
41.8.0	27.5	1.34	16	Skromme	42.52	0.6
41.8.0	27.5	1.63	17	Grøno	66.32	0.4
41.8.0	27.5	0.99	18	Middal	46.10	0.6
37.27.0	12.4	0.38	19	Strandåna	4.10	3.0

Mean runoff via Lavvann application for normal period was calculated and compared with mean runoff for the same catchment for observed period. Results are shown in Table below. As seen from graph some stations shows very huge difference from what was calculated by Lavvann. Breidalselva catchment has the biggest deviation from NVE - 52% more than, what

NVE Lavvann calculated, and Lille Grataaga catchment shows 21.63% lower than what has Lavvann.

Table 4-2. Mean runoff of SWECO and NVE Lavvann (1961-1990)

Analogue NVE station number	Stasjonsnavn	Mean runoff 61-90, NVE l/s/km2	Mean runoff SWECO, l/s/km2	Difference in percentage, %
94.19.0	Aurstadelva	98.9	92.73	-6.24
79.3.0	Berge	100.4	93.99	-6.38
79.3.0	Bjåstad	95.0	86.24	-9.22
163.6.0	Breidalselva	83.3	126.97	52.42
163.6.0	Breivikelva	104.0	111.38	7.10
156.15.0	Forsland	103.5	97.87	-5.44
94.19.0	Kasseelva	106.0	103.61	-2.25
163.6.0	Kjellingelva	73.0	75.73	3.74
155.27.0	Krutåga	44.5	46.13	3.66
156.15.0	Laupen	115.9	108.13	-6.70
163.6.0	Lille Gråttåga	82.1	64.34	-21.63
103.20.0	Skorgeelva	49.8	60.34	21.16
149.1.0	Storfjelltjønna	112.0	138.33	23.51
109.29.0	Erga	30.6	49.19	60.76
41.8.0	Bordalselv	83.9	77.38	-7.77
41.8.0	Skromme	84.8	108.33	27.75
41.8.0	Grøno	71.4	85.98	20.42
41.8.0	Middal	62.2	75.24	20.97
37.27.0	Strandåna	81.8	122.31	49.53

It is interesting to find out is there any relationship between SWECO and NVE Lavvann mean runoff. Comparison plot of NVE and SWECO station with regression equation is done. R2 value equal 0.581. From 19 analysed stations 8 stations shows lower result from NVE Lavvann and 11 stations shows higher result than NVE Lavvann. Correlation coefficient equal 0.762. Both regression equation and R2 values proof that there is strong relation between mean runoff calculated by Lavvann and SWECO measurements. This relation is very interesting and should be studied in future, since comparison is made between normal period (1960-1990) and last decade. Figure 4-1 shows relation of NVE Lavvann and SWECO mean runoff.

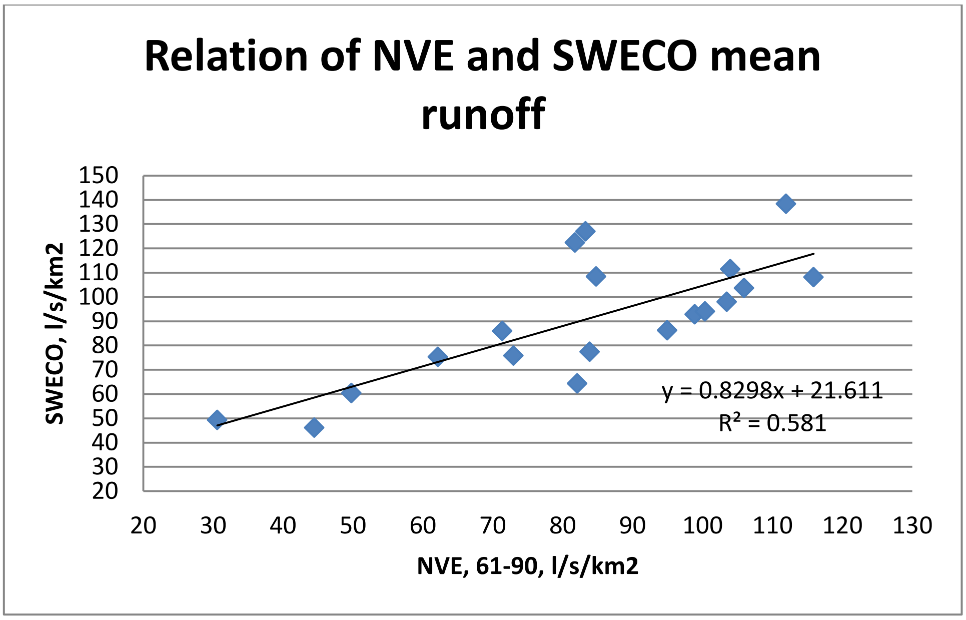


Figure 4-1. Relation of NVE and SWECO mean runoff.

The same comparison plot has been done for Q95 SWECO and Q95 for NVE Lavvann values. The 11 stations shows lower values that NVE Q95 has computed and 9 shows higher result. As seen from figure below there is no strict relation between those values, R value is very low and regression coefficient has negative value.

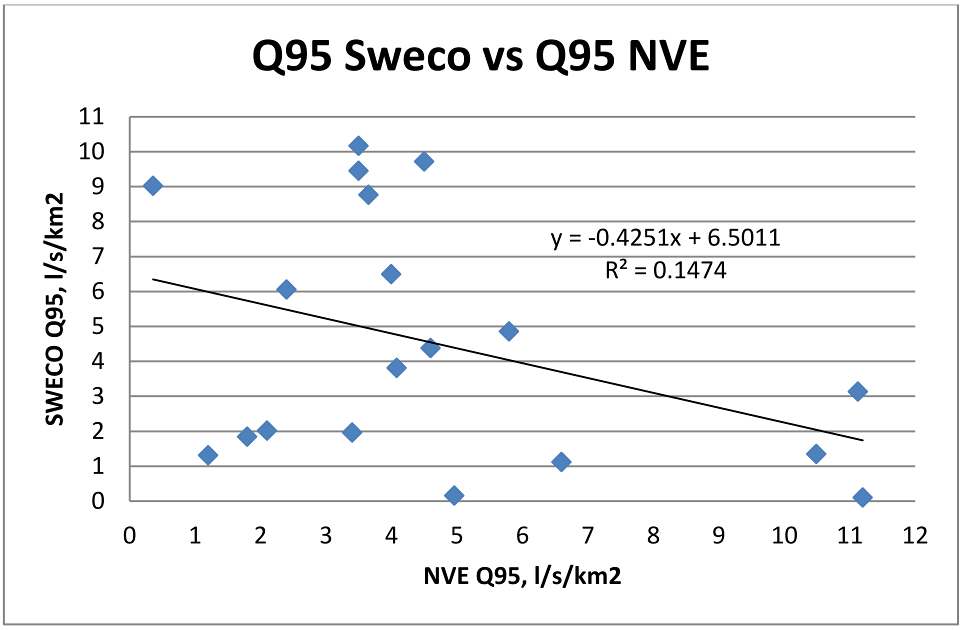


Figure 4-2. Relation of Q95 SWECO and NVE Q95 (1961-1990)

That variance could mean that distribution of flow has been changed through normal period in comparison of recent years. The proof of that change could be a plot of long-term Q95 data, including both normal period and period when SWECO observations have been done.

On the Figure 4-3 is shown two long term hydrographs from two different catchments with yearly Q95 values. It is obvious that hydrographs pattern has changed though the time. The upper hydrograph shows reducing trend it means that catchment become dryer and below hydrograph shows rising trend, that is apparent sign of that catchment in recent years has more dryer years than before.

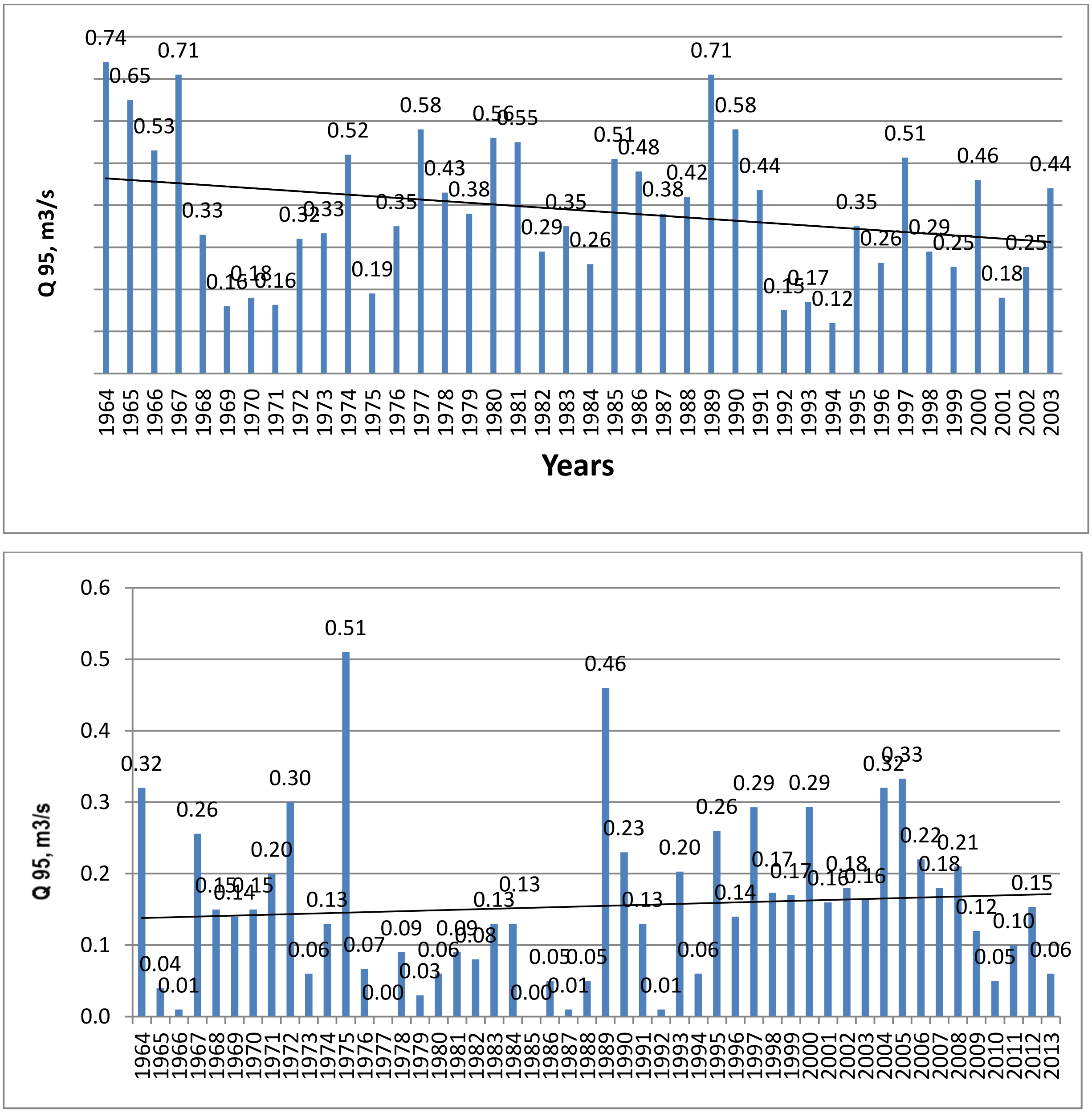


Figure 4-3. Long term plot of Q95.

Based on points described in "A Comparison of Low Flow Estimates in Ungauged Catchments Using Regional Regression and the HBV-Model" by K. Engeland and H. Hisdalf (K. Engeland, 2009) for finding relationship between flow characteristics and topographical and climatic parameters of catchment, following plots have been done.

On Figure 4-4 there is plot of Q95 relation to a height gradient. Height gradient was calculated as difference between maximum and minimum height elevations and divided by length of catchment. From regression equation it is visible that there are no strict relation between Q95 and height gradient. The regression equation shows low value, that means that this relation has almost flat trend.

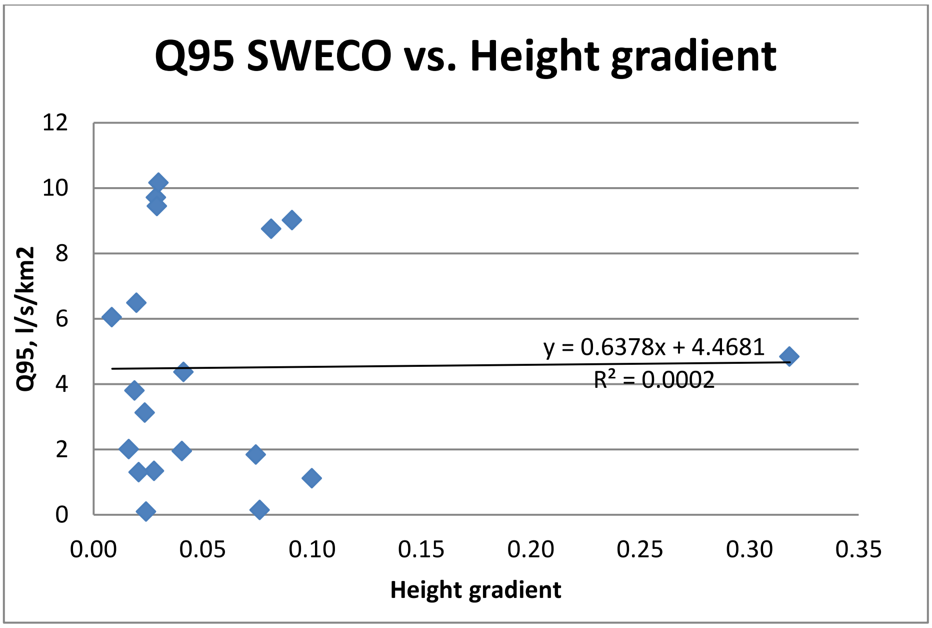


Figure 4-4. Relation of Q95 and height gradient

The relation between mean runoff and height gradient is stronger. Figure 4-5 shows that R2 value is much bigger than in case with Q95.

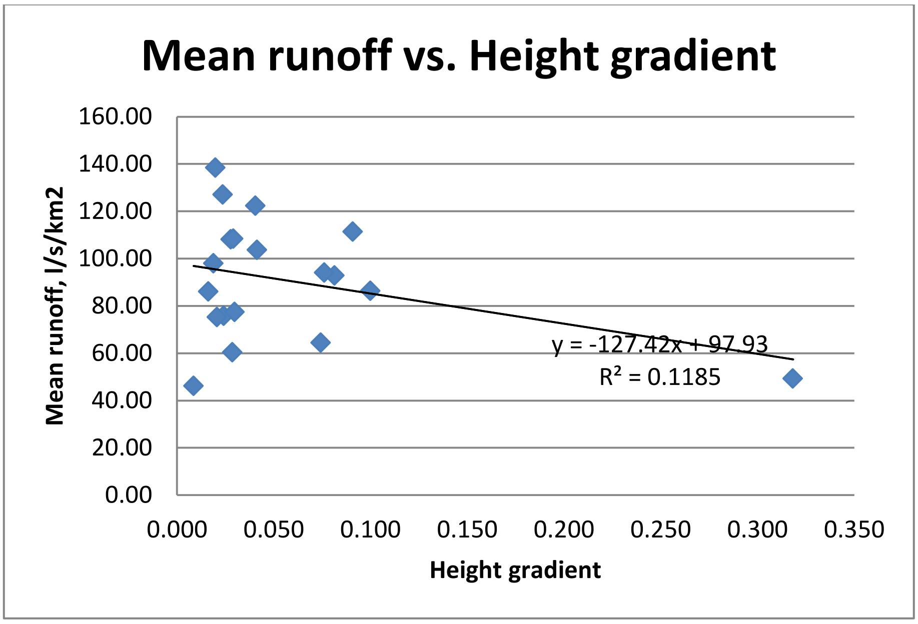


Figure 4-5. Relation of mean runoff and height gradient

The relation of Q95 with effective lake percentage is shown in Figure 4-5. The catchments which have lake percentage value equal to 0 have been rejected in order not to impact relation. As seen from below figure, R2 value is very low to establish any strong relation.

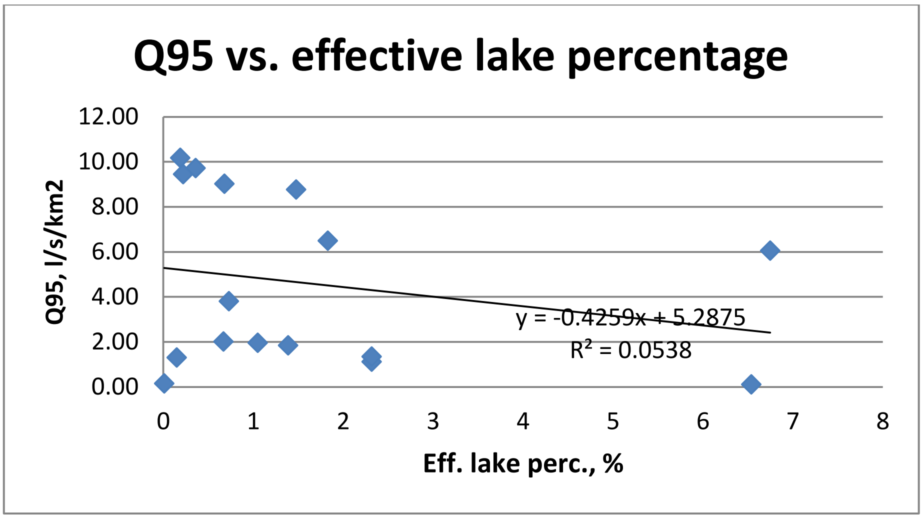


Figure 4-6. Relation of Q95 and effective lake percentage.

While plotting mean runoff versus effective lake percentage it is evident that relation is quite weak, but in comparison of R2 values it is evident that relation of mean runoff-effective lake percentage has stronger relation.

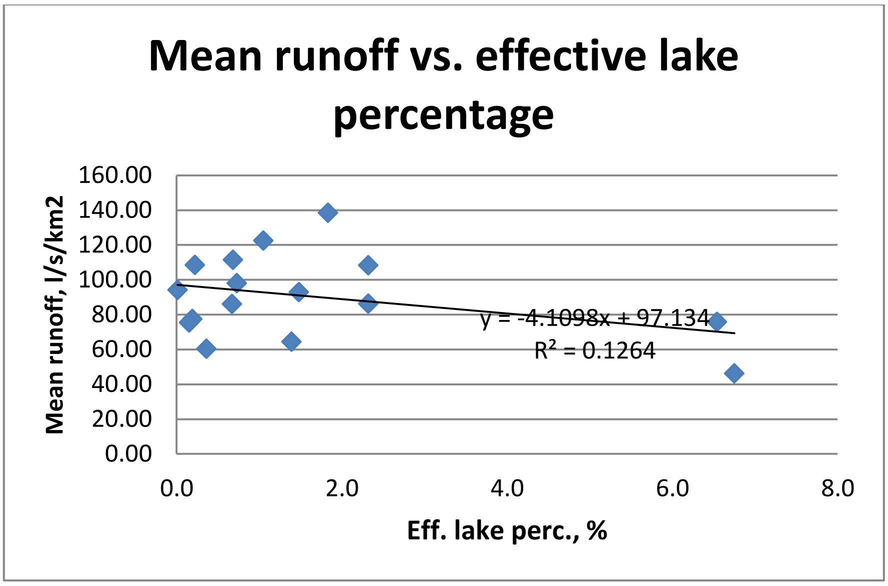


Figure 4-7. Relation of mean runoff and effective lake percentage.

On the figure below presented relation of Q95 with low vegetation percentage. Low vegetation percentage is the percentage of low vegetation like shrubs and similar growth. As seen from the Figure 4-8 there is no strong relation between Q95 and low vegetation percentage, but while plotting mean runoff versus low vegetation percentage it is evident that strong relation is present.

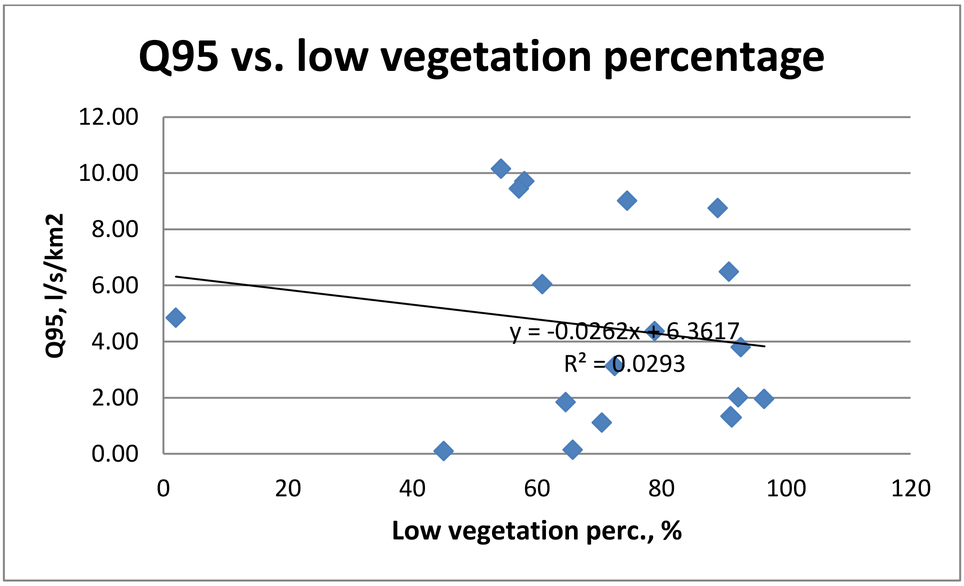


Figure 4-8.Relation of Q95 and low vegetation percentage.

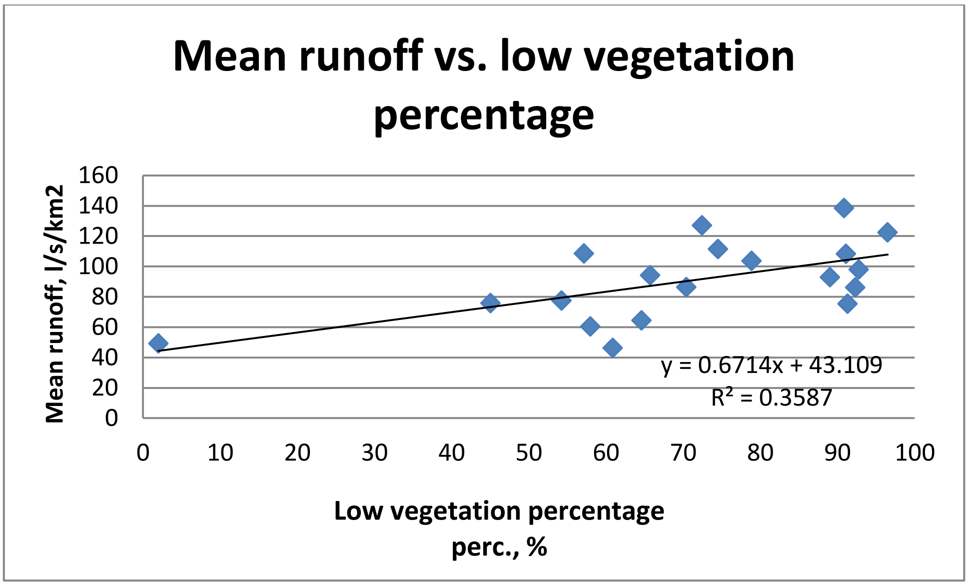


Figure 4-9. Relation of mean runoff and low vegetation percentage

For summarizing this part of analysis it is necessary to point out that relation between catchment characteristics and mean runoff of SWECO stations has better relation than with Q95. The possible reasons of that should be studied in future.

Scaling of runoff series from analogue gauged station (with similar catchment characteristics, like size, lake percentage, etc.) to SWECO is done and comparable plot of duration curves of all selected stations is presented below. Scaling was performed on the basis of mean runoff and area data. Ideally scaling factor should be equal to one, but in our case that is impossible, because of area and specific runoff difference between analogue and measured catchments. Figure 4-10 shows scaling factor for each station. Usually stations with low scaling factor have great difference at high flow and approximately no difference at low flows in comparison with SWECO data. As seen from graph the lowest scaling factor has Aurstadelva and Storfjeltjonna catchments and as seen from plot of their duration curves, in 10-20% exceedance of time they show peaked different values, but in low flow they are approximately equal. That is possible to see in duration curves presented below. When scaling factors is comparably big, the difference between two duration curves (scaled and measured one) is visible through whole plot. The highest scaling factor has Grono and Skromme stations. Grono station shows quite a good match at high flows, but at mean and low flows scaled values are bigger than measured one. The same picture has Skromme station.

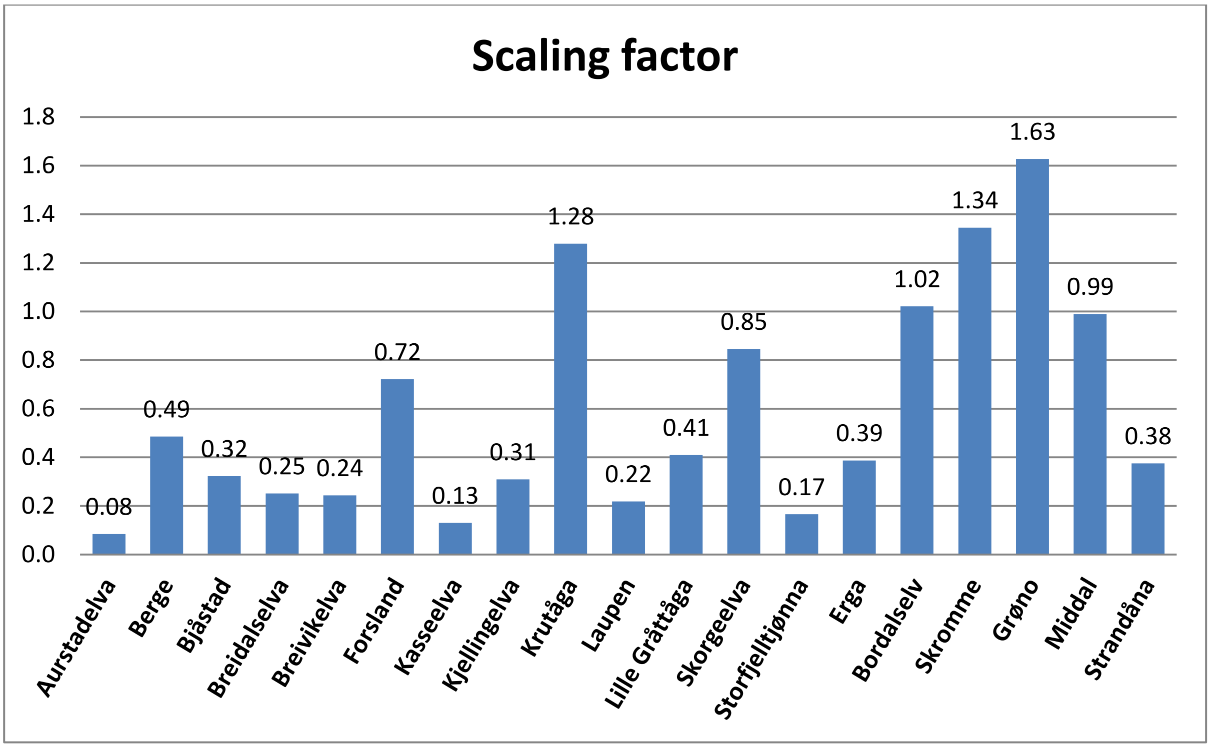


Figure 4-10. Scaling factors of selected stations.

To understand relationship between duration curve and steepness of catchment, height gradient for all selected stations was computed. It was mentioned above that height gradient is calculated on the basis of difference of maximum and minimum height of catchment, divided by catchment length. In other words height gradient is a factor of steepness of catchment. Undoubtedly steepness will influence on catchment runoff response; it means the steeper is catchment the more peaked the duration curve is.

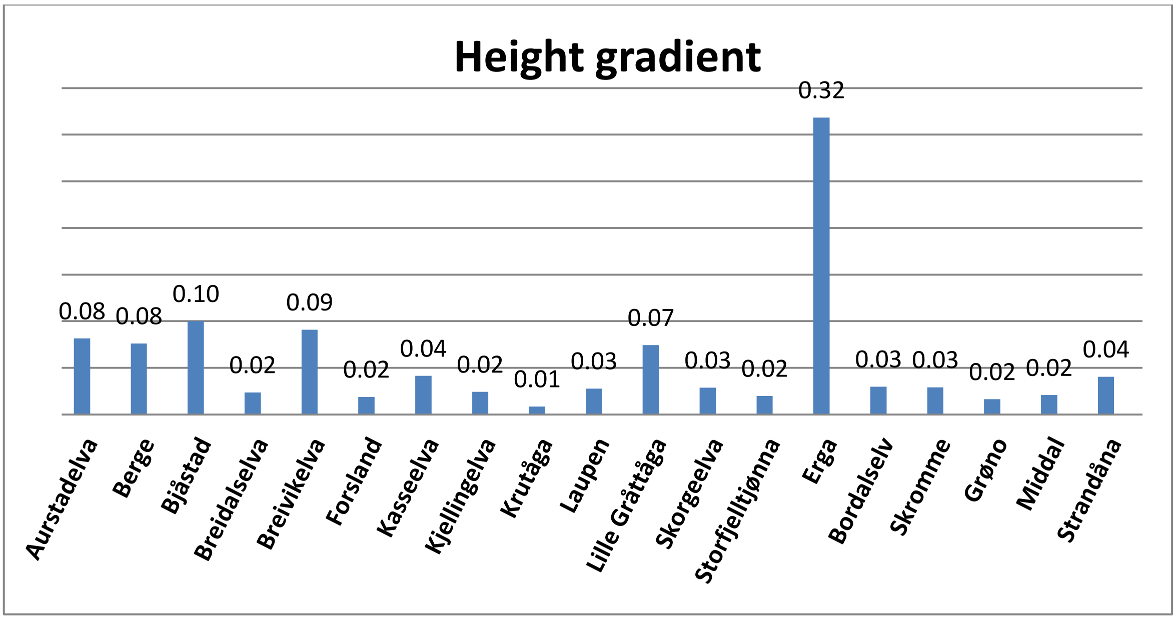


Figure 4-11. Height gradient of selected stations.

The steepest catchments in our analysis are Erga, Bjagstag, Breivikelva catchments. Erga catchment located in mountainous steep area, the height gradient is equal to 0.32. Looking at it's duration curve it is evident that during 10% time exceedance flow drops from approximately 40m3/s to 4m3/s. As seen from Figure 4-11 most of catchments are relatively flat. For example the most flat catchments are Breidalselva, Forsland, Krutaga catchments, undoubtedly their curves have peaks, although curves not pinned to axis as curves from steeper catchments it means that they have more "extended time" of runoff response.

Plots below presents three duration curves of SWECO measured data (green curve), duration curve of scaled measurements from analogue stations for certain time period as has SWECO measurements (red curve), and duration curve made on the basis of scaled data from analogue station but from long period (as long as NVE stations have data)(blue curve). The plot of long term data is important, because planning should be based on long term data and setting of environmental flow should be also calculated on the basis of longterm data. That's why relation of short term SWECO measurements with long term scaled data is analysed.

As seen from the plot that three duration curves behaves in a different way for each station. There is an inset on the plot describing zoomed look to Q95v value for both three curves. Since each station describes different catchments it is necessary to comment on each station separately.

Most stations as Aurstadelva, Bjagstad, Breivikelva, Forsland, Kasseelva, Forsland, Kjellingelva, Laupen, Skorgeelva, Storfjeltjonna, Erga, Skromme, Middal, Strandana at high flows and mid part of duration curve show higher values than scaled values from the same period as SWECO did measurements and for long term scaled data. But when taking closer look to lowest flows, as Q95 value, following stations shows lower value that scaled longterm and shortterm data: Aurstadelva, Berge, Bjagstad, Breidalselva, Kasseelva, Kjellingelva, Laupen, Lille Grataaga, Storfjeltjonna, Grono, Middal, Strandana. This is the proof that scaling could sometimes be correct solution, but sometimes (basically for selecting or computing of environmental flow for ungauged stations) that could be erroneous. Figure 4-12 shows different Q95 values for the same catchment, blue bar is Q95 generated by Lavvann, red bar is calculated on the basis of SWECO observations, and green bar is represents Q95 values calculated on the basis of long term scaled observation of nearest NVE analogue station.

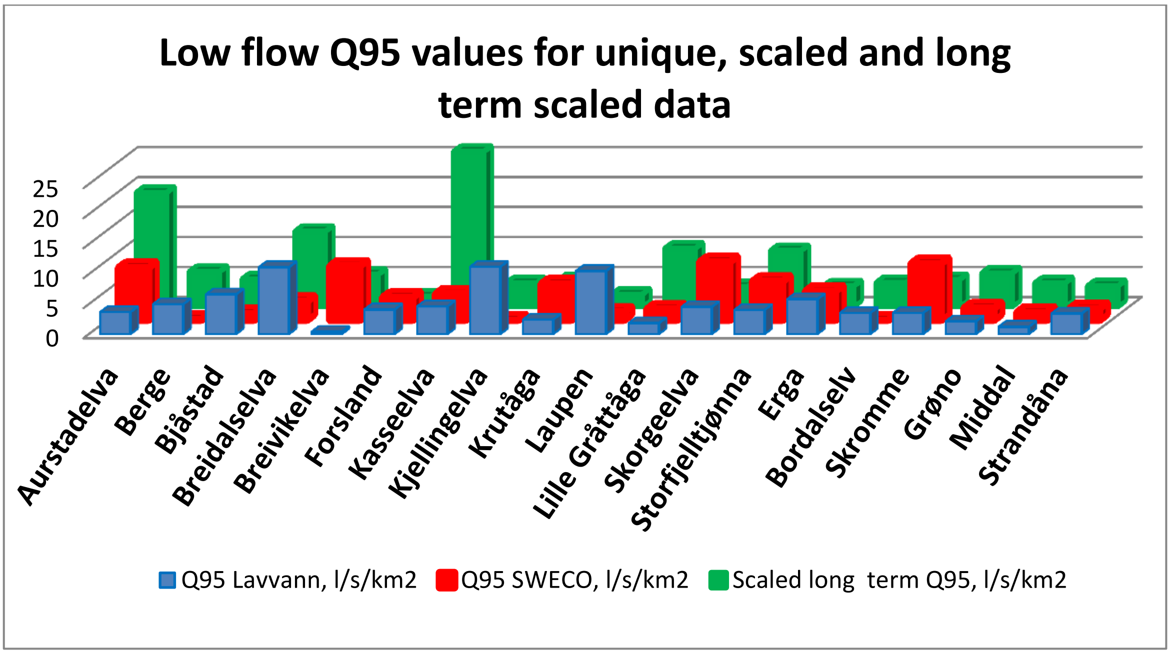


Figure 4-12. Low flow Q95 values for unique, scaled and long term scaled data

Since each station describes different catchments it is necessary to comment on each station separately.

For *Aurstadelva, Bjasted, Middal, Storfjeltjonna, Kasseelva, Strandana* catchment duration curve made on the basis of SWECO observations shows higher values for almost 30-50% exceedance, but afterwile it drops down. For Q95 values SWECO shows much less values than long-term and short-term scaled duration curves. It means if not having SWECO measurements and basing only on scaling from analogue stations 30-50% time flow would be underestimated and Q95 will be overestimated which means additional spill on low flows. For these stations both long term and short term duration curves are quite close to each other.

A *Berge* station duration curve shows some difference between other curves, from Q95 point measures value is overestimated many times.

Breidalselva and *Kjellingelva* duration curves shows that duration curve made on the basis of SWECO measurements lay between scaled long- and short-term duration curves. In this case short term and long term duration curves are located far from each other. Both for two cases Q95 value measured for that catchment is much lower than long-term or short term Q95.

Forsland, Skorgeelvaa, Skromme, Breivikelva catchments' duration curve shows higher values for entire period. In case when scaling from nearby analogue stations will be used for hydropower planning, that will lead to underestimation whole flow. For these catchments Q95 flow considered to be much more than was calculated from analogue stations both for short term and long term period. Such underestimation could have negative impact on environment.

Laupen catchment shows almost "ideally" coincidence of both three curves. Q 95 values are also very close.

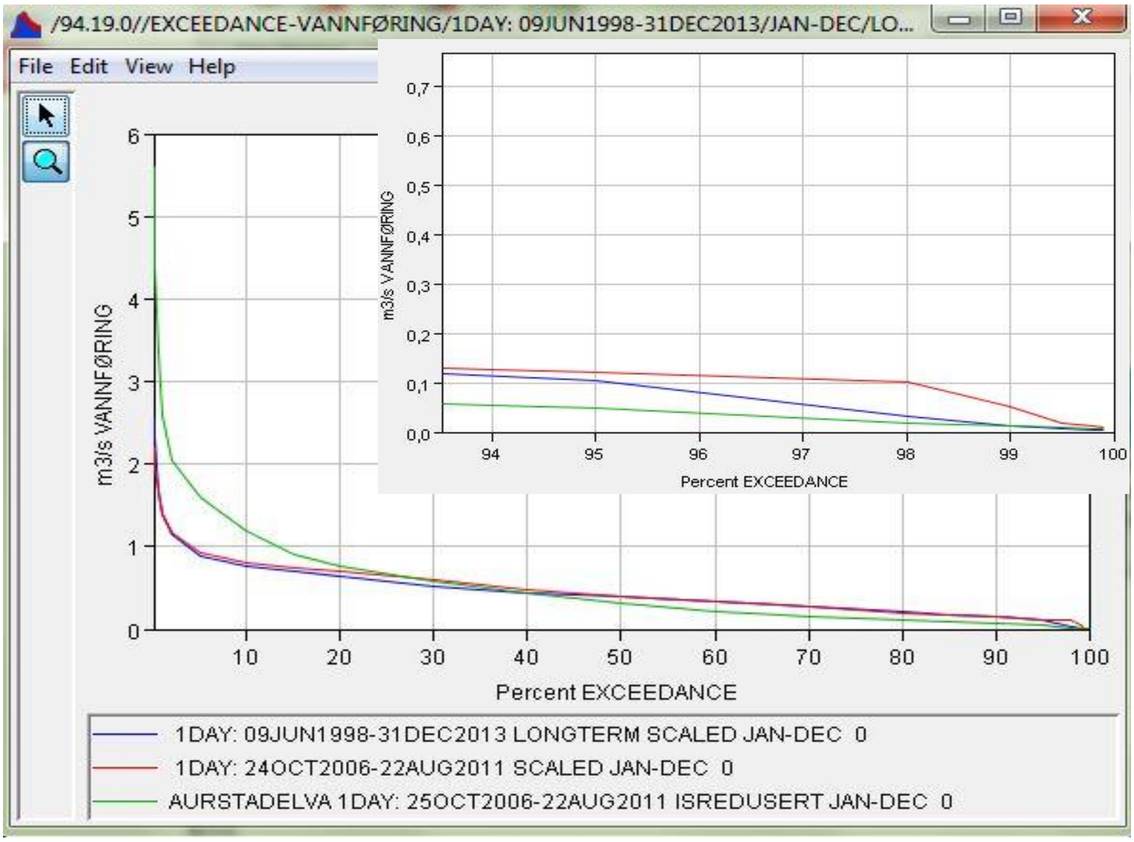
Erga catchment duration curve shows that 20% at high flows there is big difference with observed and scaled duration curves. Though Q95 value is very close to short and long term scaled values

Bordalselv, Krutaga catchment shows quite good match to other duration curves, but a little reduced in high flows. For Q95 values observed measurements shows higher values than scaled values, it means that environmental flow will be underestimated, which will have impact on environment.

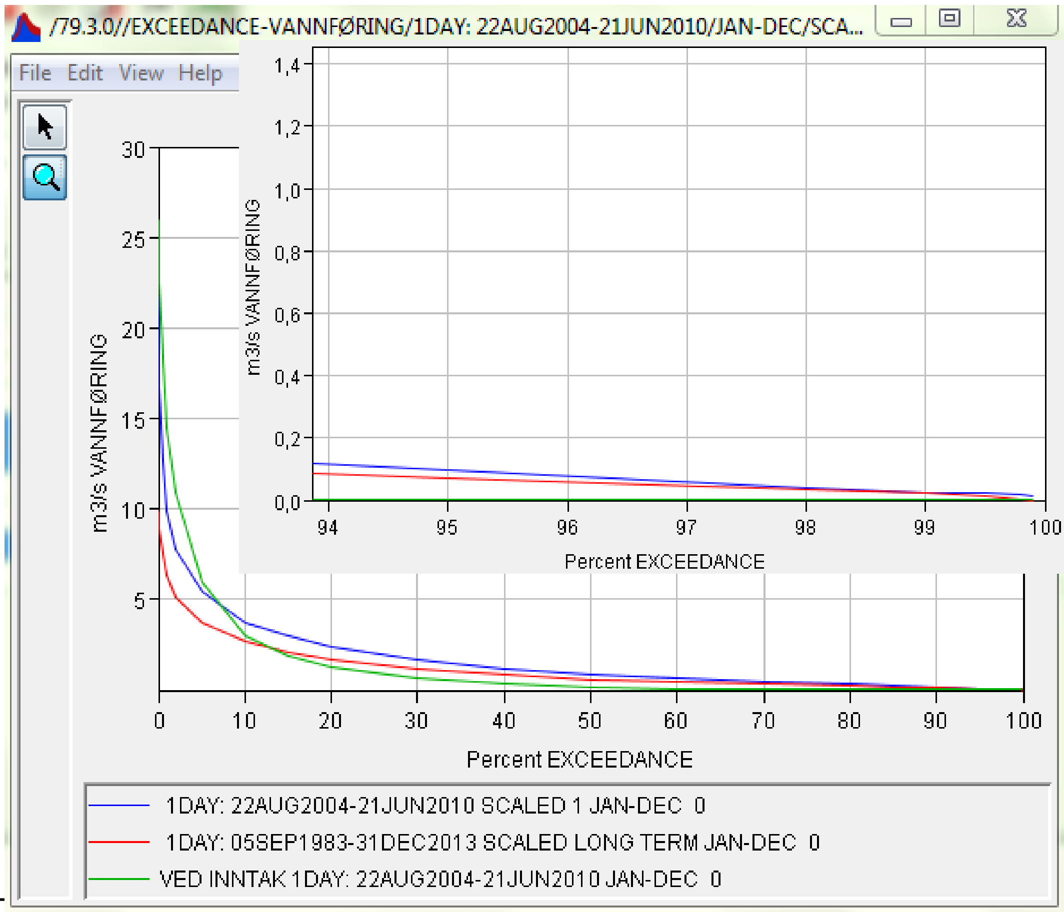
Grøno catchment duration curves shows good match, but with higher Q95 than measured one.

Table 4-3. Duration curves of measured SWECO data, scaled from NVE analogue station (from the same period) and scaled from NVE analogue station (long term)

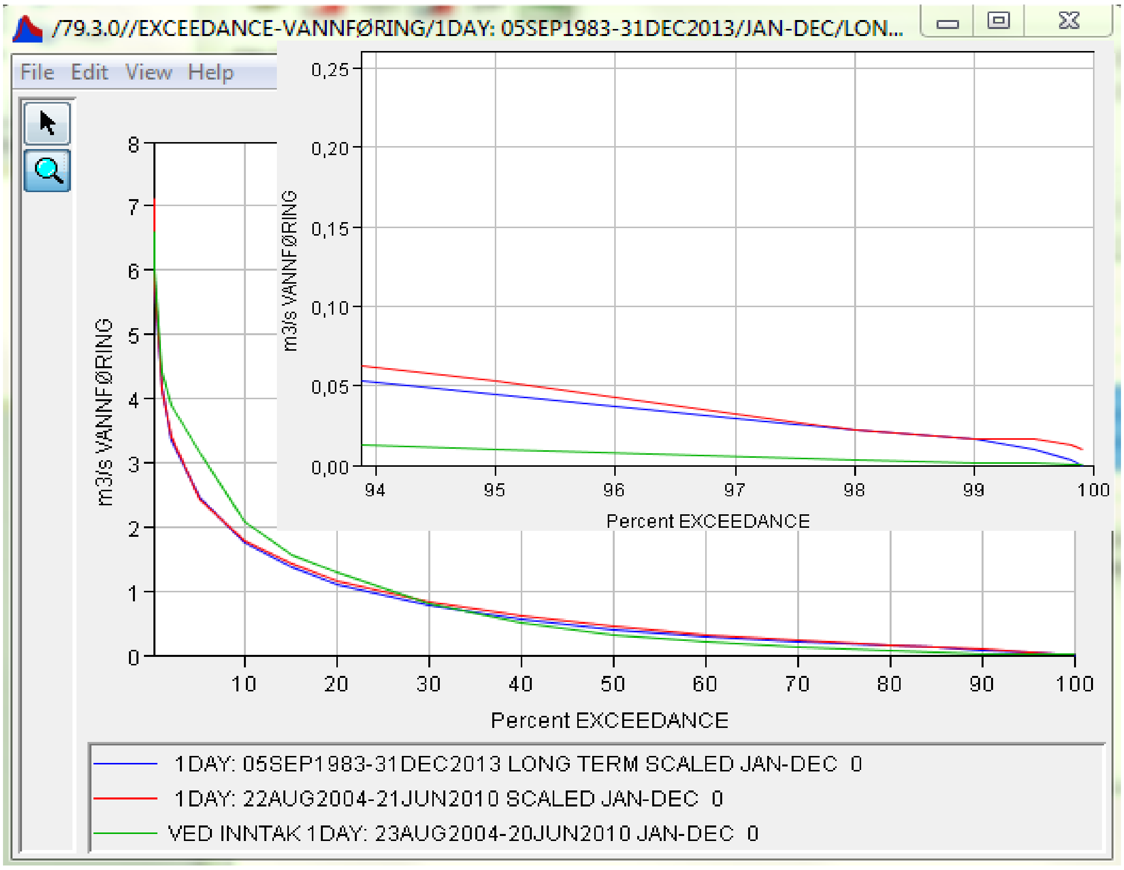
Aurstadelva



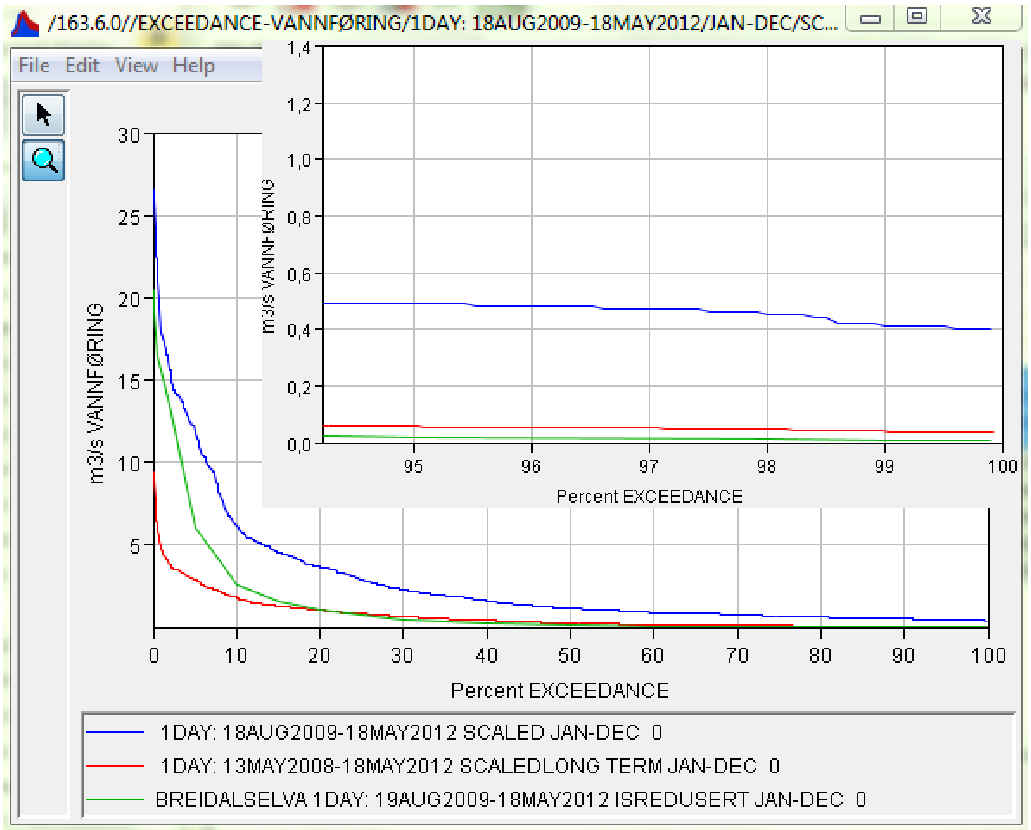
Berge



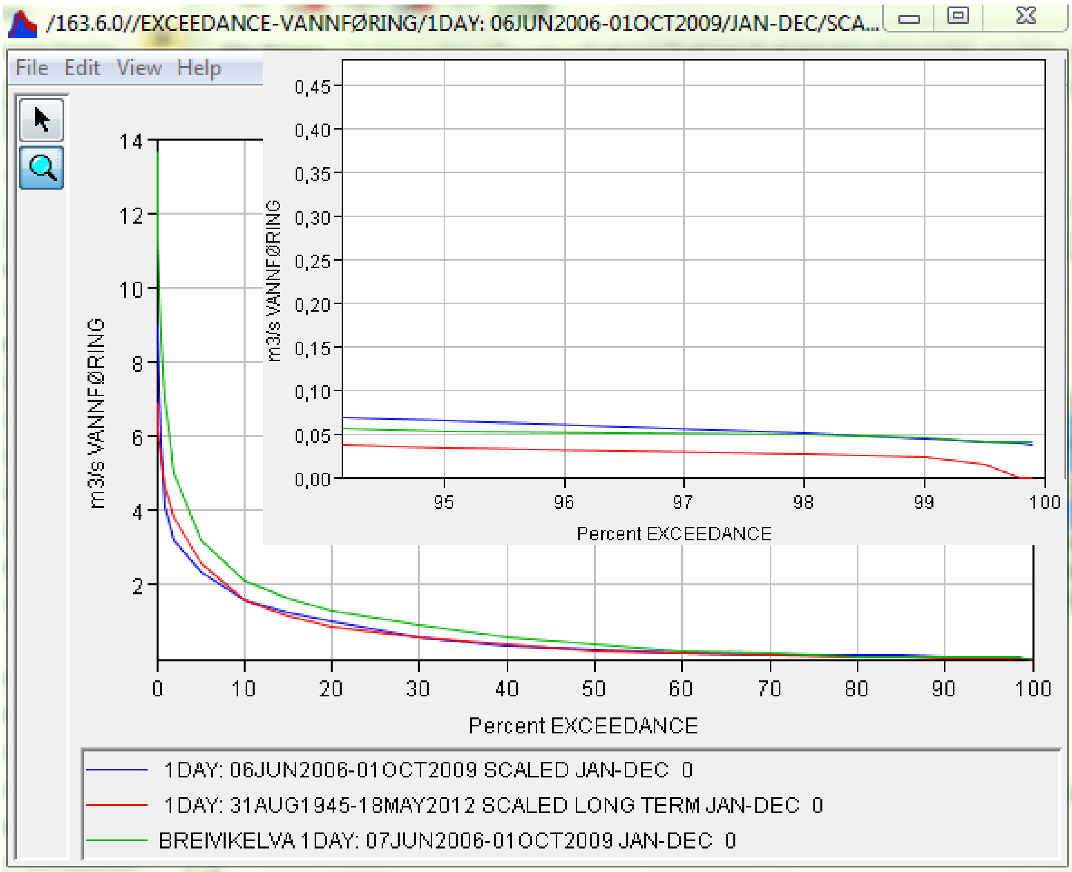
Bjåstad



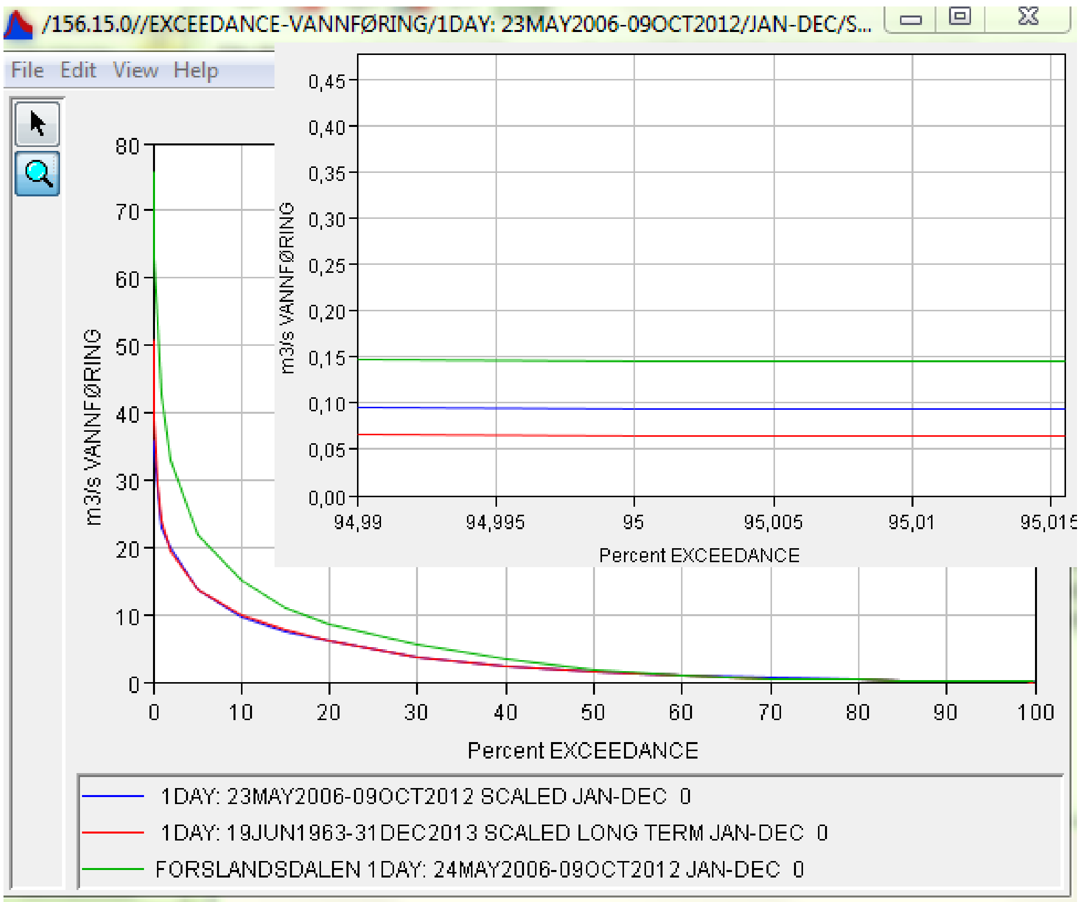
Breidalselva



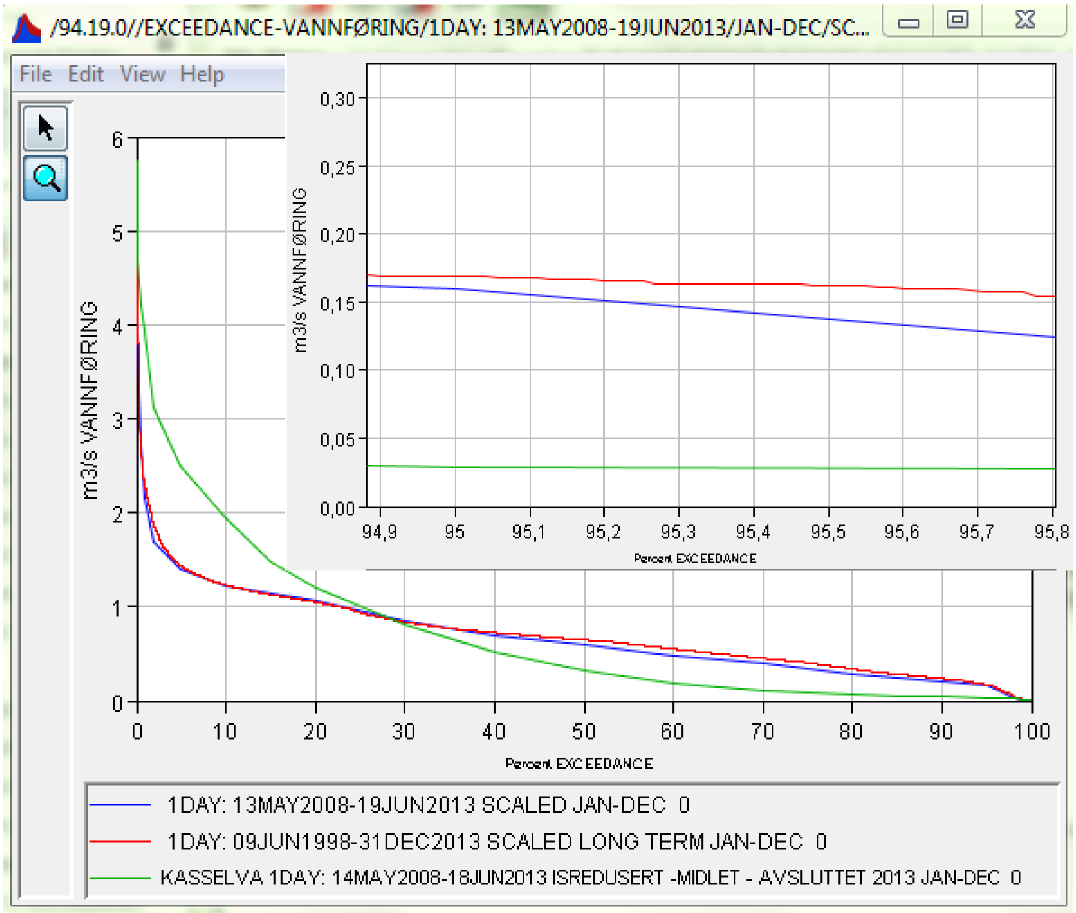
Breivikelva



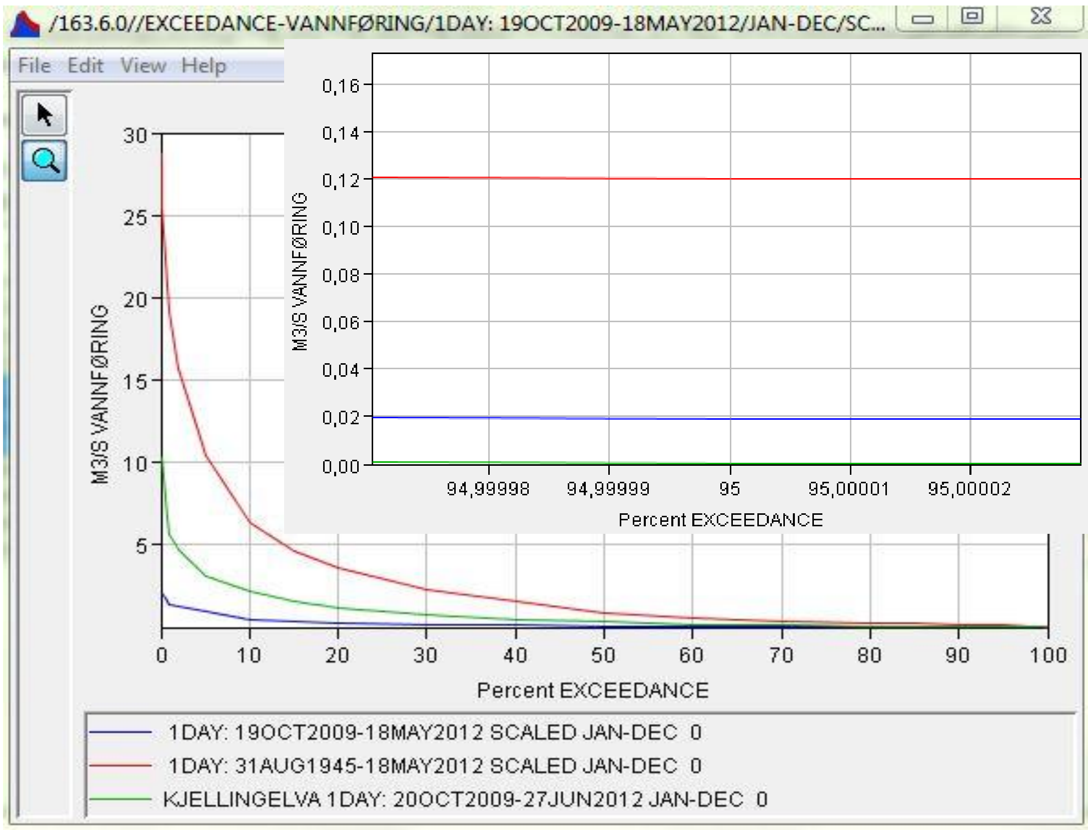
Forsland



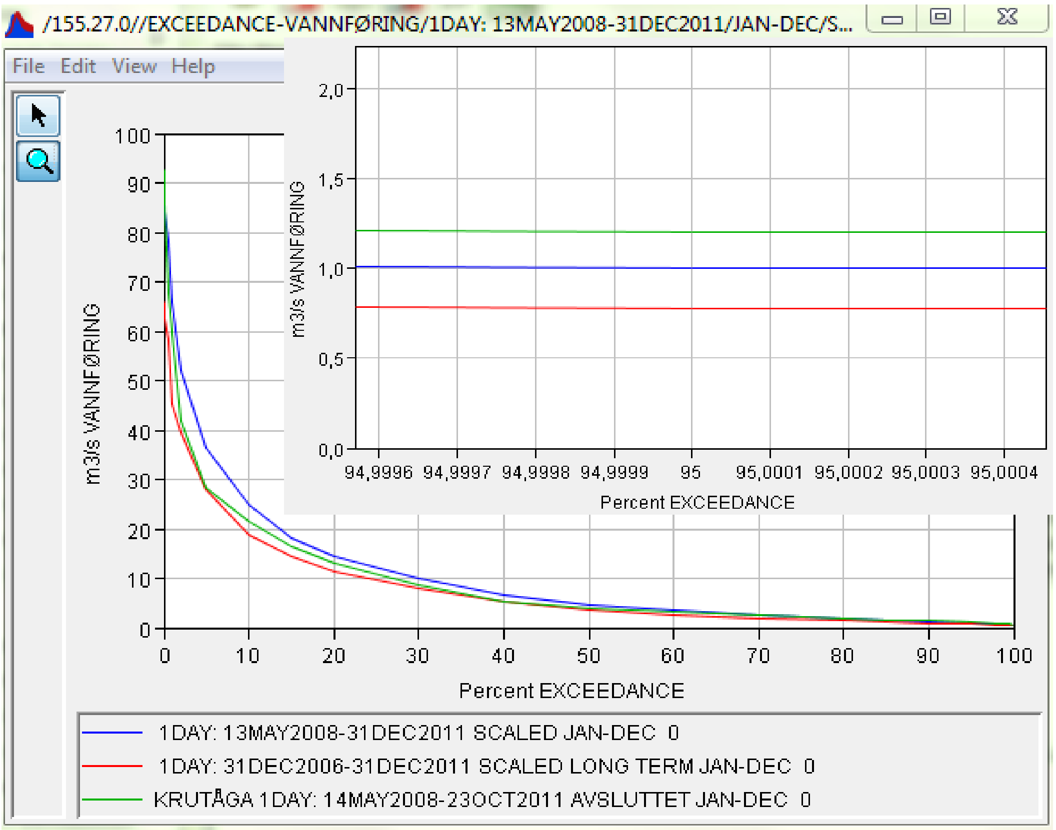
Kasseelva



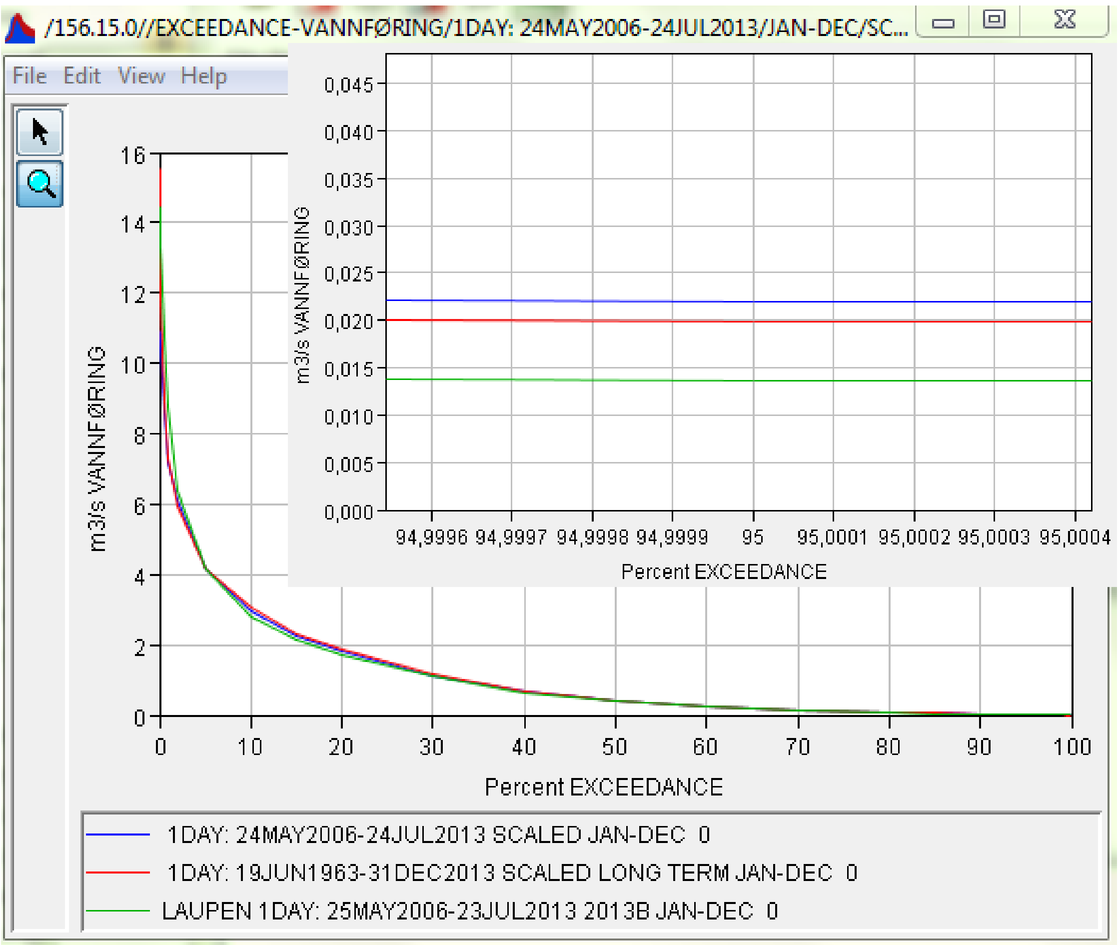
Kjellingelva



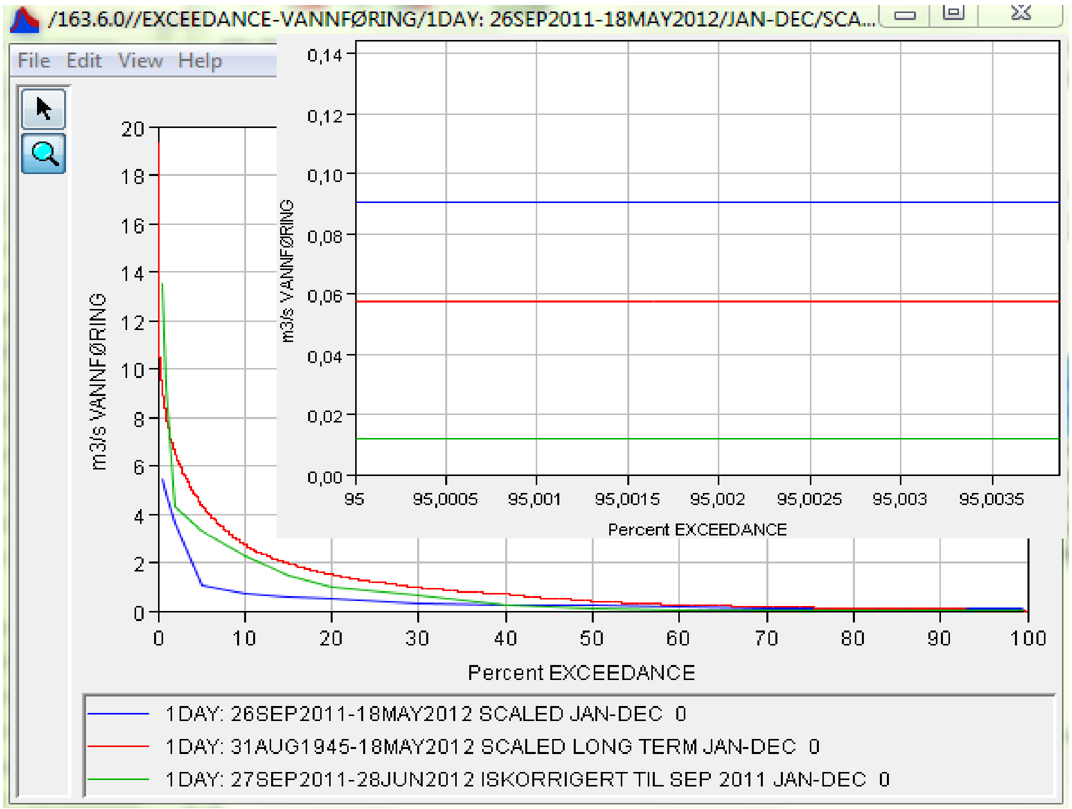
Krutåga



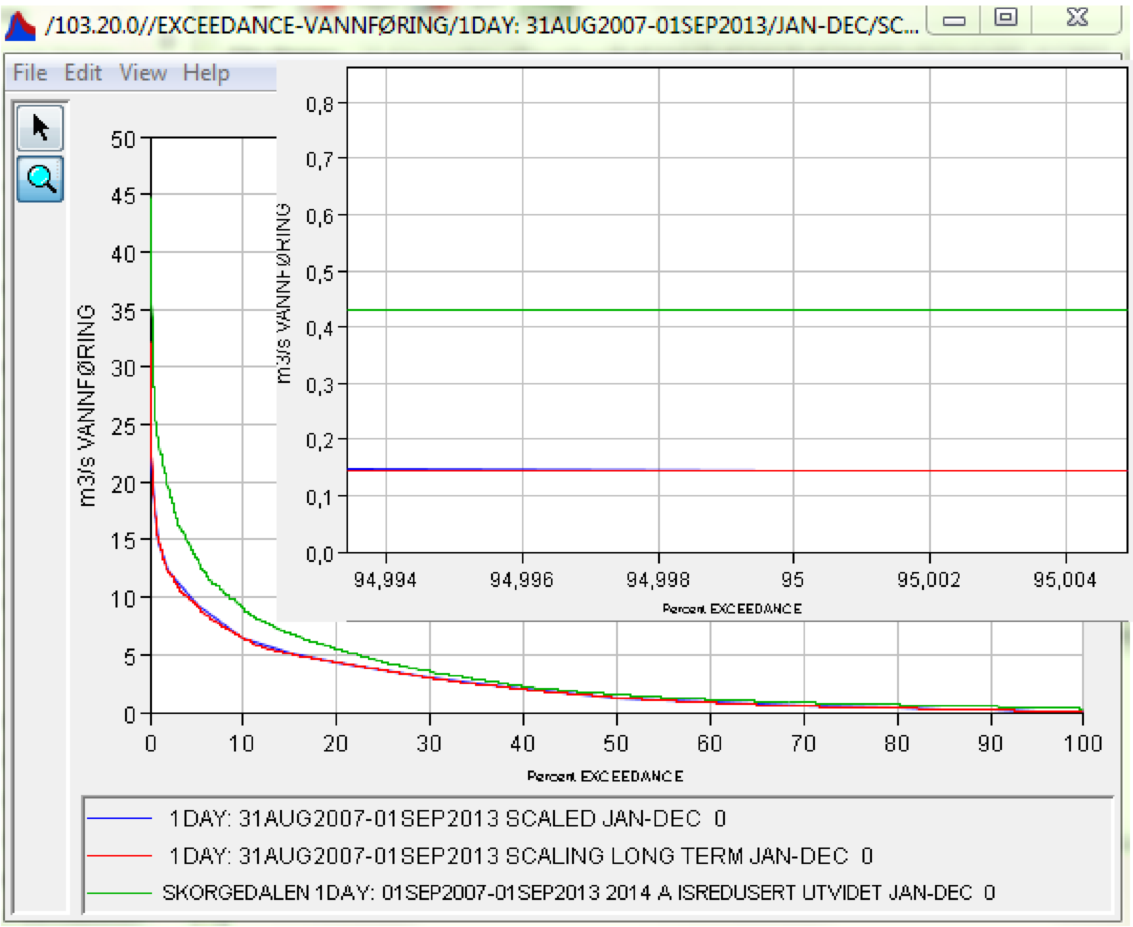
Laupen



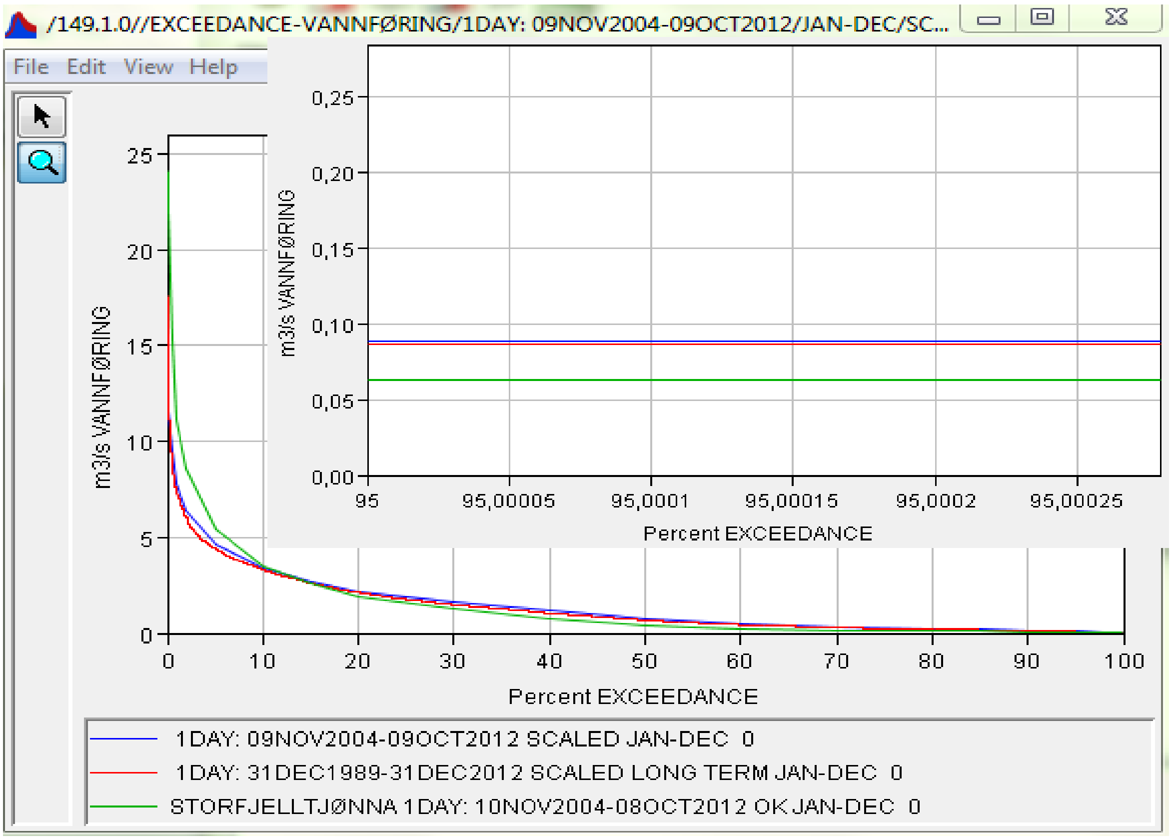
Lille Gråttåga



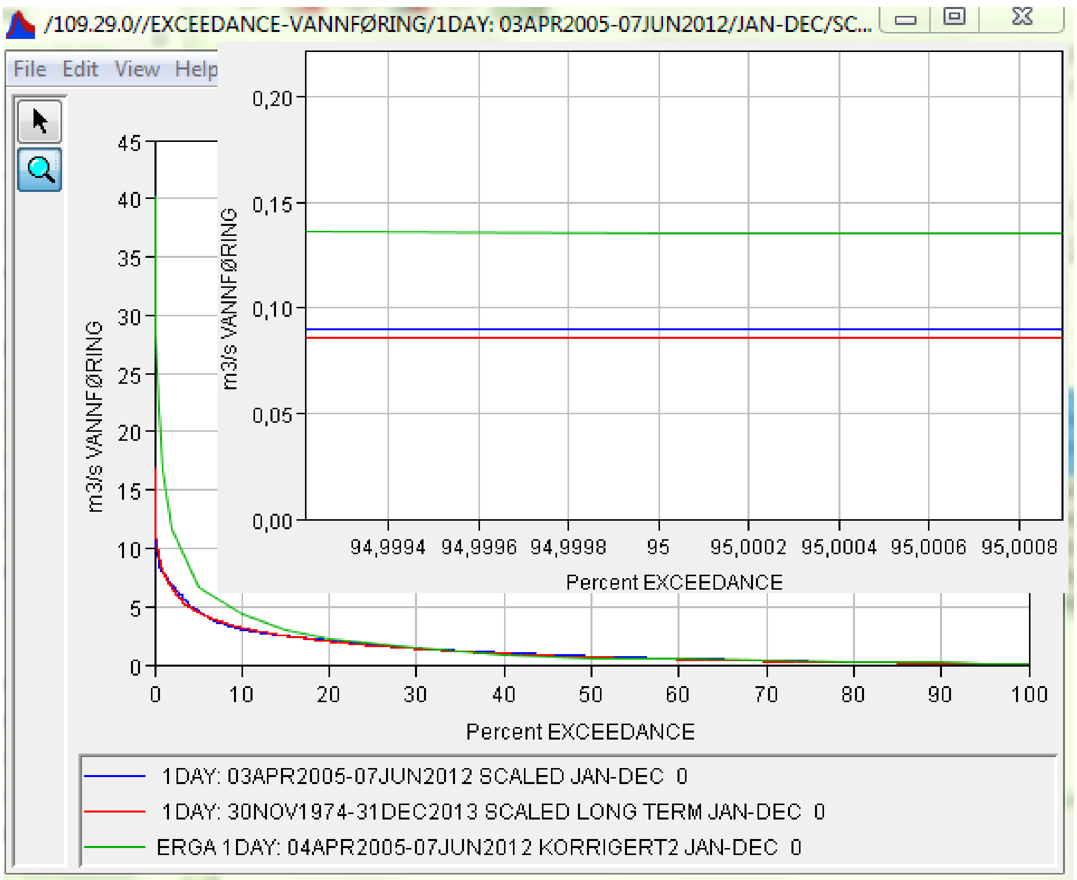
Skorgeelva



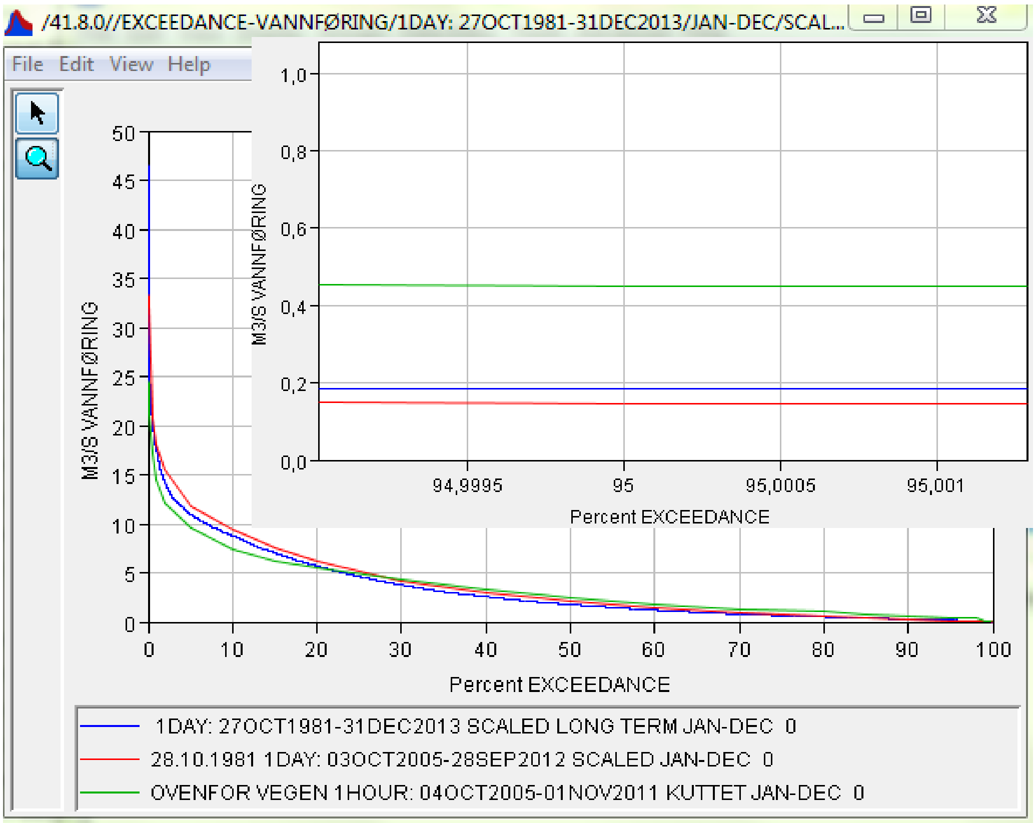
Storfjelltjønna



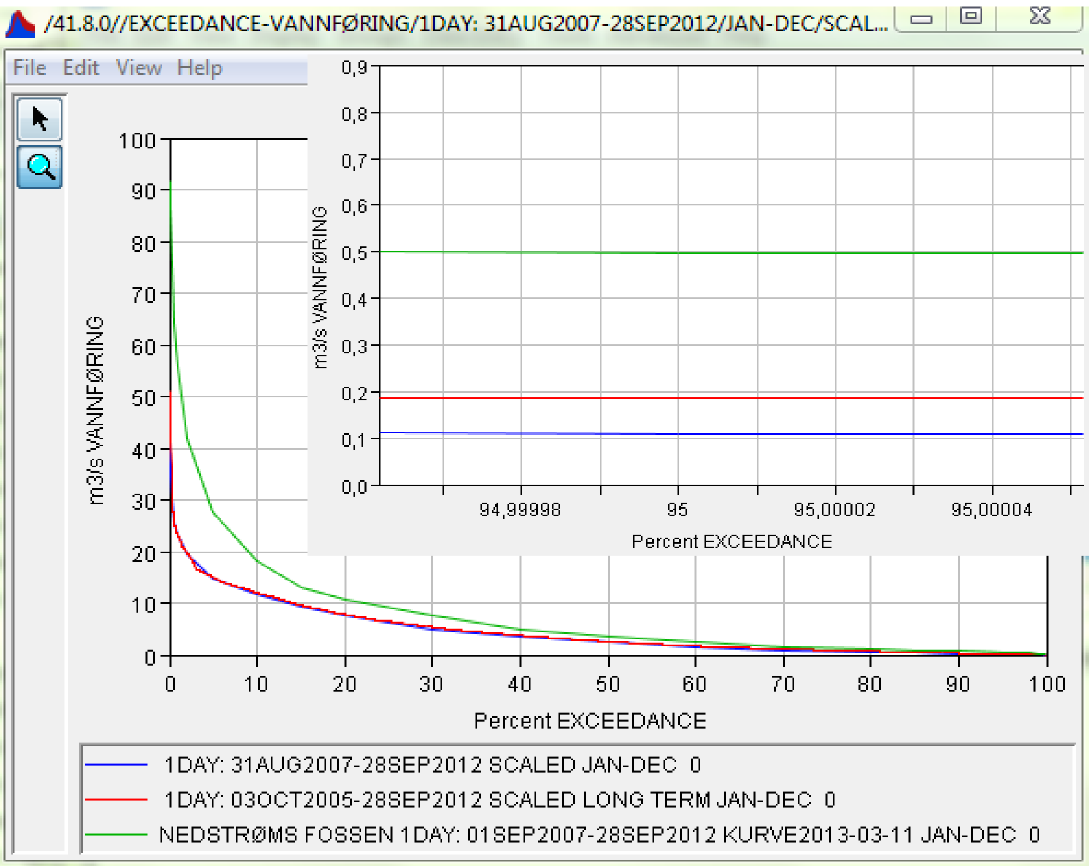
Erga



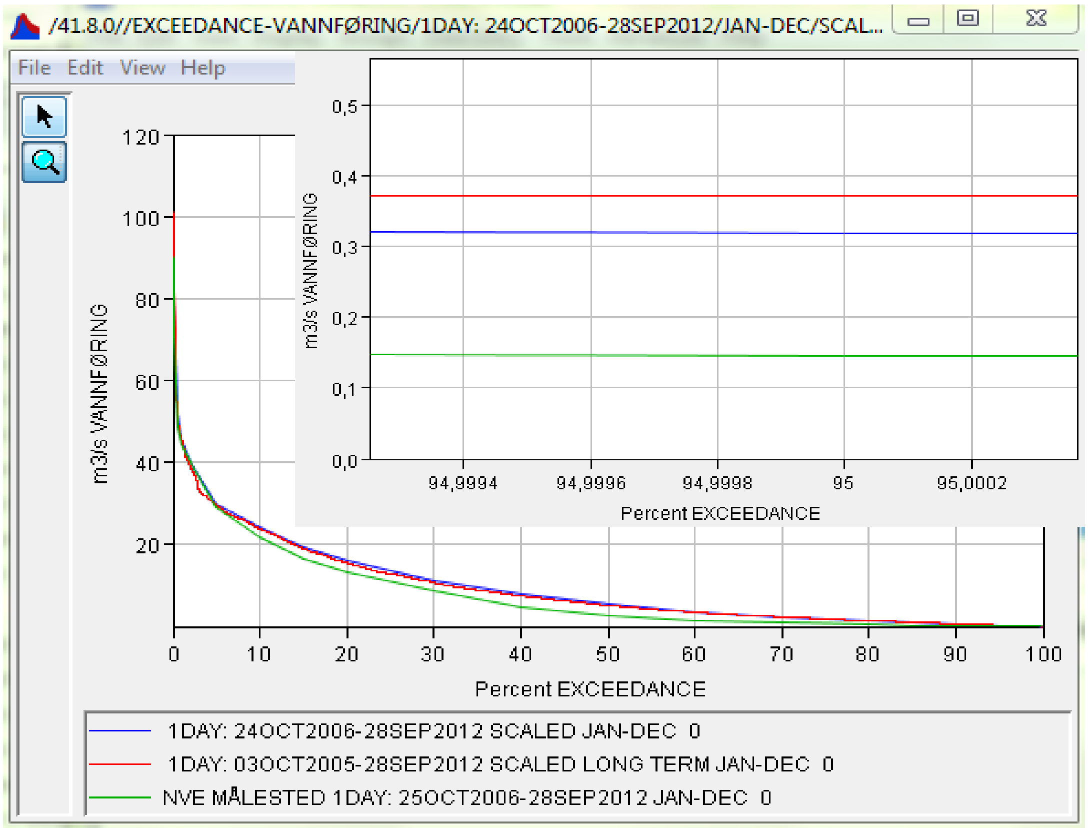
Bordalselv



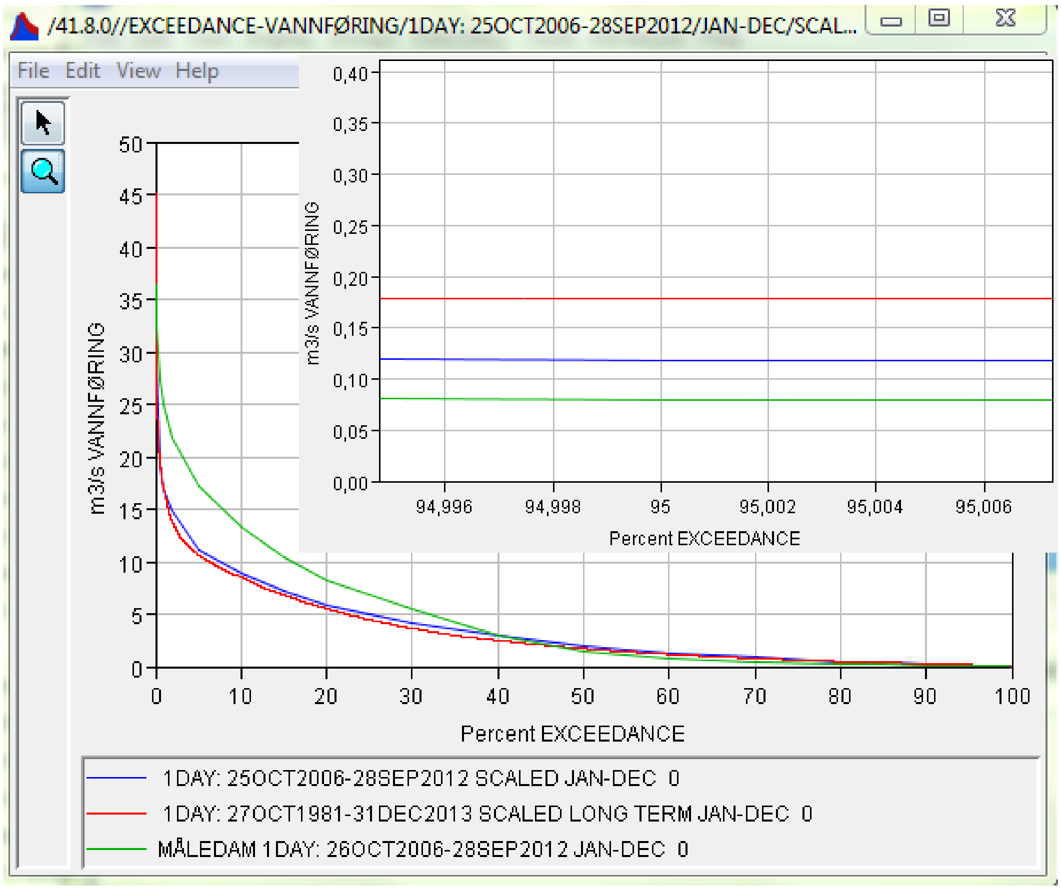
Skromme



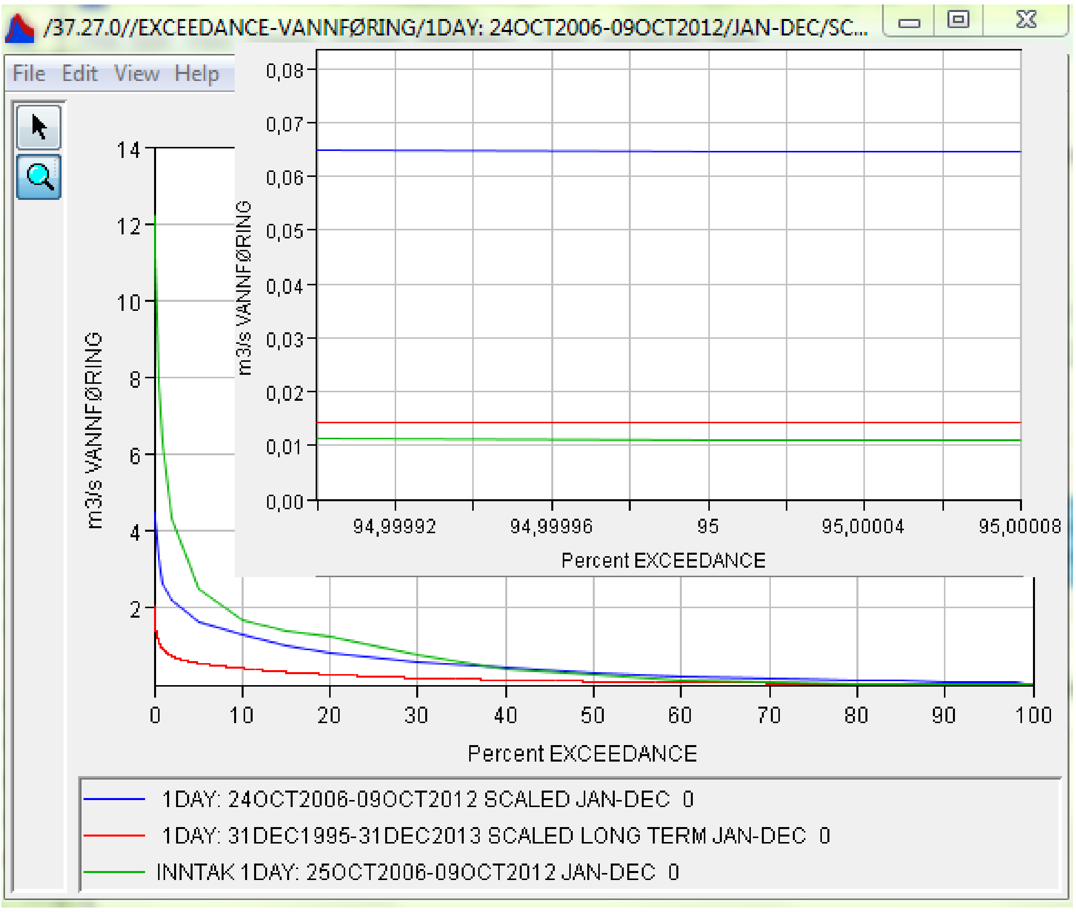
Grøno



Middal



Strandåna


/37.27.0//EXCEEDANCE-VANNFØRING/1DAY: 24OCT2006-09OCT2012/JAN-DEC/SC...
File Edit View Help
m3/s VANNFØRING
Percent EXCEEDANCE
94,99992
94,99996
95
95,00004
95,00008
1DAY: 24OCT2006-09OCT2012 SCALED JAN-DEC 0
1DAY: 31DEC1995-31DEC2013 SCALED LONG TERM JAN-DEC 0
INNTAK 1DAY: 25OCT2006-09OCT2012 JAN-DEC 0

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion and recommendations

In this chapter conclusion and recommendation will be presented for quality control procedure and for analysis provided for selected stations.

Having studied performed quality control provided by SWECO AS for selected stations following points should be improved:

For making quality control based on measurement points it is necessary to ensure that proper number of stage-discharge measurements have been done. Since SWECO AS used to create stage-discharge curve with the VFCURVE programm, which creates the curve on the basis of recorded measurements. More measurements will ensure accuracy of created curve, in other words accuracy of measurements. I would recommend to do more measurements at different stages, including flood flows, in order to avoid probable errors which creates programm while doing stage-discharge curve.

The next point which is recommended - to check observed peaks with precipitation data gained from meteorological stations. Checking peaked flow referring on analogue station could be not correct, sometimes analogue station could also show peaks at the same time by accident. To prevent erroneous scaling meteorological data as precipitation and air temperature should be taken in consideration.

As seen from analysis part sometimes downscaling method is not optimal solution for correcting or infilling missed data. The reason of that analogue stations sometimes are very difficult to find (since selection of analogue station is based on many factors) and scaling factor could be very low. In this case downscaling should be done for short period correction, but if missed data period is quite long that means that it will affect data definitely.

It is important to observe not only recorded discharge data series but temperature and stage also. Sometimes observing these data series could detect some errors which are not visible while discharge screening. (Figure 3-30.)

Having analysed selected stations following points are considered to be taken into consideration:

From 19 analysed stations 11 stations show significantly higher duration curve values that scaled for short and long term periods. It means that indicated turbine capacity would be much too low.

From the point of mean runoff more than half of stations calculated with NVE lavvan application shows lower values than mean runoff calculated on the basis of SWECO measurements, in case of lower values difference is very low.

Analyzing Q95 values it could be concluded that large catchments with even runoff have bigger Q95 than smaller catchments with more peaked runoff. More than two third of analysed stations shows that have much bigger Q95 values scaled from the larger analogue stations for long term period in comparison to the measured Q95 values. Deviations are incomparable low between stations where measured Q95 is higher than Q95 for scaled analogue stations.

Almost halve stations shows lower result for NVE Lavvann application Q95 in comparison of measured values. The deviation where Lavvann application shows bigger values is larger than for the low values. It is important to mention that Lavvann application was run for normal period and SWECO measurements have been done during last ten years, so it is difficult to make any strict conclusion. One of the reasons of that deviation could be climate change or trend in precipitation (which is shown as an example in in Chapter 4.3)

Generally the result from analysis comes that there is some uncertainty for both mean flow and Q95 values, which undoubtedly will impact small hydropower planning. It is evident that for most part of selected stations hydropower plant would get wrong installed capacity.

This analysis has been done for fifth part of all available SWECO stations. More stations should be analysed in future. During time SWECO will obtain more long data series and more extended analysis should be done to figure out more possible deviations.

6. REFERENCES

B.NILSEN & A.THIDENLANN 1993. *Rock Engineering*.

DINGMAN, L. 2002. *Physical hydrology,* USA.

GRID-ARENDAL. 1988. *Norway topography and bathymetry* [Online]. Available: http://www.grida.no/graphicslib/detail/norway-topography-and-bathymetry_b062#.

HEC 1995. HEC-DSS User's Guide. *HEC-DSS User's Guide*.

HERSCHY, R. W. 1998. *Hydrometry. Principles and Practices*.

K. ENGELAND, H. H. 2009. A Comparison of Low Flow Estimates in Ungauged Catchments Using Regional Regression and the HBV-Model.

KILLINGTVEIT, Å. & SæLTHUN, N. 1995. *Hydrology*, Norwegian Institute of Technology, Division of Hydraulic Engineering.

KLEMES, V. 1997. Guest editorial: Of carts and horses in hydrologic modeling.

NGU. *National institution for knowledge on bedrock, mineral resources, surficial deposits and groundwater (Norway)* [Online]. National institution for knowledge on bedrock, mineral resources, surficial deposits and groundwater (Norway). Available: www.ngu.no.

NMI, W. M. N. Available: www.met.no.

NVE HYDROLOGISK, A. 2013. *RE: Hyd-Wiki* Type to INTRANETT, N.

REES, G. 2008. *Hydrological Data* [Online].

REITAN, T. 2013. VFKURVE3 - Simple review of the stage-discharge curve fitting. Division of Statistics and Insurancs Mathematics, Department of Mathematics, Univercity of Oslo.

SWECO 2014. Sweco Norge AS Archive.

TERAKAWA, A. 2003. Hydrological Data Management: Present State and Trends. *Operationnal Hydrology Report No. 48.* World Meteorological Organization.

VASKINN, K. 2014. About Logger. *In:* GOVORUKHINA, I. (ed.).

W. MARCHAND, K. V. 2013. Scaling runoff from large catchments - comparison of theoretical results with measurements.

WIKIPEDIA, T. F. E. *Norway* [Online]. http://en.wikipedia.org/wiki/Norway#Geography. Available: http://en.wikipedia.org/wiki/Norway#Geography.

WMO 1994. Guide to Hydrological Practices. *Data Acquisition and Processing, Analysis, Forecasting and Other Application.* World Meteorological Organization.

WWW.ENVIROMENMENT.NO. *Norwegian Forest and Landscape Institute* [Online]. www.enviromenment.no. Available: www.enviromenment.no.

WWW.GLOBALW.COM/PRODUCTS/WL16.HTML. 2014. *WL 16 Water Level Logger* [Online]. Available: http://www.globalw.com/products/wl16.html.

WWW.RDINSTRUMENTS.COM. 2008. *ADCP* [Online]. Available: www.rdinstruments.com.

WWW.SONTEK.COM. 2007. *FlowTracker Technical Manual* [Online]. Available: www.sontek.com.

ZBIGNIEW, W., KUNDZEWICZ & ROBSON, A. 2000. Detecting Trend and Other Changes in Hydrological Data.

7. APPENDICES

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations

Appendix B: Map of selected SWECO AS station terrain with coordinates

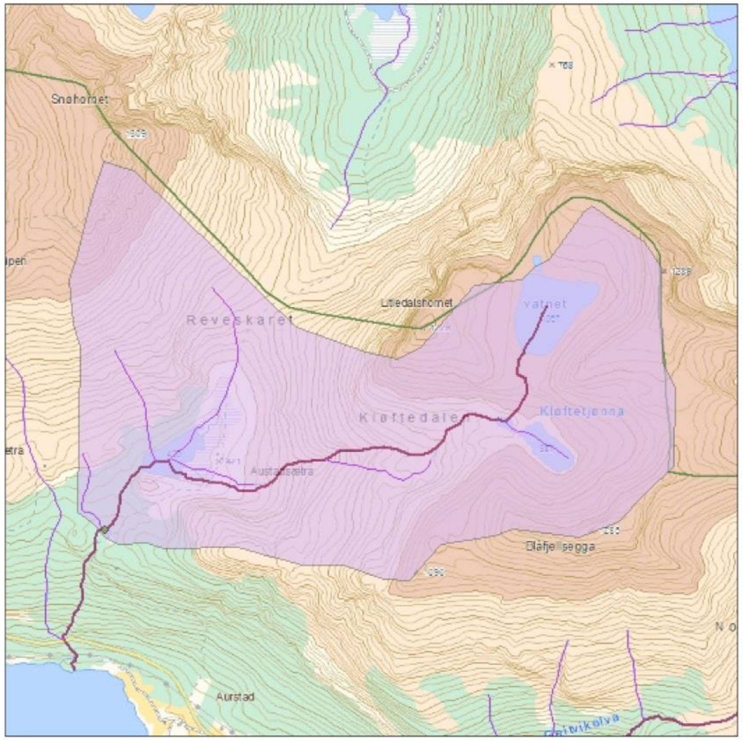
Appendix C: Duration Curves for selected SWECO AS stations

Appendix D: Stage-discharge curve for selected SWECO stations

Appendix E: Hypsographic Curve for selected SWECO stations

Appendix F: Enlarged topographic and climatic parameters of all SWECO stations

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Aurstadelva



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	094.5Z
Kommune:	Volda
Fylke:	Møre og Romsdal
Vassdrag:	AURSTADELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	98,9	l/s/km²
Alminnelig lavvannføring	4,0	l/s/km²
5-persentil (hele året)	3,7	l/s/km²
5-persentil (1/5-30/9)	22,1	l/s/km²
5-persentil (1/10-30/4)	3,6	l/s/km²
Base flow	42,5	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Vest	
Årsnedbør	2495	mm
Sommernedbør	851	mm
Vinternedbør	1644	mm
Årstemperatur	2,7	°C
Sommertemperatur	7,2	°C
Vintertemperatur	-0,5	°C
Temperatur Juli	8,9	°C
Temperatur August	9,0	°C

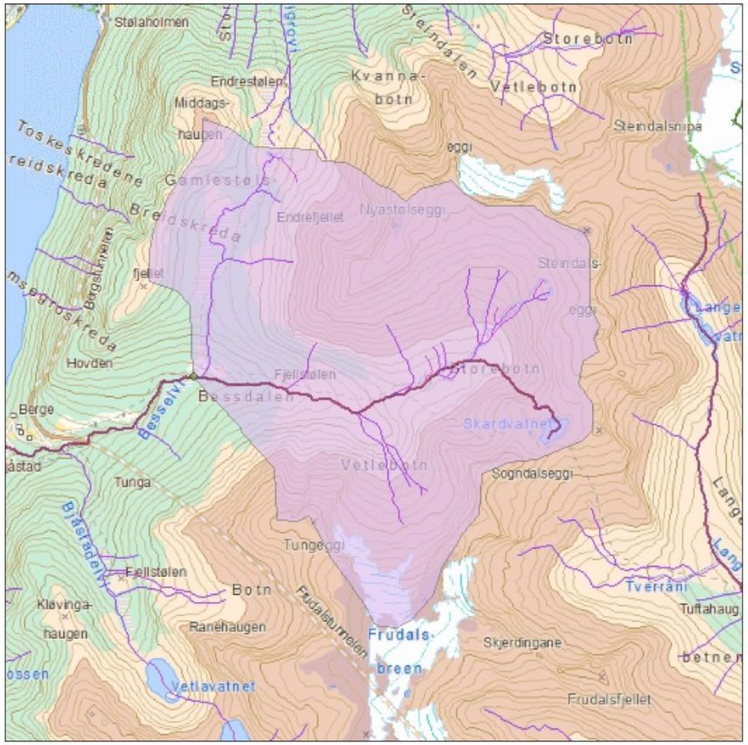
Feltparametere	
Areal (A)	5,3 km²
Effektiv sjø (S_{eff})	1,5 %
Elvelengde (E_L)	3,6 km
Elvegradient (E_G)	186,4 m/km
Elvegradient$_{1085}$(G_{1085})	223,9 m/km
Feltlengde(F_L)	3,5 km
H_{min}	398 moh.
H_{10}	493 moh.
H_{20}	585 moh.
H_{30}	681 moh.
H_{40}	788 moh.
H_{50}	900 moh.
H_{60}	999 moh.
H_{70}	1069 moh.
H_{80}	1107 moh.
H_{90}	1161 moh.
H_{max}	1297 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	1,6 %
Sjø	4,3 %
Skog	5,0 %
Snaufjell	89,1 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Berge



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	078.21Z
Kommune:	Sogndal
Fylke:	Sogn og Fjordane
Vassdrag:	BJÅSTADELVI

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	100,4	l/s/km²
Alminnelig lavvannføring	5,6	l/s/km²
5-persentil (hele året)	5,0	l/s/km²
5-persentil (1/5-30/9)	54,5	l/s/km²
5-persentil (1/10-30/4)	5,3	l/s/km²
Base flow	45,2	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Vest	
Årsnedbør	1837	mm
Sommernedbør	641	mm
Vinternedbør	1196	mm
Årstemperatur	0,2	°C
Sommertemperatur	5,2	°C
Vintertemperatur	-3,4	°C
Temperatur Juli	7,1	°C
Temperatur August	7,7	°C

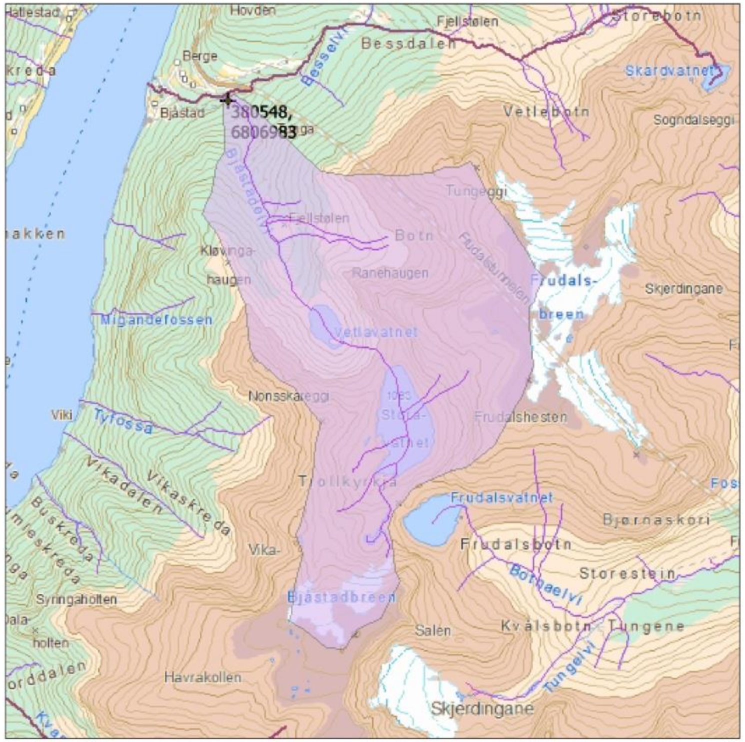
Feltparametere	
Areal (A)	12,1 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	4,2 km
Elvegradient (E_G)	193,2 m/km
Elvegradient$_{1085}$(G_{1085})	217,1 m/km
Feltlengde(F_L)	3,9 km
H_{min}	440 moh.
H_{10}	720 moh.
H_{20}	796 moh.
H_{30}	893 moh.
H_{40}	980 moh.
H_{50}	1087 moh.
H_{60}	1178 moh.
H_{70}	1254 moh.
H_{80}	1326 moh.
H_{90}	1413 moh.
H_{max}	1595 moh.
Bre	3,7 %
Dyrket mark	0,0 %
Myr	1,7 %
Sjø	0,4 %
Skog	15,7 %
Snaufjell	65,8 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.
Lavvannskartet gir usannsynlig stort estimat av en eller flere lavvannsindekser. Sjekk verdiene nøye.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Bjagstad



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn:	Statens Kartverk
Kartdatum:	EUREF89 WGS84
Projeksjon:	UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	078.21Z
Kommune:	Sogndal
Fylke:	Sogn og Fjordane
Vassdrag:	BJÅSTADELVI

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	95,0	l/s/km²
Alminnelig lavvannføring	7,2	l/s/km²
5-persentil (hele året)	6,6	l/s/km²
5-persentil (1/5-30/9)	61,2	l/s/km²
5-persentil (1/10-30/4)	6,7	l/s/km²
Base flow	48,5	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Vest	
Årsnedbør	1767	mm
Sommernedbør	613	mm
Vinternedbør	1154	mm
Årstemperatur	0,2	°C
Sommertemperatur	4,8	°C
Vintertemperatur	-3,1	°C
Temperatur Juli	6,7	°C
Temperatur August	7,2	°C

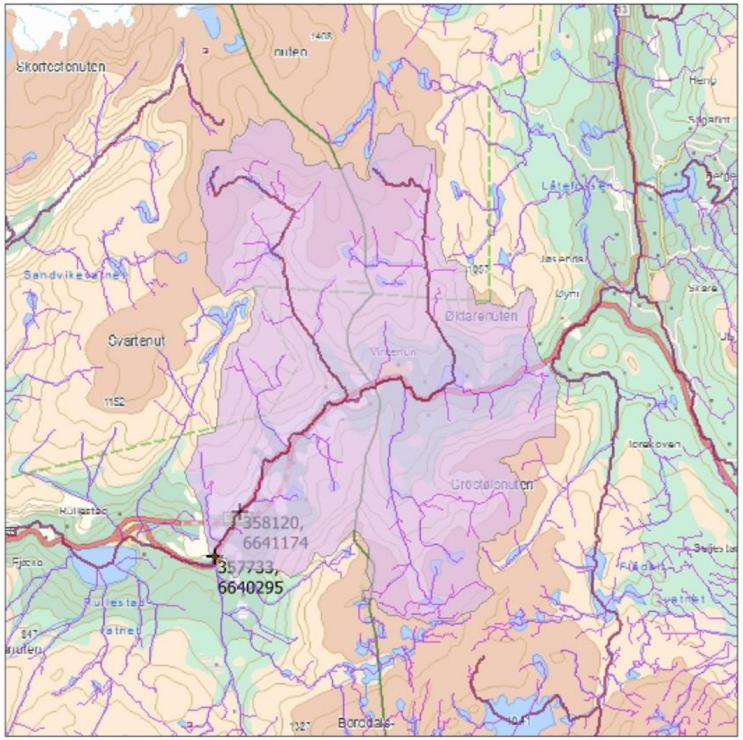
Feltparametere	
Areal (A)	8,7 km²
Effektiv sjø (S_{eff})	2,3 %
Elvelengde (E_L)	5,4 km
Elvegradient (E_G)	203,9 m/km
Elvegradient$_{1085}$(G_{1085})	178,4 m/km
Feltlengde(F_L)	5,3 km
H_{min}	159 moh.
H_{10}	679 moh.
H_{20}	828 moh.
H_{30}	974 moh.
H_{40}	1063 moh.
H_{50}	1123 moh.
H_{60}	1204 moh.
H_{70}	1304 moh.
H_{80}	1404 moh.
H_{90}	1494 moh.
H_{max}	1607 moh.
Bre	4,3 %
Dyrket mark	0,0 %
Myr	0,4 %
Sjø	5,6 %
Skog	15,2 %
Snaufjell	70,4 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene. Lavvannskartet gir usannsynlig stort estimat av en eller flere lavvannsindekser. Sjekk verdiene nøye.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Bordalselva



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	042.3D0
Kommune:	Etne
Fylke:	Hordaland
Vassdrag:	DALELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	83,9	l/s/km²
Alminnelig lavvannføring	3,4	l/s/km²
5-persentil (hele året)	3,5	l/s/km²
5-persentil (1/5-30/9)	12,2	l/s/km²
5-persentil (1/10-30/4)	2,6	l/s/km²
Base flow	30,2	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Vest	
Årsnedbør	2472	mm
Sommernedbør	845	mm
Vinternedbør	1627	mm
Årstemperatur	1,9	°C
Sommertemperatur	7,0	°C
Vintertemperatur	-1,8	°C
Temperatur Juli	8,8	°C
Temperatur August	9,6	°C

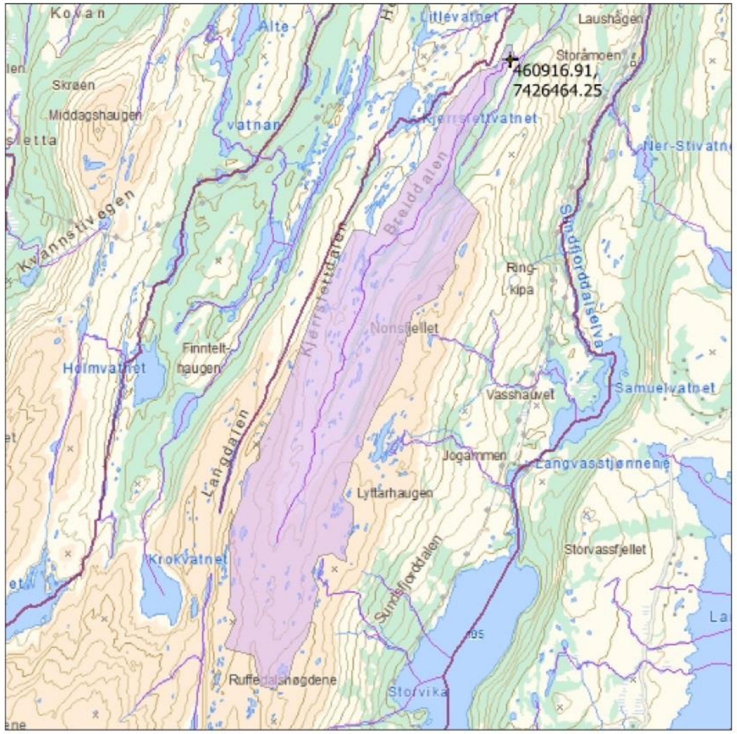
Feltparametere	
Areal (A)	45,2 km²
Effektiv sjø (S_{eff})	0,2 %
Elvelengde (E_L)	12,6 km
Elvegradient (E_G)	66,9 m/km
Elvegradient$_{1085}$(G_{1085})	64,7 m/km
Feltlengde(F_L)	9,0 km
H_{min}	239 moh.
H_{10}	435 moh.
H_{20}	525 moh.
H_{30}	627 moh.
H_{40}	724 moh.
H_{50}	806 moh.
H_{60}	886 moh.
H_{70}	960 moh.
H_{80}	1022 moh.
H_{90}	1079 moh.
H_{max}	1358 moh.
Bre	0,0 %
Dyrket mark	0,5 %
Myr	0,3 %
Sjø	2,4 %
Skog	19,8 %
Snaufjell	54,3 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Breidalselva



Norges vassdrags- og energidirektorat

N V E

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.1A3Z
Kommune:	Gildeskål
Fylke:	Nordland
Vassdrag:	TVERRÅGA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	83,3	l/s/km²
Alminnelig lavvannføring	13,5	l/s/km²
5-persentil (hele året)	11,1	l/s/km²
5-persentil (1/5-30/9)	7,4	l/s/km²
5-persentil (1/10-30/4)	9,6	l/s/km²
Base flow	27,5	l/s/km²
BFI	0,3	

Klima		
Klimaregion	Nord	
Årsnedbør	2091	mm
Sommernedbør	732	mm
Vinternedbør	1359	mm
Årstemperatur	3,0	°C
Sommertemperatur	7,7	°C
Vintertemperatur	-0,3	°C
Temperatur Juli	9,9	°C
Temperatur August	9,8	°C

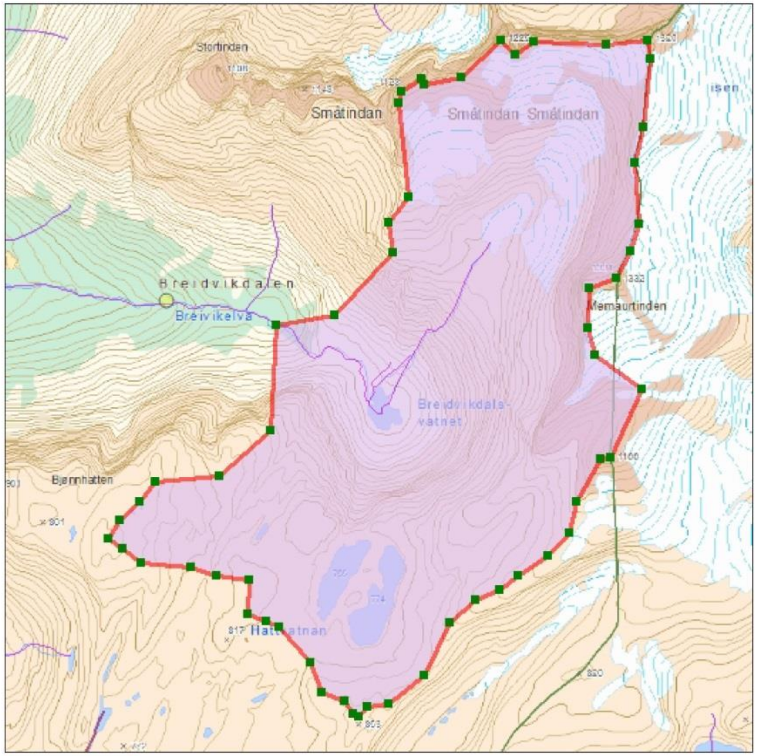
Feltparametere	
Areal (A)	4,8 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	5,5 km
Elvegradient (E_G)	40,7 m/km
$\text{Elvegradient}_{1085}(G_{1085})$	37,6 m/km
Feltlengde(F_L)	6,5 km
H_{min}	284 moh.
H_{10}	391 moh.
H_{20}	420 moh.
H_{30}	445 moh.
H_{40}	464 moh.
H_{50}	491 moh.
H_{60}	525 moh.
H_{70}	548 moh.
H_{80}	566 moh.
H_{90}	582 moh.
H_{max}	640 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,4 %
Sjø	2,3 %
Skog	2,1 %
Snaufjell	72,5 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Breivikelva



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.22
Kommune:	Gildeskål
Fylke:	Nordland
Vassdrag:	KYSTFELT

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	104,0	l/s/km²
Alminnelig lavvannføring	0,4	l/s/km²
5-persentil (hele året)	0,4	l/s/km²
5-persentil (1/5-30/9)	13,2	l/s/km²
5-persentil (1/10-30/4)	0,2	l/s/km²
Base flow	45,8	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Bre-Nord	
Årsnedbør	2182	mm
Sommernedbør	817	mm
Vinternedbør	1365	mm
Årstemperatur	1,1	°C
Sommertemperatur	5,4	°C
Vintertemperatur	-2,0	°C
Temperatur Juli	7,7	°C
Temperatur August	7,7	°C

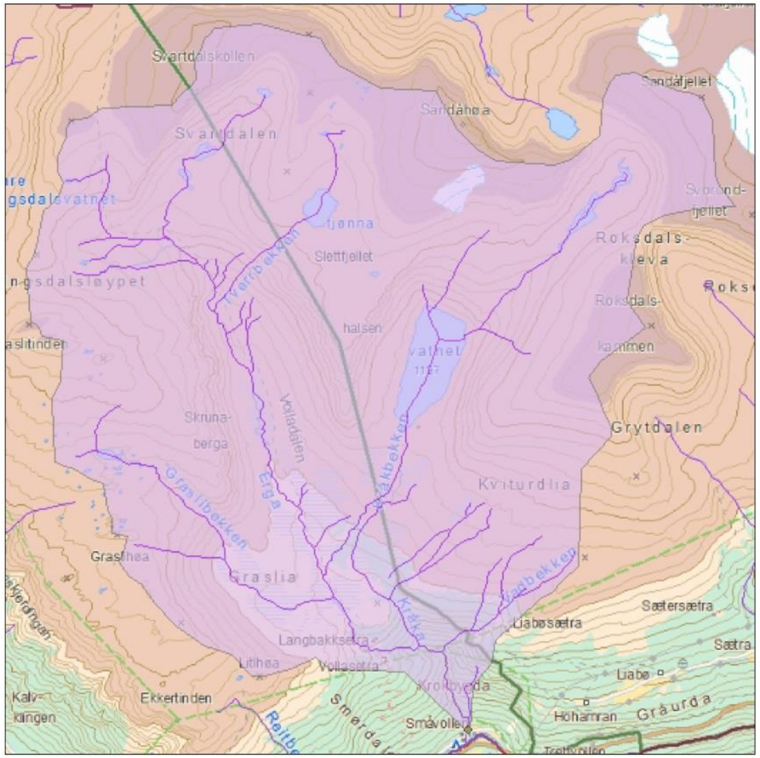
Feltparametere	
Areal (A)	5,6 km²
Effektiv sjø (S_{eff})	0,7 %
Elvelengde (E_L)	2,1 km
Elvegradient (E_G)	253,8 m/km
Elvegradient$_{1085}$(G_{1085})	274,8 m/km
Feltlengde(F_L)	2,6 km
H_{min}	257 moh.
H_{10}	508 moh.
H_{20}	703 moh.
H_{30}	774 moh.
H_{40}	796 moh.
H_{50}	823 moh.
H_{60}	870 moh.
H_{70}	924 moh.
H_{80}	1001 moh.
H_{90}	1092 moh.
H_{max}	1325 moh.
Bre	13,2 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	2,7 %
Skog	0,2 %
Snaufjell	74,5 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Datagrunnlaget er for dårlig til å gi tilstrekkelig kvalitet på estimatene, og resultatene er derfor ikke presentert.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Erga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn:	Statens Kartverk
Kartdatum:	EUREF89 WGS84
Projeksjon:	UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	109.C0
Kommune:	Sunndal
Fylke:	Møre og Romsdal
Vassdrag:	DRIVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	52,4	l/s/km²
Alminnelig lavvannføring	5,6	l/s/km²
5-persentil (hele året)	5,8	l/s/km²
5-persentil (1/5-30/9)	12,0	l/s/km²
5-persentil (1/10-30/4)	3,9	l/s/km²
Base flow	23,0	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Midt	
Årsnedbør	805	mm
Sommernedbør	316	mm
Vinternedbør	489	mm
Årstemperatur	-0,8	°C
Sommertemperatur	3,7	°C
Vintertemperatur	-4,0	°C
Temperatur Juli	5,1	°C
Temperatur August	6,6	°C

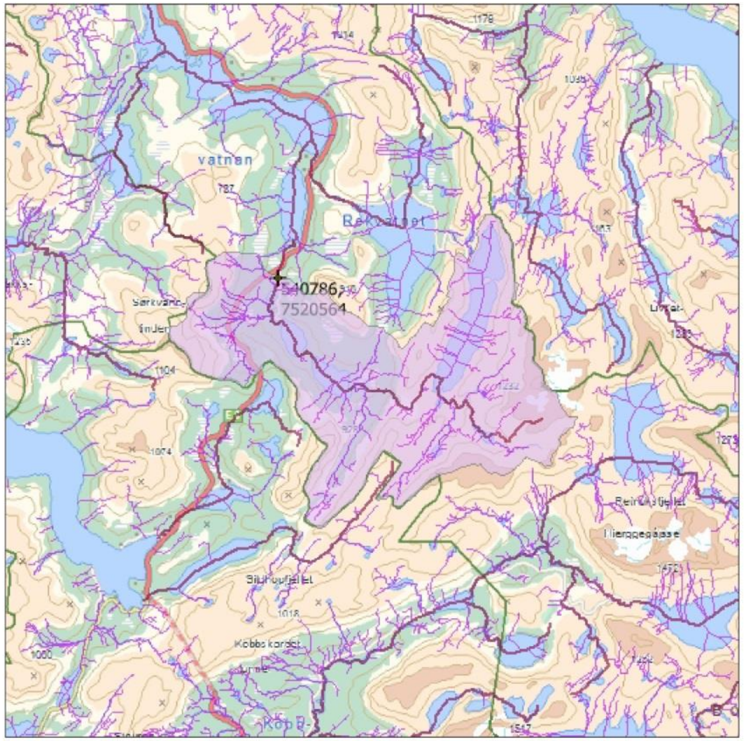
Feltparametere	
Areal (A)	26,5 km²
Effektiv sjø (S_{eff})	0,5 %
Elvelengde (E_L)	8,3 km
Elvegradient (E_G)	142,3 m/km
Elvegradient$_{1085}$(G_{1085})	119,6 m/km
Feltlengde(F_L)	6,9 km
H_{min}	214 moh.
H_{10}	985 moh.
H_{20}	1073 moh.
H_{30}	1147 moh.
H_{40}	1243 moh.
H_{50}	1310 moh.
H_{60}	1373 moh.
H_{70}	1415 moh.
H_{80}	1462 moh.
H_{90}	1520 moh.
H_{max}	1692 moh.
Bre	0,4 %
Dyrket mark	0,0 %
Myr	4,2 %
Sjø	2,4 %
Skog	4,8 %
Snaufjell	87,8 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Femtevasselva



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn:	Statens Kartverk
Kartdatum:	EUREF89 WGS84
Projeksjon:	UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	170.D
Kommune:	Hamarøy
Fylke:	Nordland
Vassdrag:	SAGELVVASSDRAGET

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	66,4	l/s/km²
Alminnelig lavvannføring	11,0	l/s/km²
5-persentil (hele året)	9,1	l/s/km²
5-persentil (1/5-30/9)	18,0	l/s/km²
5-persentil (1/10-30/4)	6,4	l/s/km²
Base flow	31,2	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Nord	
Årsnedbør	1489	mm
Sommernedbør	500	mm
Vinternedbør	989	mm
Årstemperatur	0,8	°C
Sommertemperatur	6,9	°C
Vintertemperatur	-3,6	°C
Temperatur Juli	9,8	°C
Temperatur August	9,3	°C

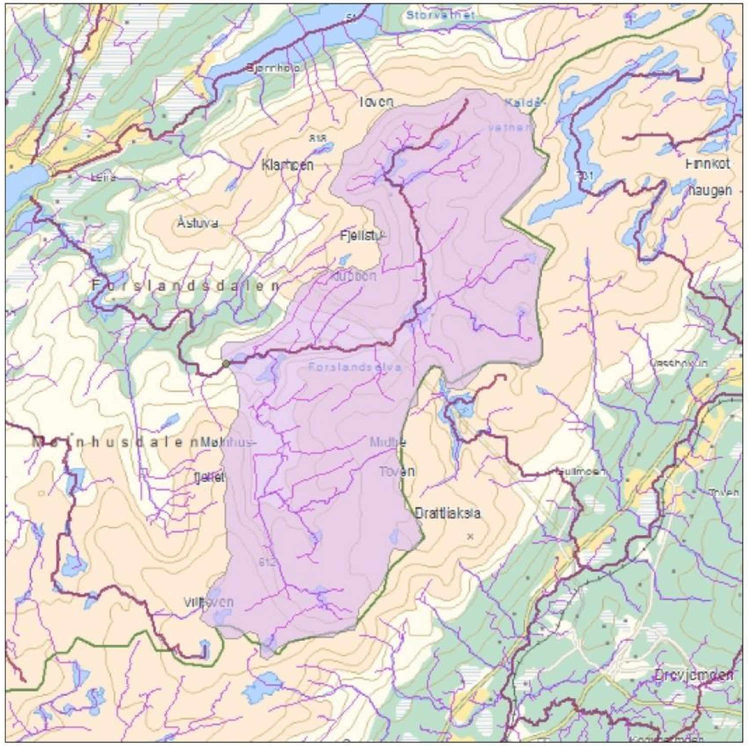
Feltparametere	
Areal (A)	83,5 km²
Effektiv sjø (S_{eff})	5,7 %
Elvelengde (E_L)	18,8 km
Elvegradient (E_G)	48,9 m/km
Elvegradient$_{1085}$(G_{1085})	35,6 m/km
Feltlengde(F_L)	12,5 km
H_{min}	146 moh.
H_{10}	199 moh.
H_{20}	318 moh.
H_{30}	434 moh.
H_{40}	531 moh.
H_{50}	547 moh.
H_{60}	618 moh.
H_{70}	688 moh.
H_{80}	775 moh.
H_{90}	927 moh.
H_{max}	1230 moh.
Bre	0,7 %
Dyrket mark	0,0 %
Myr	2,3 %
Sjø	11,4 %
Skog	26,4 %
Snaufjell	54,9 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Forsland



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	153.2C
Kommune:	Leirfjord
Fylke:	Nordland
Vassdrag:	FORSLANDSELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	103,5	l/s/km²
Alminnelig lavvannføring	3,7	l/s/km²
5-persentil (hele året)	4,1	l/s/km²
5-persentil (1/5-30/9)	12,6	l/s/km²
5-persentil (1/10-30/4)	3,2	l/s/km²
Base flow	35,2	l/s/km²
BFI	0,3	

Klima		
Klimaregion	Midt	
Årsnedbør	2032	mm
Sommernedbør	732	mm
Vinternedbør	1300	mm
Årstemperatur	1,1	°C
Sommertemperatur	6,7	°C
Vintertemperatur	-3,0	°C
Temperatur Juli	9,1	°C
Temperatur August	8,9	°C

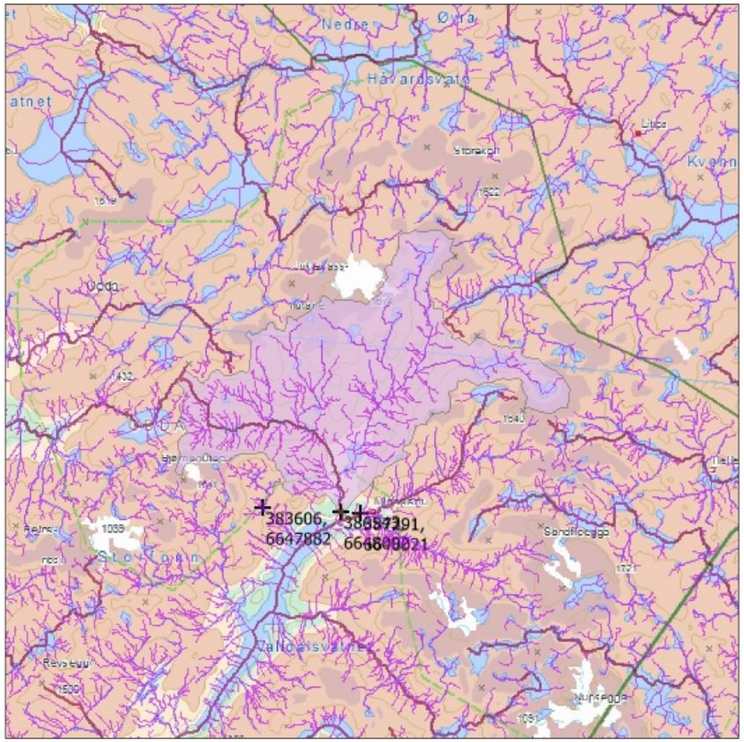
Feltparametere	
Areal (A)	36,3 km²
Effektiv sjø (S_{eff})	0,7 %
Elvelengde (E_L)	10,0 km
Elvegradient (E_G)	44,0 m/km
Elvegradient$_{1085}$(G_{1085})	38,2 m/km
Feltlengde(F_L)	7,4 km
H_{min}	246 moh.
H_{10}	446 moh.
H_{20}	515 moh.
H_{30}	566 moh.
H_{40}	600 moh.
H_{50}	631 moh.
H_{60}	662 moh.
H_{70}	695 moh.
H_{80}	737 moh.
H_{90}	795 moh.
H_{max}	910 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,1 %
Sjø	3,8 %
Skog	0,3 %
Snaufjell	92,8 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Grono



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	036.J
Kommune:	Odda
Fylke:	Hordaland
Vassdrag:	SULDALSVASSDRAGET

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	71,4	l/s/km²
Alminnelig lavvannføring	2,6	l/s/km²
5-persentil (hele året)	2,1	l/s/km²
5-persentil (1/5-30/9)	19,2	l/s/km²
5-persentil (1/10-30/4)	1,7	l/s/km²
Base flow	25,7	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Sor	
Årsnedbør	1624	mm
Sommernedbør	596	mm
Vinternedbør	1028	mm
Årstemperatur	-1,8	°C
Sommertemperatur	3,9	°C
Vintertemperatur	-5,8	°C
Temperatur Juli	5,9	°C
Temperatur August	7,0	°C

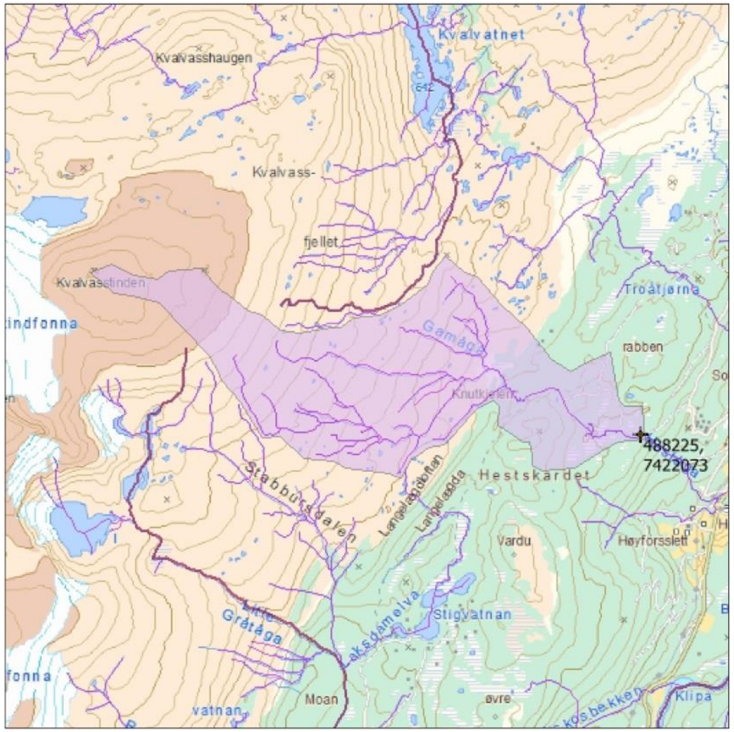
Feltparametere	
Areal (A)	66,3 km²
Effektiv sjø (S_{eff})	0,7 %
Elvelengde (E_L)	10,9 km
Elvegradient (E_G)	61,6 m/km
Elvegradient$_{1085}$(G_{1085})	42,7 m/km
Feltlengde(F_L)	11,3 km
H_{min}	780 moh.
H_{10}	1033 moh.
H_{20}	1120 moh.
H_{30}	1201 moh.
H_{40}	1274 moh.
H_{50}	1341 moh.
H_{60}	1398 moh.
H_{70}	1439 moh.
H_{80}	1469 moh.
H_{90}	1510 moh.
H_{max}	1666 moh.
Bre	0,6 %
Dyrket mark	0,0 %
Myr	0,4 %
Sjø	5,9 %
Skog	0,3 %
Snaufjell	92,3 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen har ofte stor usikkerhet rundt klassifisering av dominerende lavvannssesong og feilklassifisering forekommer. Resultatene er allikevel normalt gode.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Hestaaga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk
Kartdatum: EUREF89 WGS84
Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.D0
Kommune:	Beiarn
Fylke:	Nordland
Vassdrag:	BEIARELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	57,7	l/s/km²
Alminnelig lavvannføring	8,2	l/s/km²
5-persentil (hele året)	6,8	l/s/km²
5-persentil (1/5-30/9)	11,6	l/s/km²
5-persentil (1/10-30/4)	5,2	l/s/km²
Base flow	29,4	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Nord	
Årsnedbør	1287	mm
Sommernedbør	446	mm
Vinternedbør	840	mm
Årstemperatur	0,6	°C
Sommertemperatur	6,5	°C
Vintertemperatur	-3,7	°C
Temperatur Juli	9,0	°C
Temperatur August	9,2	°C

Feltparametere	
Areal (A)	5,3 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	5,6 km
Elvegradient (E_G)	102,5 m/km
Elvegradient $_{1085}$(G_{1085})	92,1 m/km
Feltlengde(F_L)	5,5 km
H_{min}	356 moh.
H_{10}	460 moh.
H_{20}	499 moh.
H_{30}	539 moh.
H_{40}	595 moh.
H_{50}	639 moh.
H_{60}	688 moh.
H_{70}	749 moh.
H_{80}	821 moh.
H_{90}	970 moh.
H_{max}	1164 moh.
Bre	3,6 %
Dyrket mark	0,0 %
Myr	1,4 %
Sjø	0,3 %
Skog	20,4 %
Snaufjell	74,4 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Kassen

Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	092.B
Kommune:	Vanylven
Fylke:	Møre og Romsdal
Vassdrag:	GUSDALELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	106,0	l/s/km²
Alminnelig lavvannføring	4,2	l/s/km²
5-persentil (hele året)	4,6	l/s/km²
5-persentil (1/5-30/9)	5,0	l/s/km²
5-persentil (1/10-30/4)	3,6	l/s/km²
Base flow	38,2	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Vest	
Årsnedbør	2254	mm
Sommernedbør	781	mm
Vinternedbør	1474	mm
Årstemperatur	4,4	°C
Sommertemperatur	8,6	°C
Vintertemperatur	1,3	°C
Temperatur Juli	10,2	°C
Temperatur August	10,5	°C

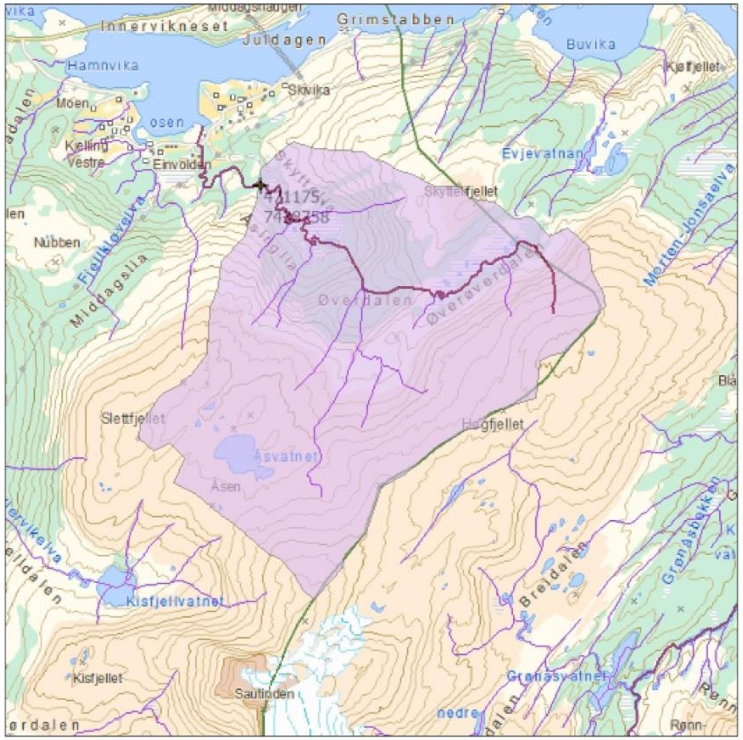
Feltparametere	
Areal (A)	6,6 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	5,8 km
Elvegradient (E_G)	84,3 m/km
Elvegradient$_{1085}$(G_{1085})	93,9 m/km
Feltlengde(F_L)	4,9 km
H_{min}	177 moh.
H_{10}	391 moh.
H_{20}	465 moh.
H_{30}	515 moh.
H_{40}	553 moh.
H_{50}	599 moh.
H_{60}	637 moh.
H_{70}	666 moh.
H_{80}	687 moh.
H_{90}	717 moh.
H_{max}	787 moh.
Bre	0,0 %
Dyrket mark	0,7 %
Myr	1,1 %
Sjø	4,6 %
Skog	13,6 %
Snaufjell	78,9 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Kjellingelva



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.31Z
Kommune:	Gildeskål
Fylke:	Nordland
Vassdrag:	KJELLINGELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	73,0	l/s/km²
Alminnelig lavvannføring	13,3	l/s/km²
5-persentil (hele året)	11,2	l/s/km²
5-persentil (1/5-30/9)	21,5	l/s/km²
5-persentil (1/10-30/4)	8,3	l/s/km²
Base flow	37,2	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Nord	
Årsnedbør	1783	mm
Sommernedbør	654	mm
Vinternedbør	1129	mm
Årstemperatur	2,1	°C
Sommertemperatur	7,0	°C
Vintertemperatur	-1,4	°C
Temperatur Juli	9,4	°C
Temperatur August	9,3	°C

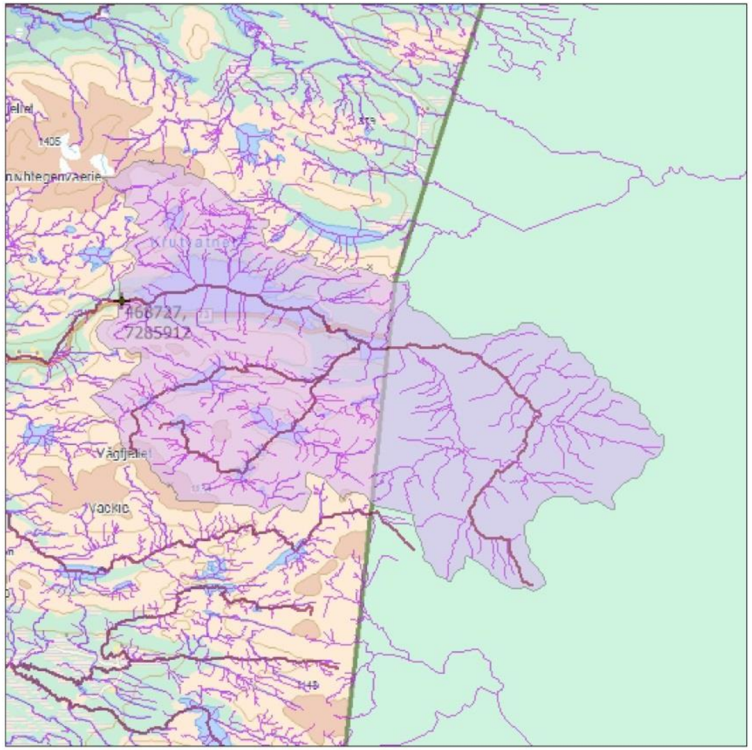
Feltparametere	
Areal (A)	10,3 km²
Effektiv sjø (S_{eff})	0,1 %
Elvelengde (E_L)	5,2 km
Elvegradient (E_G)	129,7 m/km
Elvegradient $_{1085}$(G_{1085})	88,5 m/km
Feltlengde(F_L)	4,0 km
H_{min}	57 moh.
H_{10}	193 moh.
H_{20}	356 moh.
H_{30}	433 moh.
H_{40}	485 moh.
H_{50}	551 moh.
H_{60}	617 moh.
H_{70}	641 moh.
H_{80}	678 moh.
H_{90}	737 moh.
H_{max}	916 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	3,7 %
Sjø	1,4 %
Skog	20,1 %
Snaufjell	64,4 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Krutaga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	155.D7A
Kommune:	Hattfjelldal
Fylke:	Nordland
Vassdrag:	KRUTÅGA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	44,5	l/s/km²
Alminnelig lavvannføring	2,5	l/s/km²
5-persentil (hele året)	2,4	l/s/km²
5-persentil (1/5-30/9)	5,9	l/s/km²
5-persentil (1/10-30/4)	2,0	l/s/km²
Base flow	21,4	l/s/km²
BFI	0,5	

Klima		
Klimaregion	Midt	
Årsnedbør	729	mm
Sommernedbør	294	mm
Vinternedbør	435	mm
Årstemperatur	-1,7	°C
Sommertemperatur	5,8	°C
Vintertemperatur	-7,0	°C
Temperatur Juli	8,5	°C
Temperatur August	8,6	°C

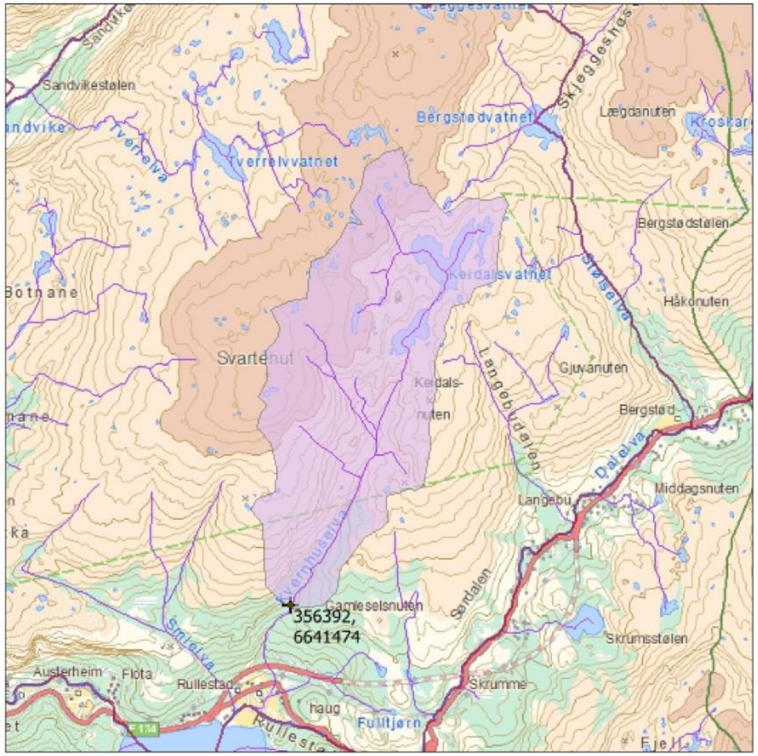
Feltparametere	
Areal (A)	173,6 km²
Effektiv sjø (S_{eff})	6,8 %
Elvelengde (E_L)	28,1 km
Elvegradient (E_G)	15,6 m/km
Elvegradient$_{1085}$(G_{1085})	14,1 m/km
Feltlengde(F_L)	21,0 km
H_{min}	575 moh.
H_{10}	604 moh.
H_{20}	694 moh.
H_{30}	758 moh.
H_{40}	789 moh.
H_{50}	817 moh.
H_{60}	848 moh.
H_{70}	883 moh.
H_{80}	922 moh.
H_{90}	982 moh.
H_{max}	1237 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,9 %
Sjø	9,8 %
Skog	12,6 %
Snaufjell	60,9 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Kvernhusbekken



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	042.3C
Kommune:	Etne
Fylke:	Hordaland
Vassdrag:	DALELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	102,0	l/s/km²
Alminnelig lavvannføring	3,9	l/s/km²
5-persentil (hele året)	4,0	l/s/km²
5-persentil (1/5-30/9)	14,0	l/s/km²
5-persentil (1/10-30/4)	3,3	l/s/km²
Base flow	38,7	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Vest	
Årsnedbør	2682	mm
Sommernedbør	919	mm
Vinternedbør	1764	mm
Årstemperatur	1,8	°C
Sommertemperatur	6,9	°C
Vintertemperatur	-1,8	°C
Temperatur Juli	8,7	°C
Temperatur August	9,5	°C

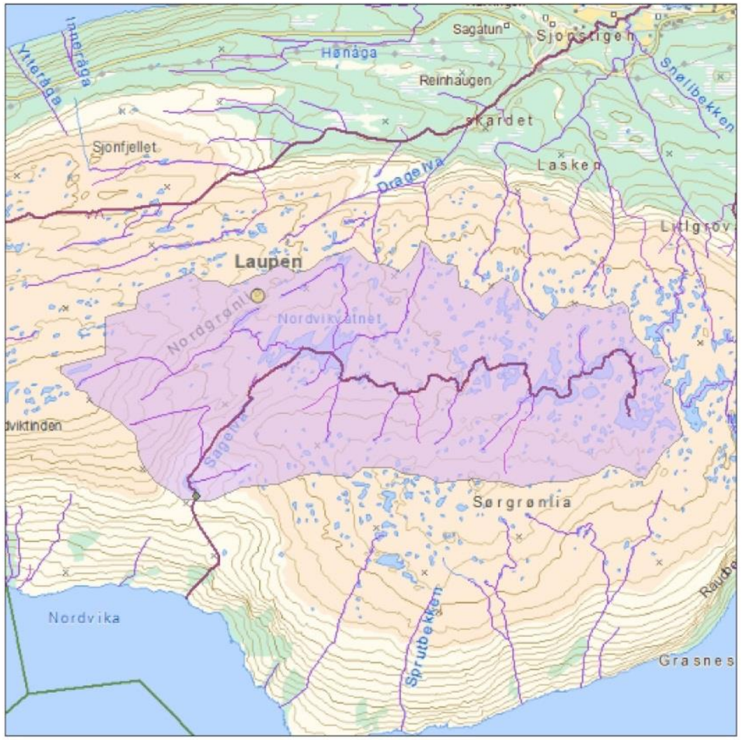
Feltparametere	
Areal (A)	5,3 km²
Effektiv sjø (S_{eff})	1,8 %
Elvelengde (E_L)	5,0 km
Elvegradient (E_G)	130,2 m/km
Elvegradient$_{1085}$(G_{1085})	115,5 m/km
Feltlengde(F_L)	4,4 km
H_{min}	352 moh.
H_{10}	668 moh.
H_{20}	766 moh.
H_{30}	852 moh.
H_{40}	890 moh.
H_{50}	910 moh.
H_{60}	939 moh.
H_{70}	989 moh.
H_{80}	1039 moh.
H_{90}	1077 moh.
H_{max}	1151 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	6,3 %
Skog	6,4 %
Snaufjell	80,3 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Laupen



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.: 157.2Z
Kommune: Rana
Fylke: Nordland
Vassdrag: SAGELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	115,9	l/s/km²
Alminnelig lavvannføring	12,9	l/s/km²
5-persentil (hele året)	10,5	l/s/km²
5-persentil (1/5-30/9)	5,9	l/s/km²
5-persentil (1/10-30/4)	8,9	l/s/km²
Base flow	19,7	l/s/km²
BFI	0,2	

Klima		
Klimaregion	Nord	
Årsnedbør	1843	mm
Sommernedbør	649	mm
Vinternedbør	1194	mm
Årstemperatur	1,4	°C
Sommertemperatur	6,8	°C
Vintertemperatur	-2,5	°C
Temperatur Juli	9,2	°C
Temperatur August	9,0	°C

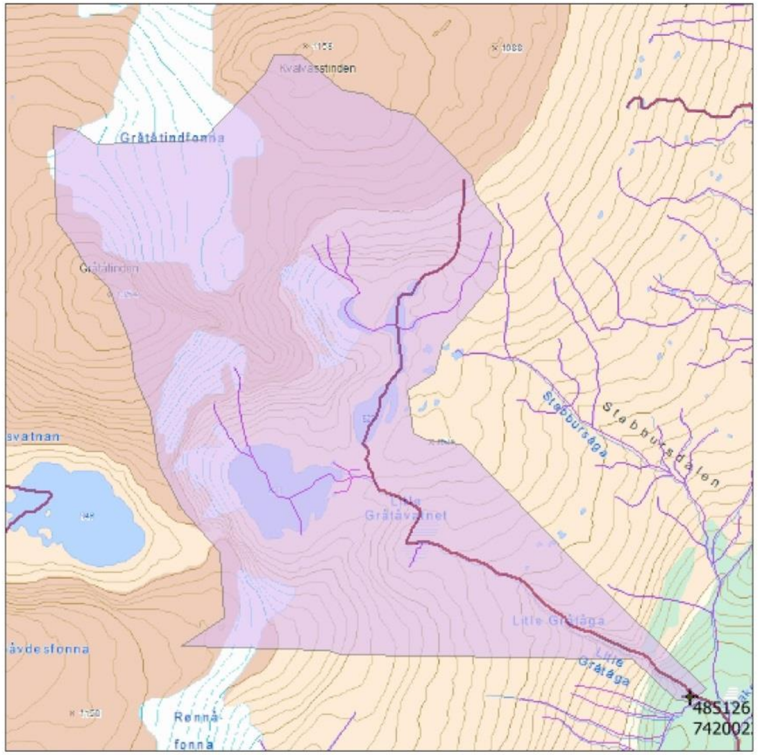
Feltparametere	
Areal (A)	9,8 km²
Effektiv sjø (S_{eff})	2,3 %
Elvelengde (E_L)	7,3 km
Elvegradient (E_G)	27,6 m/km
Elvegradient$_{1085}$(G_{1085})	21,2 m/km
Feltlengde(F_L)	4,7 km
H_{min}	405 moh.
H_{10}	527 moh.
H_{20}	556 moh.
H_{30}	580 moh.
H_{40}	604 moh.
H_{50}	613 moh.
H_{60}	620 moh.
H_{70}	629 moh.
H_{80}	650 moh.
H_{90}	692 moh.
H_{max}	837 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	8,8 %
Skog	0,0 %
Snaufjell	91,1 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Lille Grataga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.DAZ
Kommune:	Beiarn
Fylke:	Nordland
Vassdrag:	LILLE GRÅTÅGA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	82,1	l/s/km²
Alminnelig lavvannføring	1,9	l/s/km²
5-persentil (hele året)	1,8	l/s/km²
5-persentil (1/5-30/9)	7,1	l/s/km²
5-persentil (1/10-30/4)	1,6	l/s/km²
Base flow	22,2	l/s/km²
BFI	0,3	

Klima		
Klimaregion	Bre-Nord	
Årsnedbør	1413	mm
Sommernedbør	495	mm
Vinternedbør	918	mm
Årstemperatur	-0,6	°C
Sommertemperatur	4,8	°C
Vintertemperatur	-4,4	°C
Temperatur Juli	7,3	°C
Temperatur August	7,6	°C

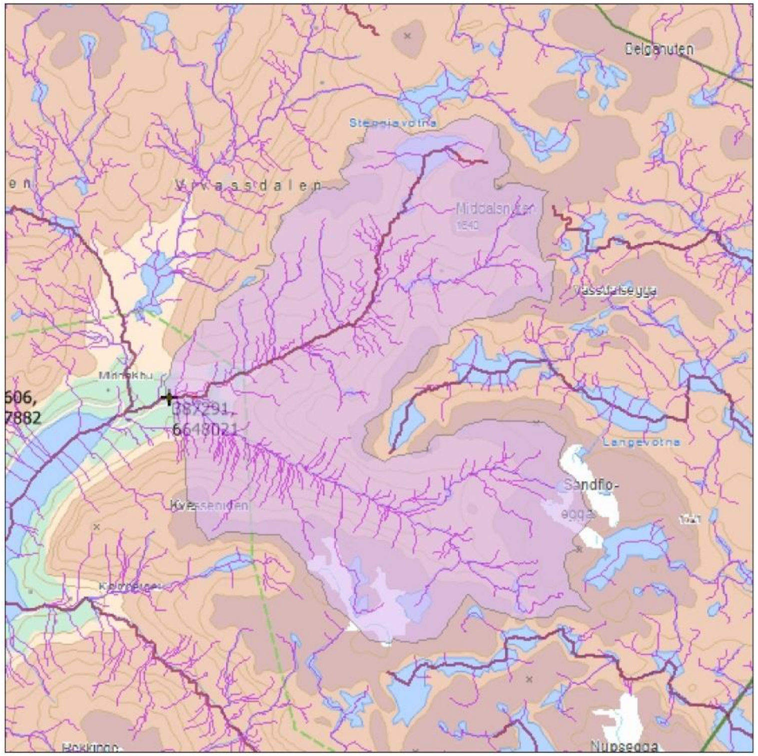
Feltparametere	
Areal (A)	6,2 km²
Effektiv sjø (S_{eff})	1,4 %
Elvelengde (E_L)	4,4 km
Elvegradient (E_G)	144,0 m/km
Elvegradient$_{1085}$(G_{1085})	90,8 m/km
Feltlengde(F_L)	4,8 km
H_{min}	377 moh.
H_{10}	745 moh.
H_{20}	827 moh.
H_{30}	840 moh.
H_{40}	869 moh.
H_{50}	933 moh.
H_{60}	1007 moh.
H_{70}	1071 moh.
H_{80}	1114 moh.
H_{90}	1179 moh.
H_{max}	1349 moh.
Bre	30,2 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	4,5 %
Skog	0,6 %
Snaufjell	64,6 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Datagrunnlaget er for dårlig til å gi tilstrekkelig kvalitet på estimatene, og resultatene er derfor ikke presentert.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Middal



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	036.HA
Kommune:	Odda
Fylke:	Hordaland
Vassdrag:	MIDDALSELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	62,2	l/s/km²
Alminnelig lavvannføring	1,5	l/s/km²
5-persentil (hele året)	1,2	l/s/km²
5-persentil (1/5-30/9)	13,4	l/s/km²
5-persentil (1/10-30/4)	1,0	l/s/km²
Base flow	21,8	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Sor	
Årsnedbør	1476	mm
Sommernedbør	555	mm
Vinternedbør	921	mm
Årstemperatur	-2,2	°C
Sommertemperatur	3,4	°C
Vintertemperatur	-6,2	°C
Temperatur Juli	5,4	°C
Temperatur August	6,6	°C

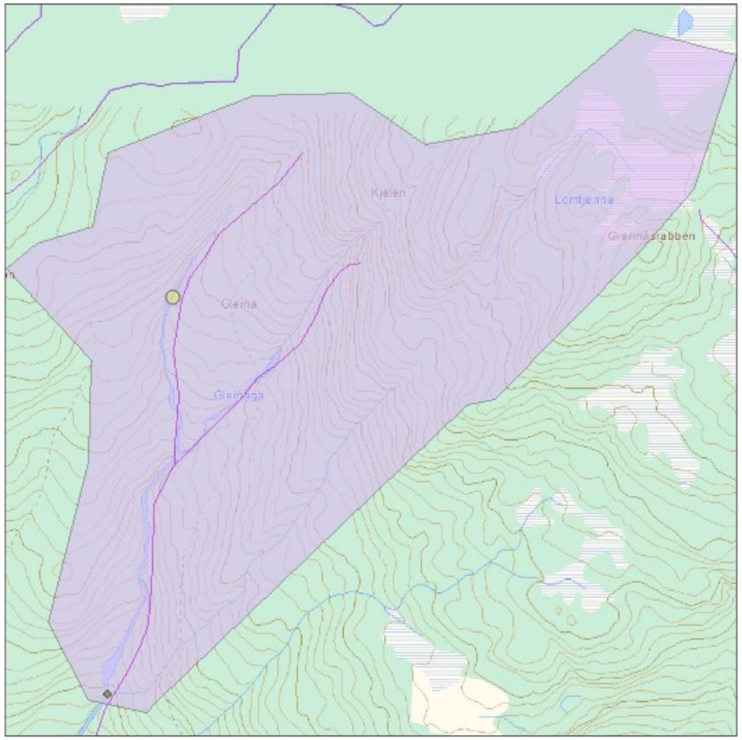
Feltparametere	
Areal (A)	46,1 km²
Effektiv sjø (S_{eff})	0,2 %
Elvelengde (E_L)	9,2 km
Elvegradient (E_G)	72,8 m/km
Elvegradient$_{1085}$(G_{1085})	72,1 m/km
Feltlengde(F_L)	8,8 km
H_{min}	833 moh.
H_{10}	1115 moh.
H_{20}	1225 moh.
H_{30}	1304 moh.
H_{40}	1368 moh.
H_{50}	1407 moh.
H_{60}	1455 moh.
H_{70}	1493 moh.
H_{80}	1526 moh.
H_{90}	1565 moh.
H_{max}	1684 moh.
Bre	2,5 %
Dyrket mark	0,0 %
Myr	0,1 %
Sjø	3,8 %
Skog	1,6 %
Snaufjell	91,3 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen har ofte stor usikkerhet rundt klassifisering av dominerende lavvannssesong og feilklassifisering forekommer. Resultatene er allikevel normalt gode.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Savjord Savaga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.B4
Kommune:	Beiarn
Fylke:	Nordland
Vassdrag:	BEIARELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	36,4	l/s/km²
Alminnelig lavvannføring	0,1	l/s/km²
5-persentil (hele året)	0,1	l/s/km²
5-persentil (1/5-30/9)	0,0	l/s/km²
5-persentil (1/10-30/4)	0,1	l/s/km²
Base flow	4,4	l/s/km²
BFI	0,1	

Klima		
Klimaregion	Nord	
Årsnedbør	1299	mm
Sommernedbør	446	mm
Vinternedbør	853	mm
Årstemperatur	0,9	°C
Sommertemperatur	7,4	°C
Vintertemperatur	-3,7	°C
Temperatur Juli	9,9	°C
Temperatur August	9,9	°C

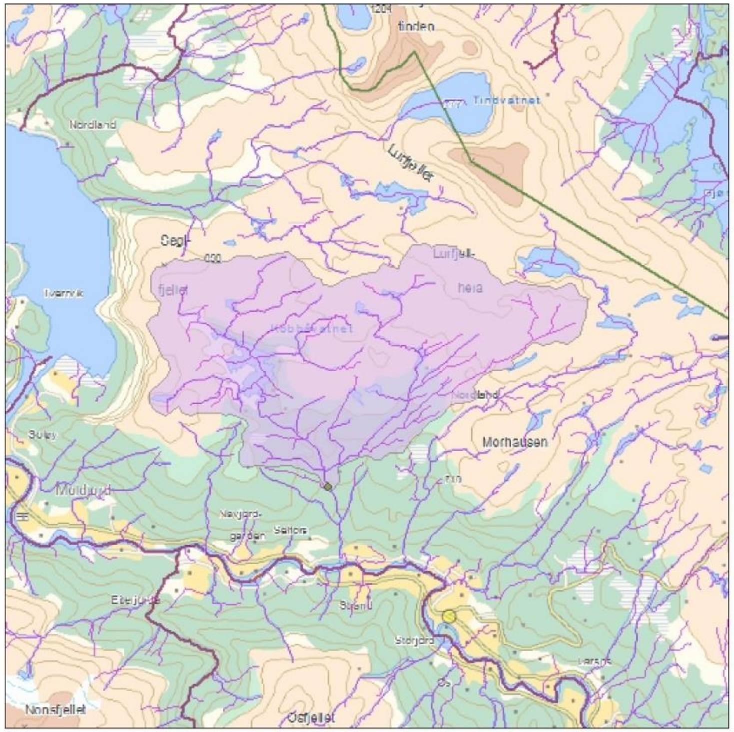
Feltparametere	
Areal (A)	0,6 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	0,9 km
Elvegradient (E_G)	159,5 m/km
Elvegradient$_{1085}$(G_{1085})	145,6 m/km
Feltlengde(F_L)	1,4 km
H_{min}	222 moh.
H_{10}	277 moh.
H_{20}	303 moh.
H_{30}	321 moh.
H_{40}	339 moh.
H_{50}	355 moh.
H_{60}	373 moh.
H_{70}	411 moh.
H_{80}	445 moh.
H_{90}	464 moh.
H_{max}	490 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	4,3 %
Sjø	0,1 %
Skog	95,7 %
Snaufjell	0,0 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Selfors Savaga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.B4
Kommune:	Beiarn
Fylke:	Nordland
Vassdrag:	BEIARELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	51,5	l/s/km²
Alminnelig lavvannføring	9,0	l/s/km²
5-persentil (hele året)	7,6	l/s/km²
5-persentil (1/5-30/9)	7,5	l/s/km²
5-persentil (1/10-30/4)	6,3	l/s/km²
Base flow	28,3	l/s/km²
BFI	0,6	

Klima		
Klimaregion	Nord	
Årsnedbør	1353	mm
Sommernedbør	463	mm
Vinternedbør	890	mm
Årstemperatur	0,7	°C
Sommertemperatur	6,6	°C
Vintertemperatur	-3,6	°C
Temperatur Juli	9,2	°C
Temperatur August	9,2	°C

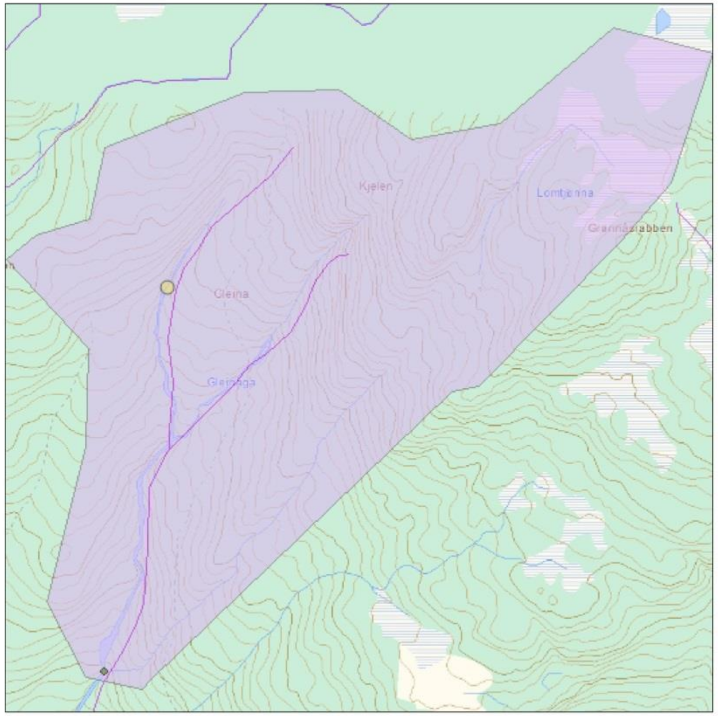
Feltparametere	
Areal (A)	24,1 km²
Effektiv sjø (S_{eff})	1,1 %
Elvelengde (E_L)	7,0 km
Elvegradient (E_G)	42,6 m/km
Elvegradient$_{1085}$(G_{1085})	30,9 m/km
Feltlengde(F_L)	6,2 km
H_{min}	274 moh.
H_{10}	472 moh.
H_{20}	493 moh.
H_{30}	520 moh.
H_{40}	542 moh.
H_{50}	561 moh.
H_{60}	583 moh.
H_{70}	608 moh.
H_{80}	628 moh.
H_{90}	675 moh.
H_{max}	778 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	1,9 %
Sjø	4,6 %
Skog	23,0 %
Snaufjell	67,5 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Savjord Savaga



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	161.B4
Kommune:	Beiarn
Fylke:	Nordland
Vassdrag:	BEIARELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	36,4	l/s/km²
Alminnelig lavvannføring	0,1	l/s/km²
5-persentil (hele året)	0,1	l/s/km²
5-persentil (1/5-30/9)	0,0	l/s/km²
5-persentil (1/10-30/4)	0,1	l/s/km²
Base flow	4,4	l/s/km²
BFI	0,1	

Klima		
Klimaregion	Nord	
Årsnedbør	1299	mm
Sommernedbør	446	mm
Vinternedbør	853	mm
Årstemperatur	0,9	°C
Sommertemperatur	7,4	°C
Vintertemperatur	-3,7	°C
Temperatur Juli	9,9	°C
Temperatur August	9,9	°C

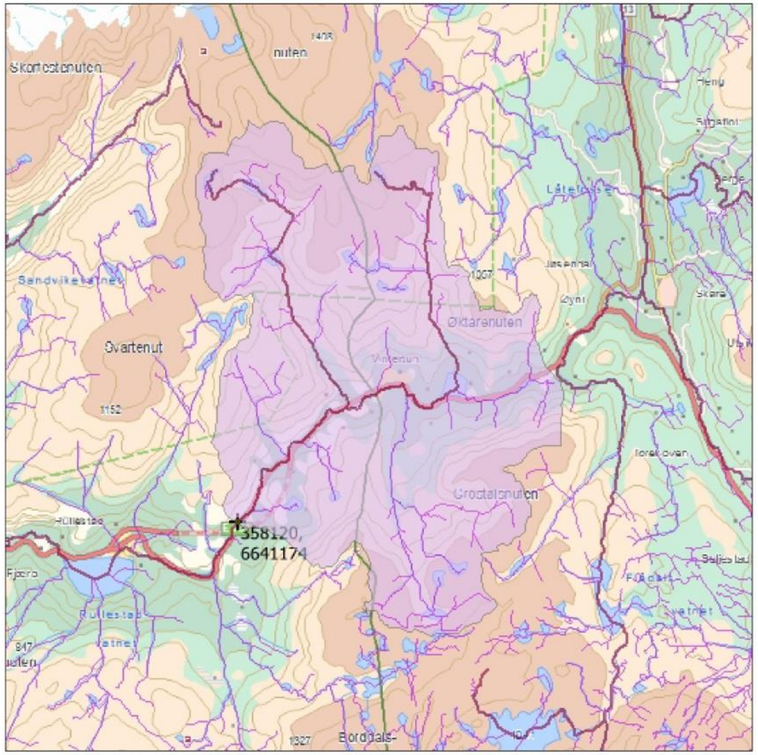
Feltparametere	
Areal (A)	0,6 km²
Effektiv sjø (S_{eff})	0,0 %
Elvelengde (E_L)	0,9 km
Elvegradient (E_G)	159,5 m/km
Elvegradient$_{1085}$ (G_{1085})	145,6 m/km
Feltlengde(F_L)	1,4 km
H_{min}	222 moh.
H_{10}	277 moh.
H_{20}	303 moh.
H_{30}	321 moh.
H_{40}	339 moh.
H_{50}	355 moh.
H_{60}	373 moh.
H_{70}	411 moh.
H_{80}	445 moh.
H_{90}	464 moh.
H_{max}	490 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	4,3 %
Sjø	0,1 %
Skog	95,7 %
Snaufjell	0,0 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

De estimerte lavvannsindeksene i denne regionen er usikre, og det er ofte noe tendens til overestimering av verdiene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Skromme



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.: 042.3D0
Kommune: Etne
Fylke: Hordaland
Vassdrag: DALELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	84,8	l/s/km²
Alminnelig lavvannføring	3,3	l/s/km²
5-persentil (hele året)	3,5	l/s/km²
5-persentil (1/5-30/9)	12,3	l/s/km²
5-persentil (1/10-30/4)	2,6	l/s/km²
Base flow	30,5	l/s/km²
BFI	0,4	

Klima		
Klimaregion	Vest	
Årsnedbør	2459	mm
Sommernedbør	840	mm
Vinternedbør	1618	mm
Årstemperatur	1,8	°C
Sommertemperatur	6,9	°C
Vintertemperatur	-1,9	°C
Temperatur Juli	8,7	°C
Temperatur August	9,6	°C

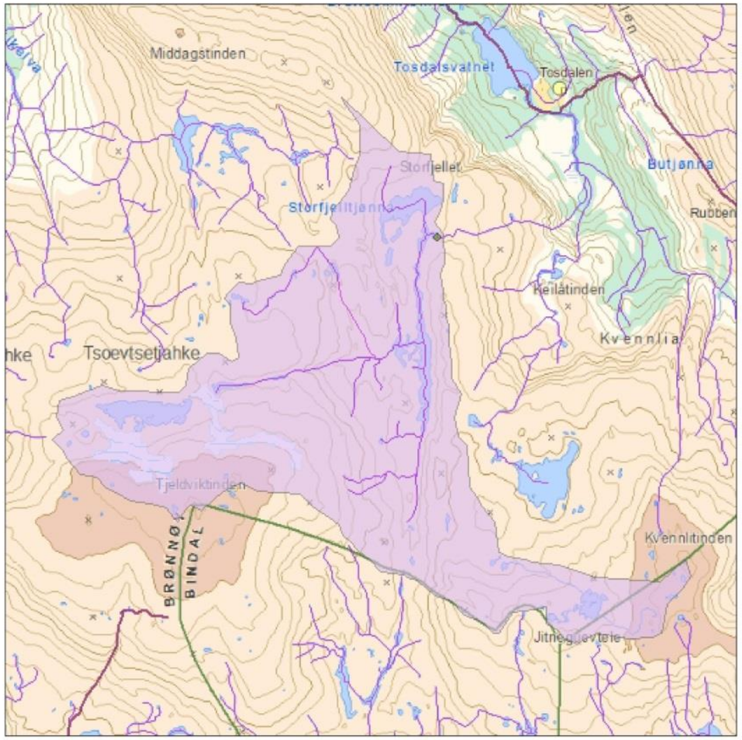
Feltparametere	
Areal (A)	42,5 km²
Effektiv sjø (S_{eff})	0,2 %
Elvelengde (E_L)	11,6 km
Elvegradient (E_G)	66,2 m/km
Elvegradient$_{1085}$(G_{1085})	67,4 m/km
Feltlengde(F_L)	8,0 km
H_{min}	317 moh.
H_{10}	448 moh.
H_{20}	553 moh.
H_{30}	657 moh.
H_{40}	750 moh.
H_{50}	829 moh.
H_{60}	904 moh.
H_{70}	973 moh.
H_{80}	1027 moh.
H_{90}	1082 moh.
H_{max}	1358 moh.
Bre	0,0 %
Dyrket mark	0,5 %
Myr	0,3 %
Sjø	2,5 %
Skog	18,4 %
Snaufjell	57,2 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Stjortfjeltjonna



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	144.7B
Kommune:	Brønnøy
Fylke:	Nordland
Vassdrag:	STORELVA

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	112,0	l/s/km²
Alminnelig lavvannføring	3,6	l/s/km²
5-persentil (hele året)	4,0	l/s/km²
5-persentil (1/5-30/9)	16,1	l/s/km²
5-persentil (1/10-30/4)	3,2	l/s/km²
Base flow	36,9	l/s/km²
BFI	0,3	

Klima		
Klimaregion	Midt	
Årsnedbør	2483	mm
Sommernedbør	864	mm
Vinternedbør	1620	mm
Årstemperatur	0,7	°C
Sommertemperatur	6,1	°C
Vintertemperatur	-3,1	°C
Temperatur Juli	8,3	°C
Temperatur August	8,5	°C

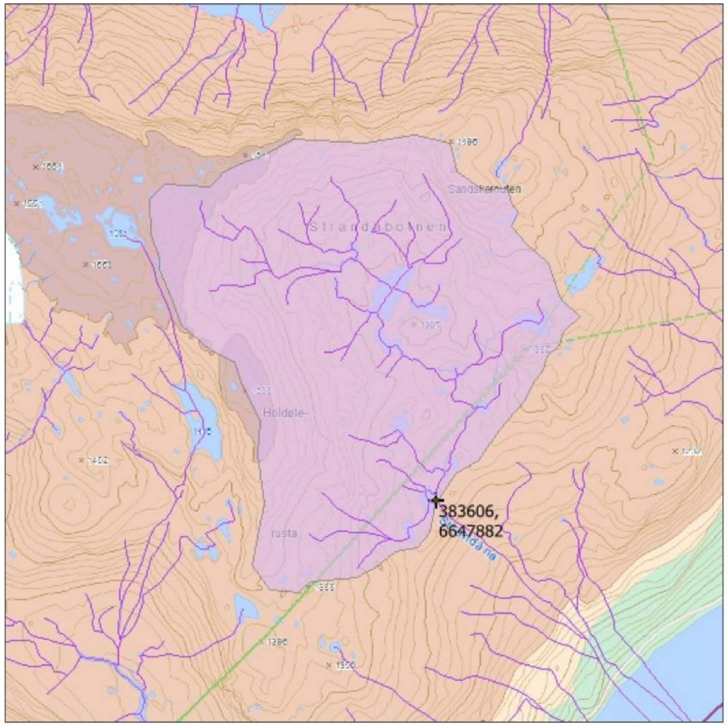
Feltparametere	
Areal (A)	9,7 km²
Effektiv sjø (S_{eff})	1,8 %
Elvelengde (E_L)	4,1 km
Elvegradient (E_G)	38,8 m/km
Elvegradient$_{1085}$(G_{1085})	40,8 m/km
Feltlengde(F_L)	4,3 km
H_{min}	679 moh.
H_{10}	702 moh.
H_{20}	728 moh.
H_{30}	760 moh.
H_{40}	795 moh.
H_{50}	828 moh.
H_{60}	856 moh.
H_{70}	893 moh.
H_{80}	930 moh.
H_{90}	986 moh.
H_{max}	1092 moh.
Bre	3,5 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	5,6 %
Skog	0,0 %
Snaufjell	90,9 %
Urban	0,0 %

Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen gir generelt gode estimater av lavvannsindeksene.

Appendix A: NVE Low Flow Application (Lavvannskart) for selected SWECO AS stations Stranda



Norges vassdrags- og energidirektorat

NVE

Kartbakgrunn: Statens Kartverk

Kartdatum: EUREF89 WGS84

Projeksjon: UTM 33N

Nedbørfeltgrenser, feltparametere og vannføringsindekser er automatisk generert og kan inneholde feil. Resultatene må kvalitetssikres.

Lavvannskart

Vassdragsnr.:	036.H4
Kommune:	Odda
Fylke:	Hordaland
Vassdrag:	SULDALSVASSDRAGET

Vannføringsindeks, se merknader		
Middelvannføring (61-90)	81,8	l/s/km²
Alminnelig lavvannføring	3,5	l/s/km²
5-persentil (hele året)	3,4	l/s/km²
5-persentil (1/5-30/9)	20,8	l/s/km²
5-persentil (1/10-30/4)	2,4	l/s/km²
Base flow	22,9	l/s/km²
BFI	0,3	

Klima		
Klimaregion	Sor	
Årsnedbør	1669	mm
Sommernedbør	611	mm
Vinternedbør	1058	mm
Årstemperatur	-1,3	°C
Sommertemperatur	3,5	°C
Vintertemperatur	-4,7	°C
Temperatur Juli	5,4	°C
Temperatur August	6,8	°C

Feltparametere	
Areal (A)	4,1 km²
Effektiv sjø (S_{eff})	1,1 %
Elvelengde (E_L)	3,6 km
Elvegradient (E_G)	81,2 m/km
Elvegradient$_{1085}$(G_{1085})	64,7 m/km
Feltlengde(F_L)	2,4 km
H_{min}	1221 moh.
H_{10}	1269 moh.
H_{20}	1294 moh.
H_{30}	1311 moh.
H_{40}	1334 moh.
H_{50}	1358 moh.
H_{60}	1383 moh.
H_{70}	1413 moh.
H_{80}	1447 moh.
H_{90}	1487 moh.
H_{max}	1564 moh.
Bre	0,0 %
Dyrket mark	0,0 %
Myr	0,0 %
Sjø	3,4 %
Skog	0,0 %
Snaufjell	96,5 %
Urban	0,0 %

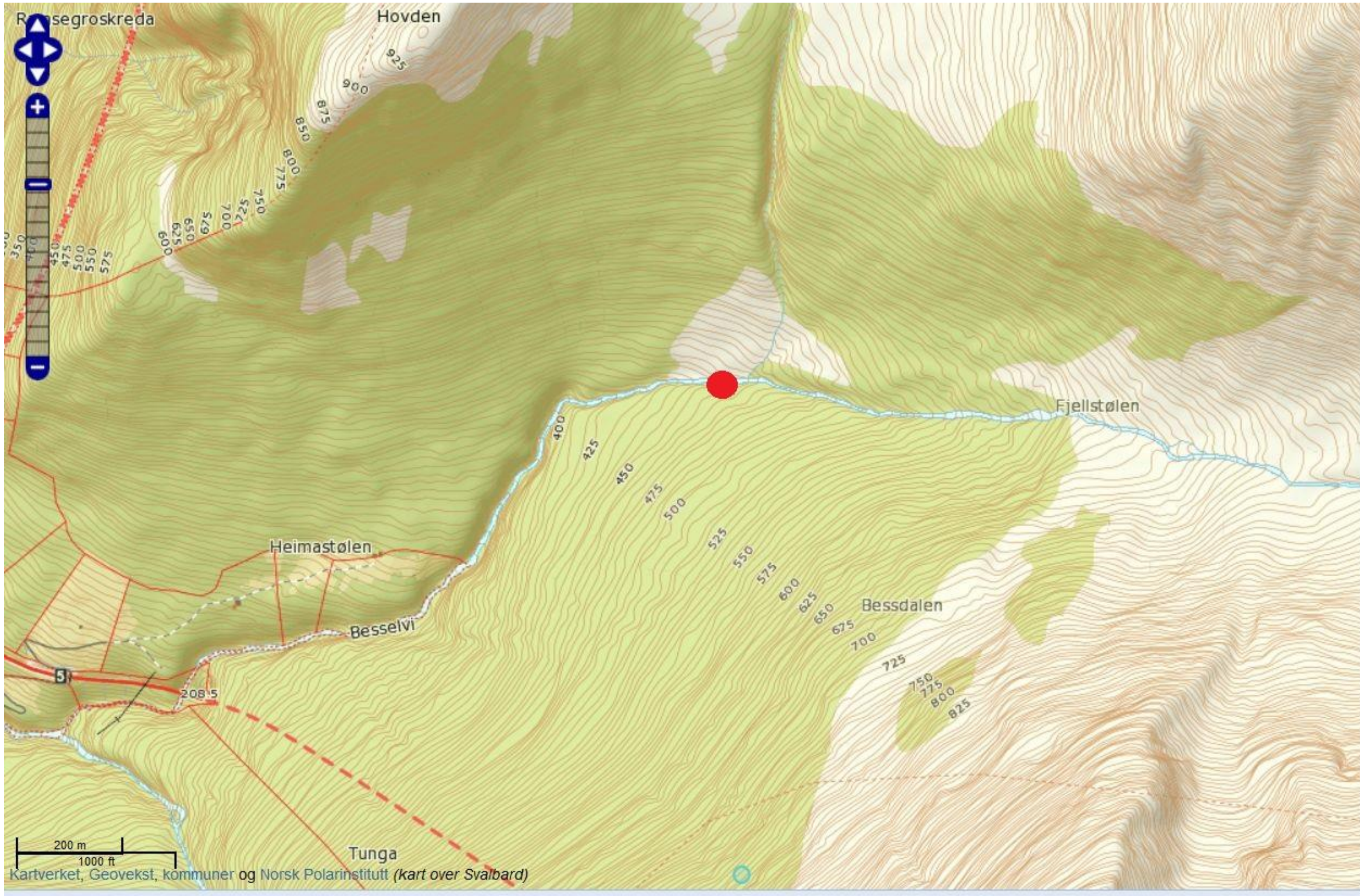
Det er generelt stor usikkerhet i beregninger av lavvannsindekser. Resultatene bør verifiseres mot egne observasjoner eller sammenlignbare målestasjoner.

I nedbørfelt med høy breprosent eller stor innsjøprosent vil tørrværsavrenning (baseflow) ha store bidrag fra disse lagringsmagasinene.

Denne regionen har ofte stor usikkerhet rundt klassifisering av dominerende lavvannssesong og feilklassifisering forekommer. Resultatene er allikevel normalt gode.

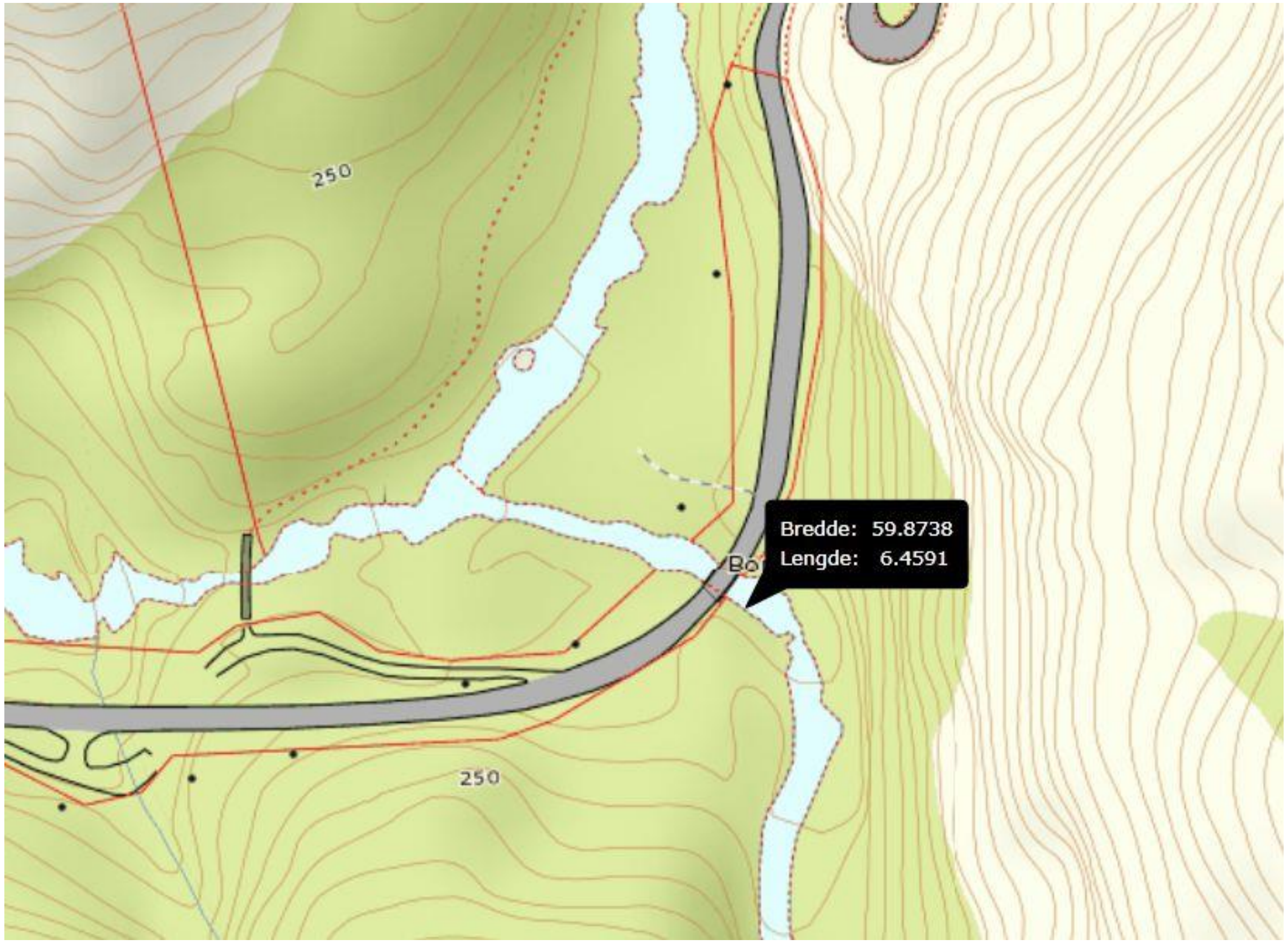
Appendix B: Map of selected SWECO AS station terrain Aurstadelava

Appendix B: Map of selected SWECO AS station terrain Berge

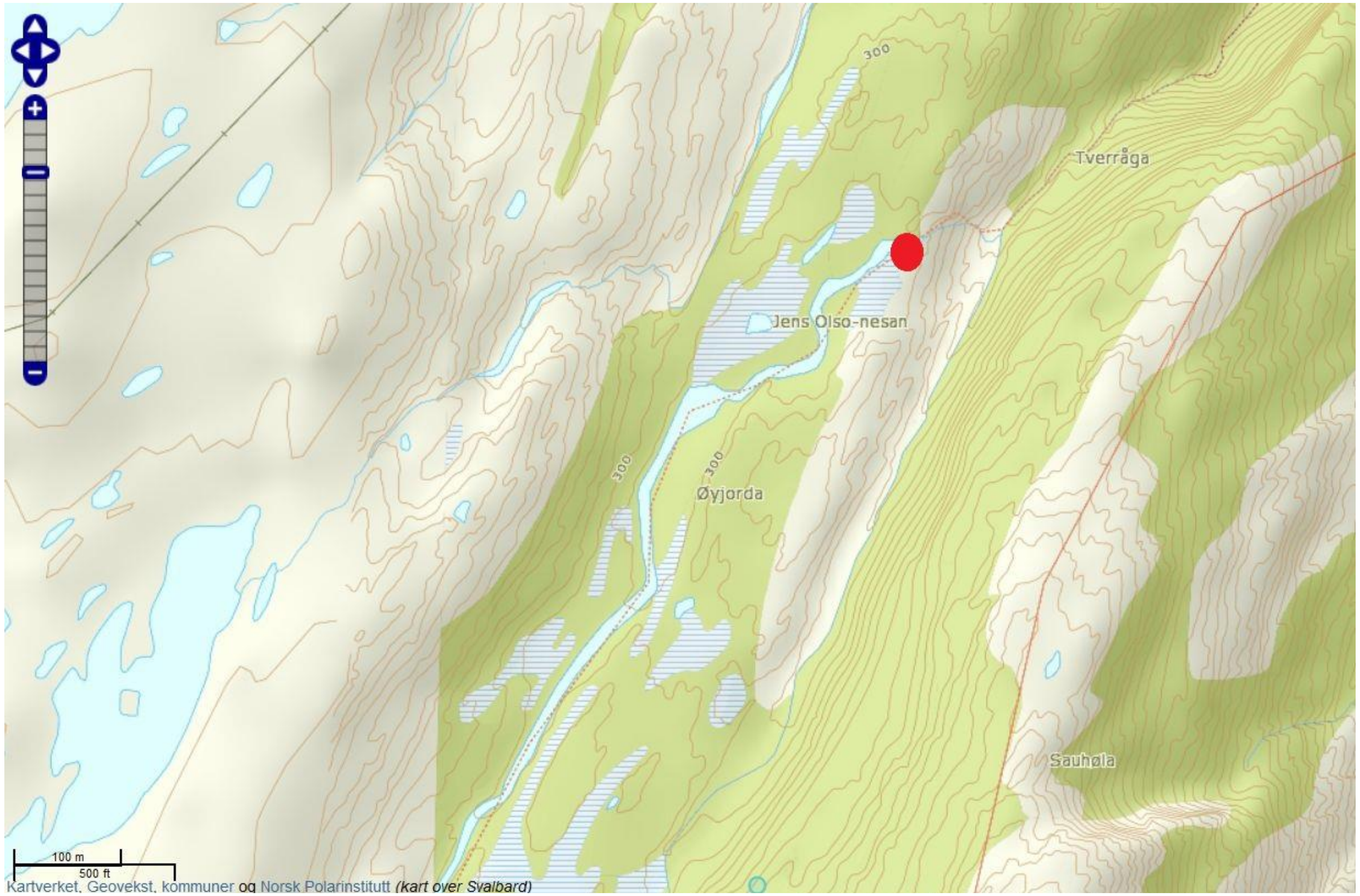


Appendix B: Map of selected SWECO AS station terrain Bjaastad

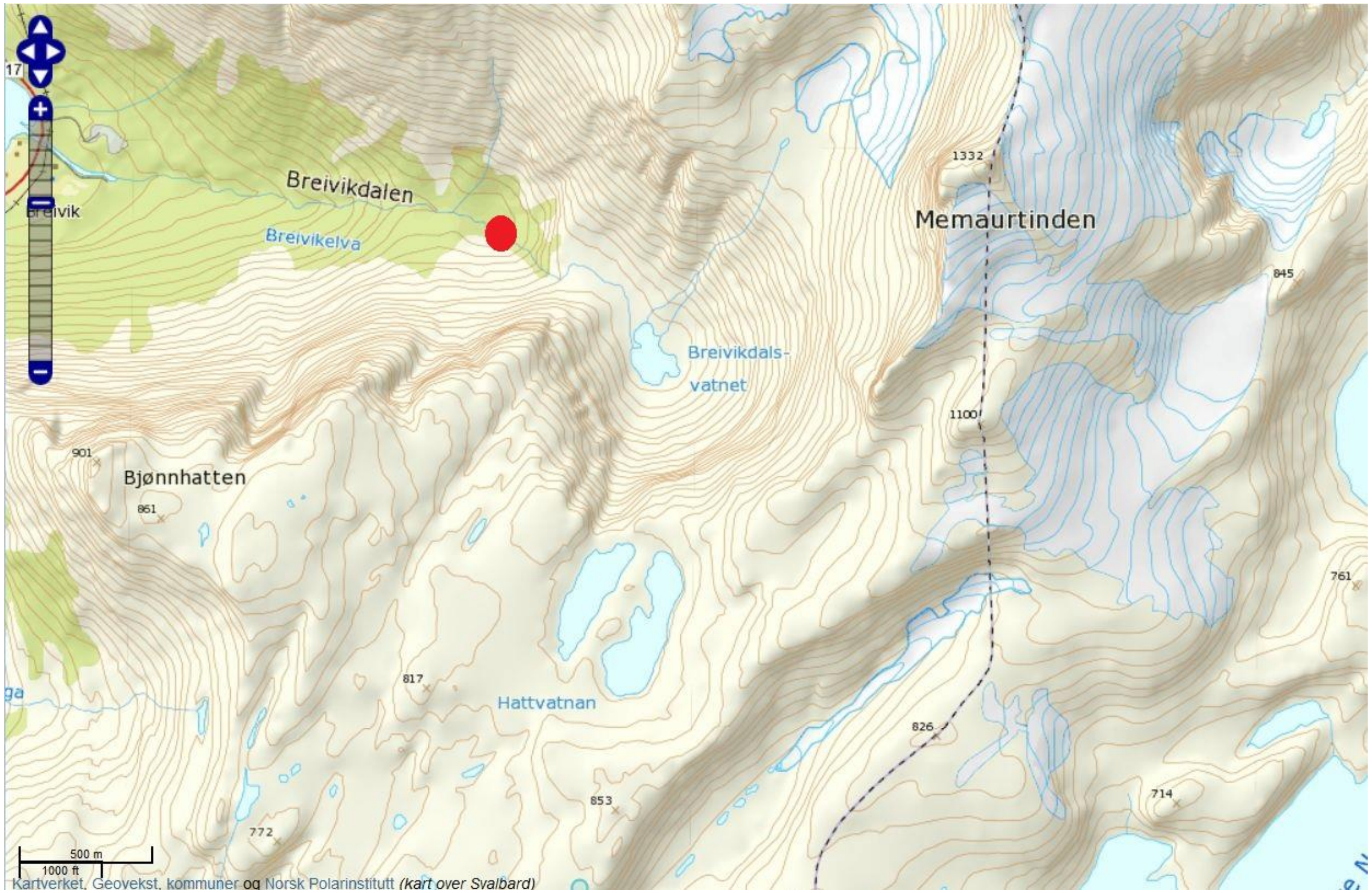
Appendix B: Map of selected SWECO AS station terrain Bordalselva



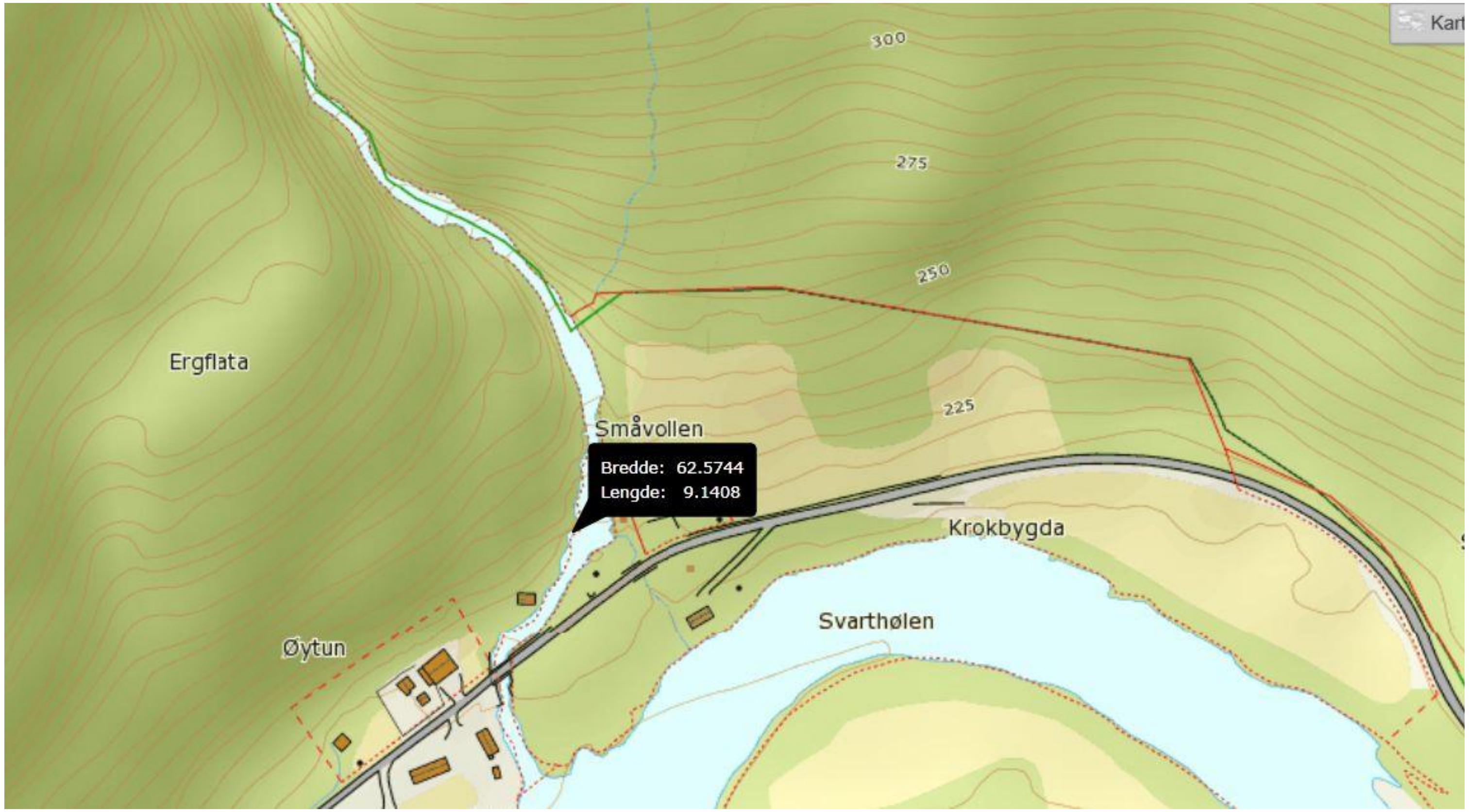
Appendix B: Map of selected SWECO AS station terrain Breidalselva



Appendix B: Map of selected SWECO AS station terrain Breivikelva

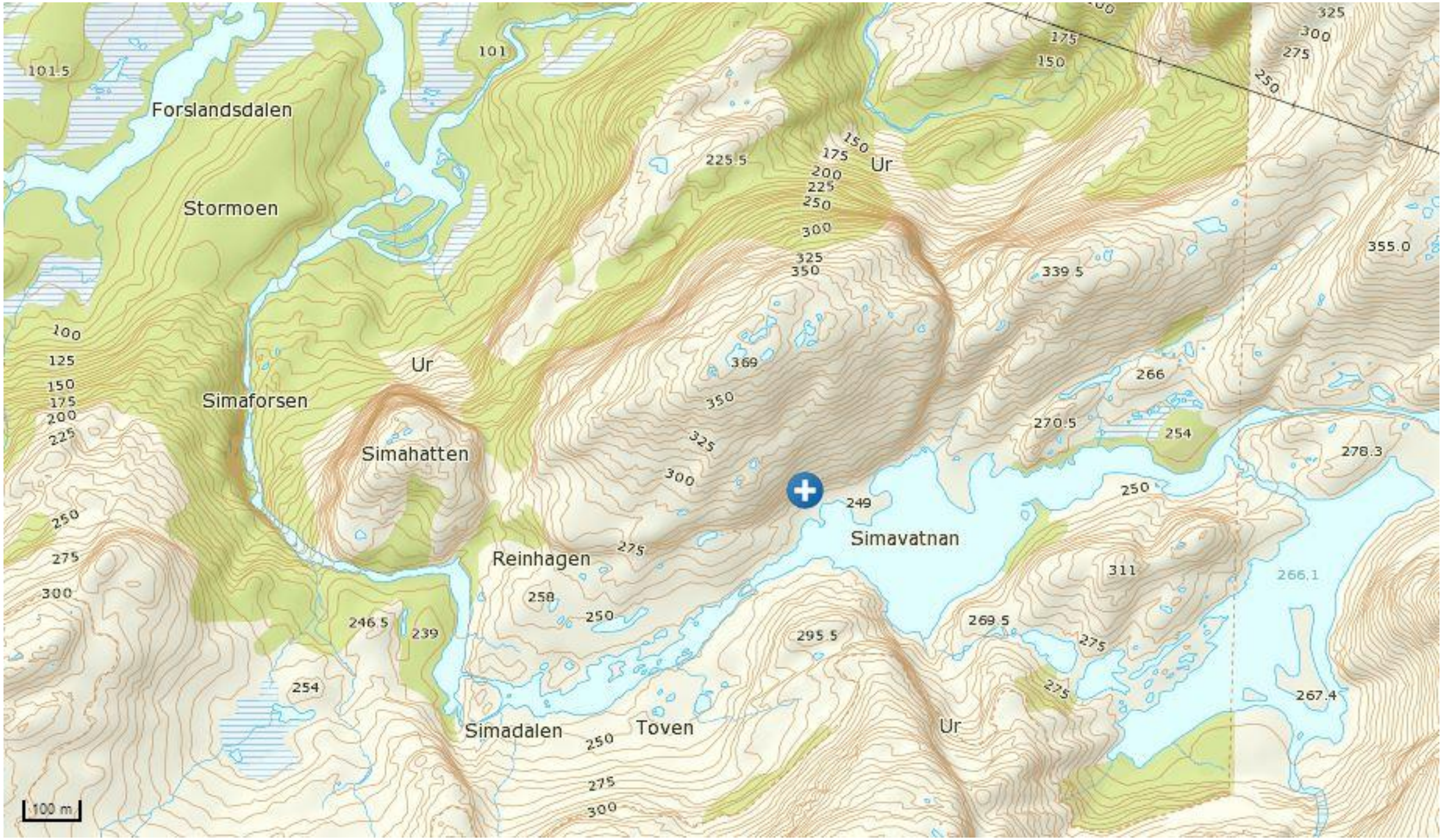


Appendix B: Map of selected SWECO AS station terrain Erga

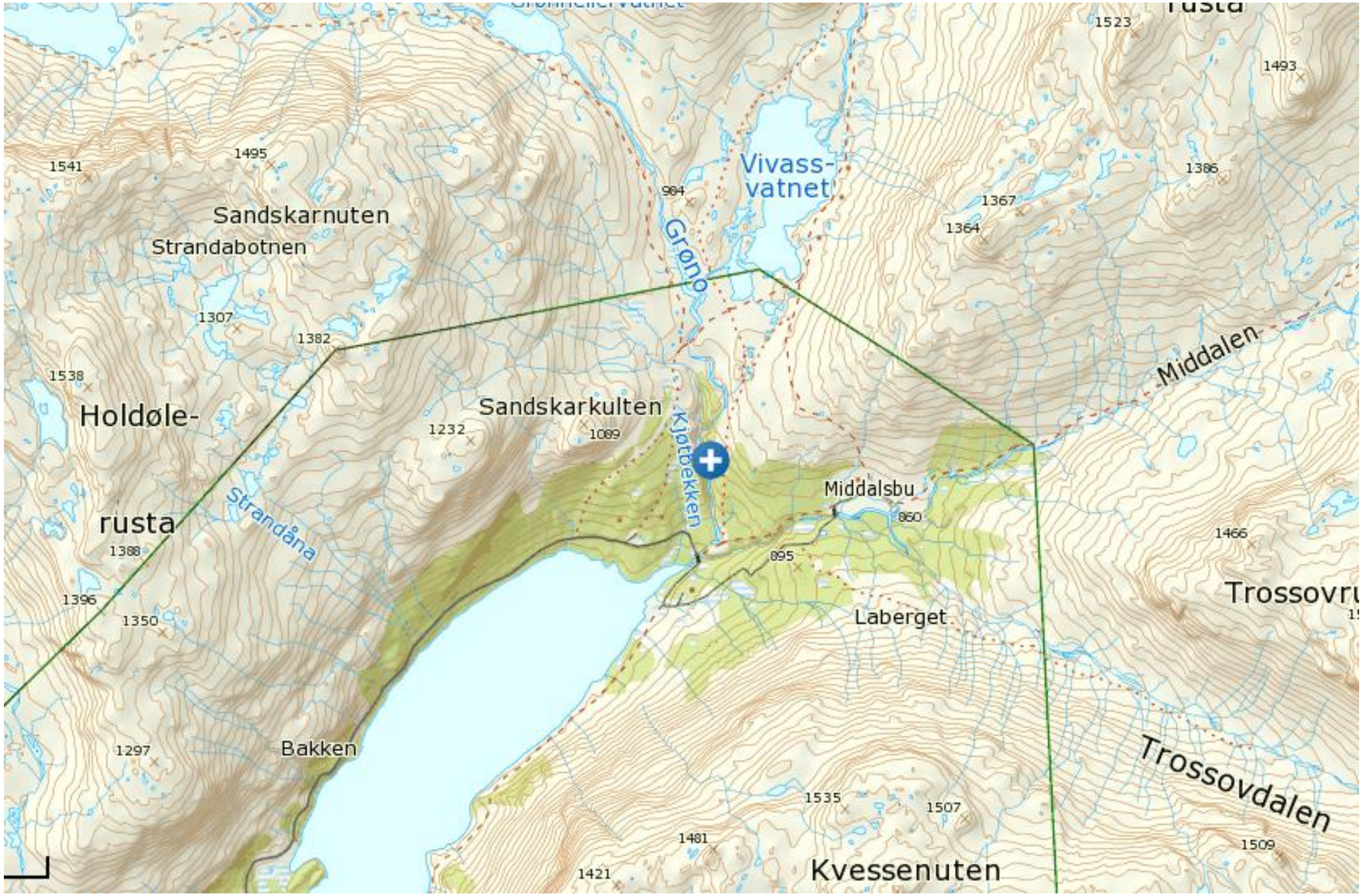


Appendix B: Map of selected SWECO AS station terrain Femtevasselva

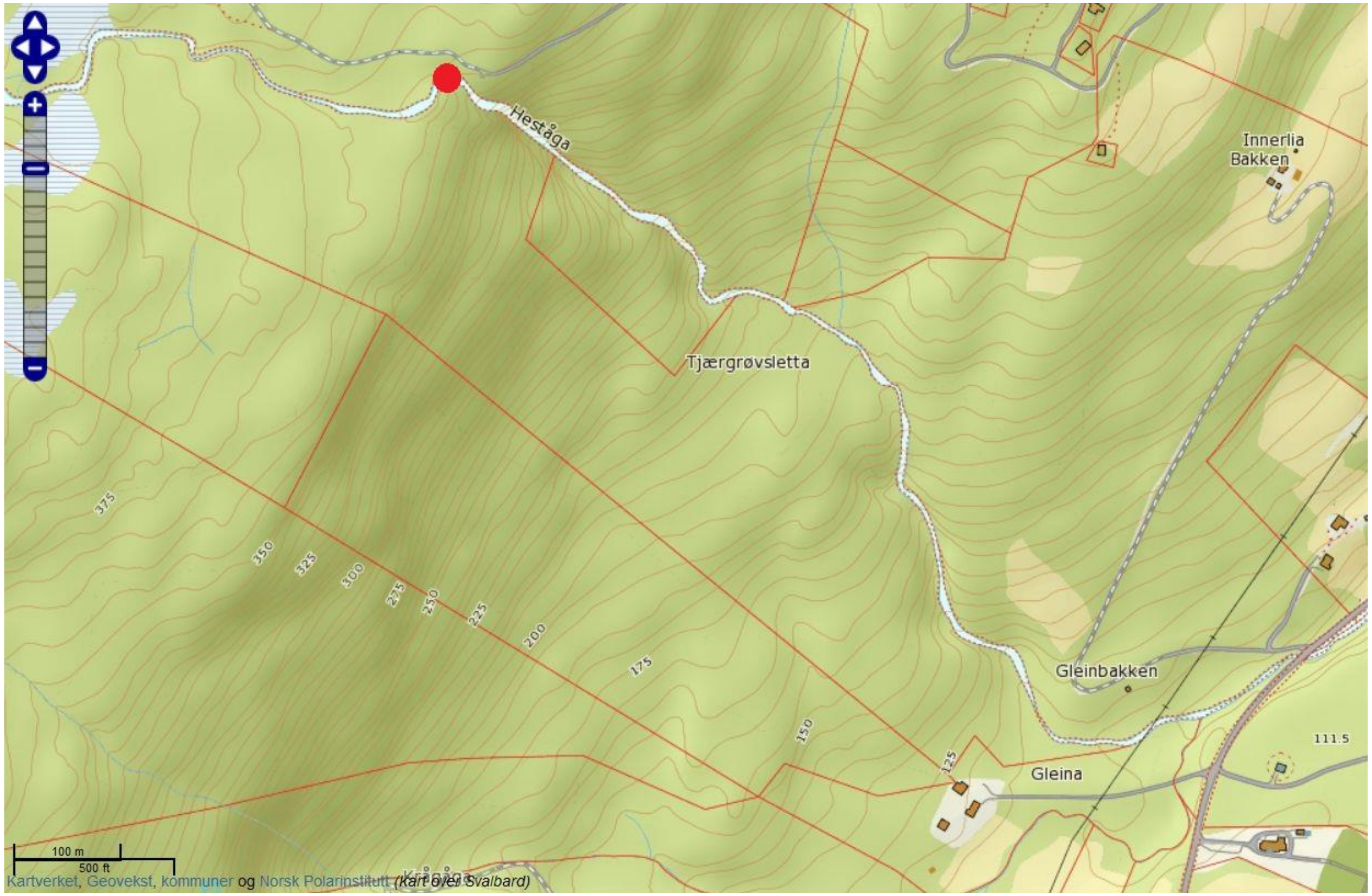
Appendix B: Map of selected SWECO AS station terrain Forsland



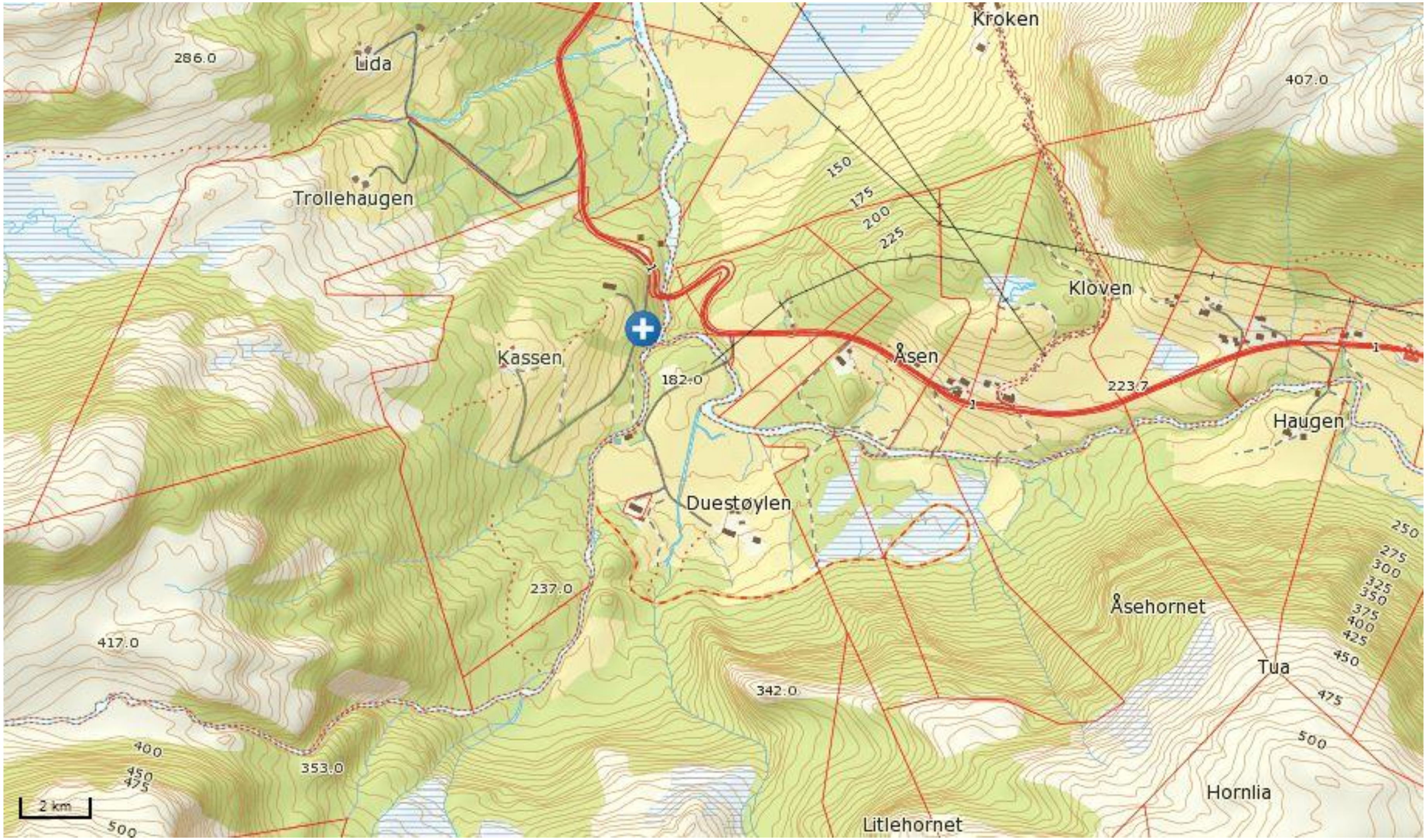
Appendix B: Map of selected SWECO AS station terrain Grono



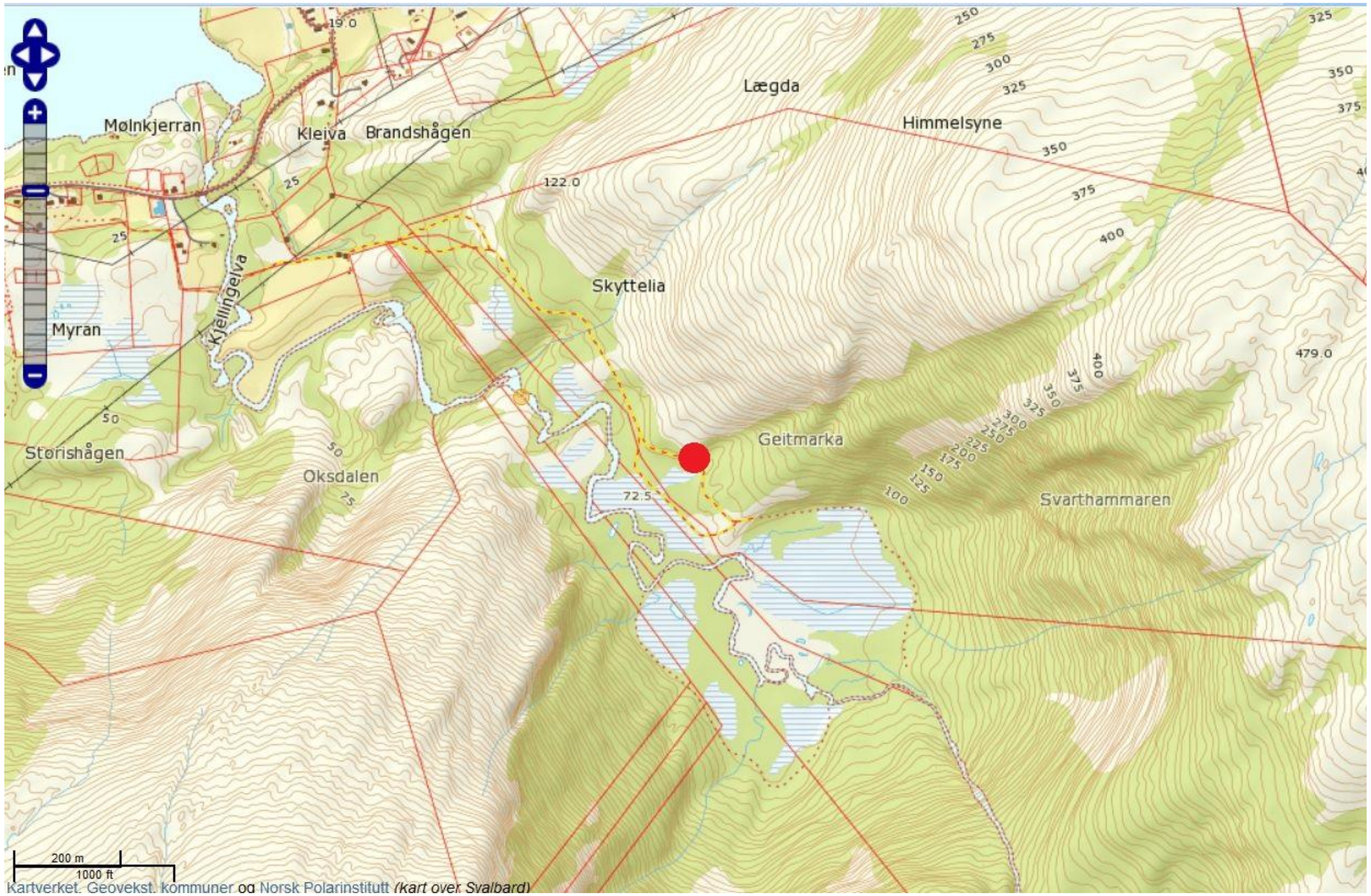
Appendix B: Map of selected SWECO AS station terrain Hestaaga



Appendix B: Map of selected SWECO AS station terrain Kasseelva



Appendix B: Map of selected SWECO AS station terrain Kjellingelva

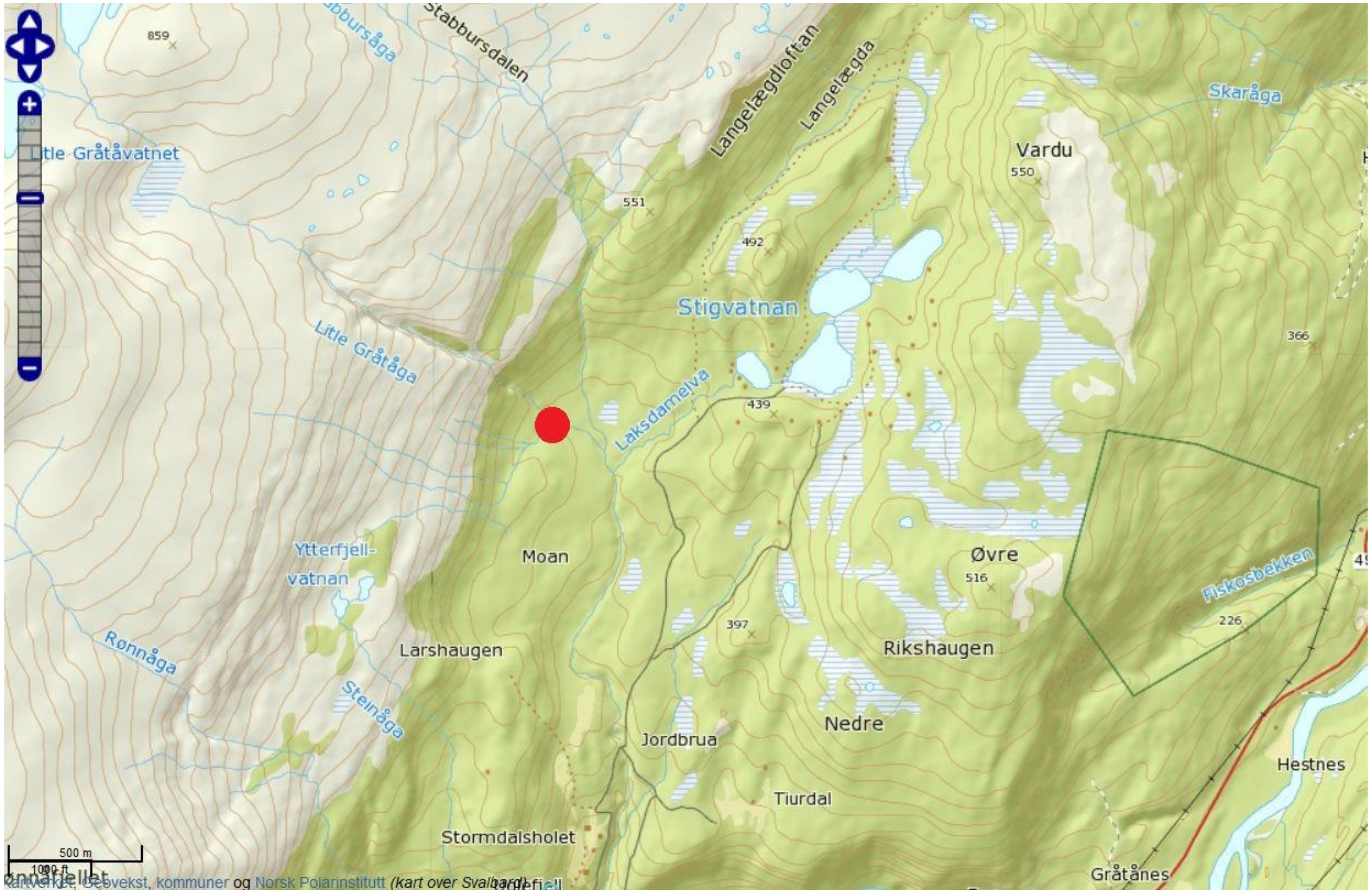


Appendix B: Map of selected SWECO AS station terrain Krutaaga

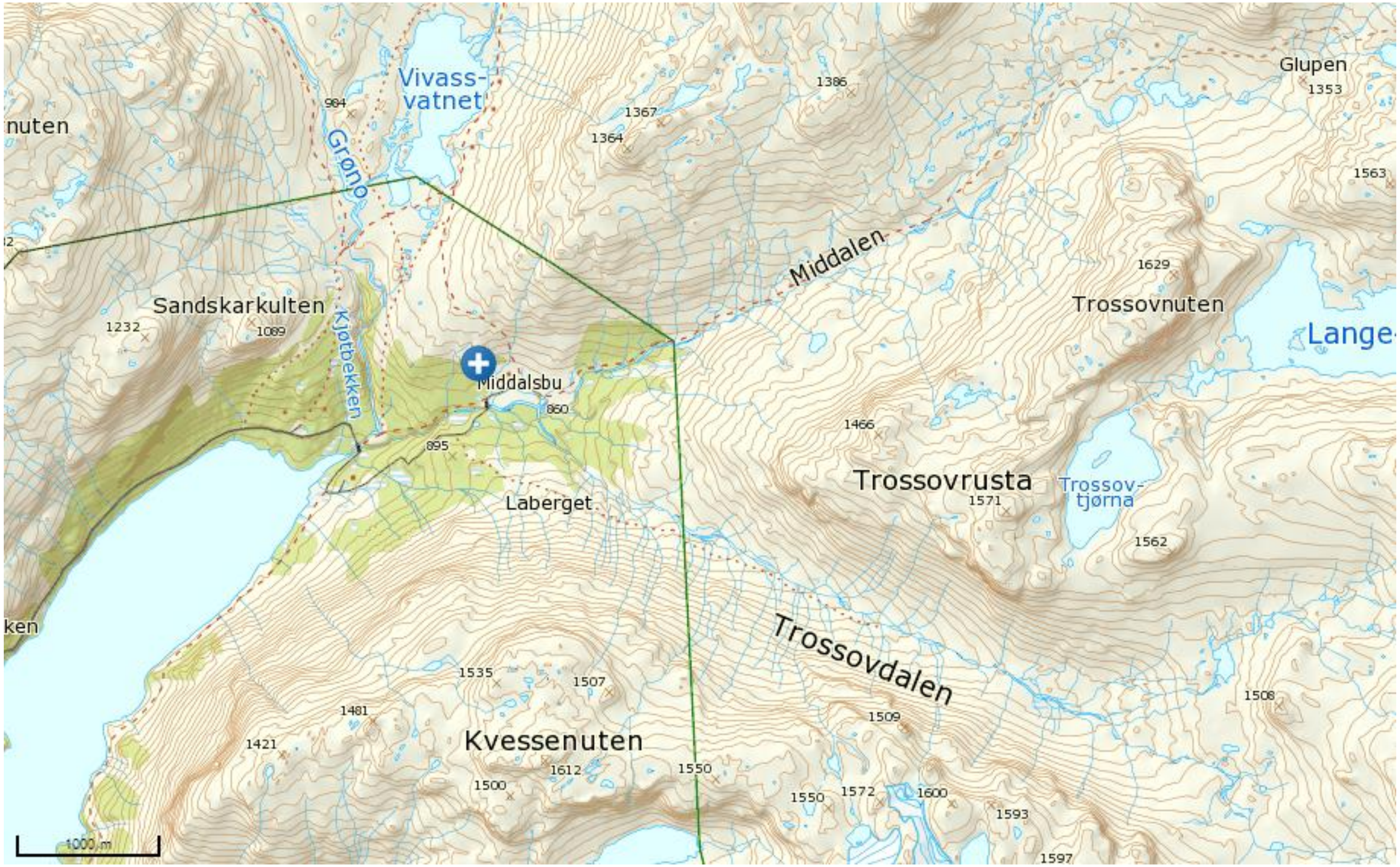
Appendix B: Map of selected SWECO AS station terrain Kvernhusbekken

Appendix B: Map of selected SWECO AS station terrain Laupen

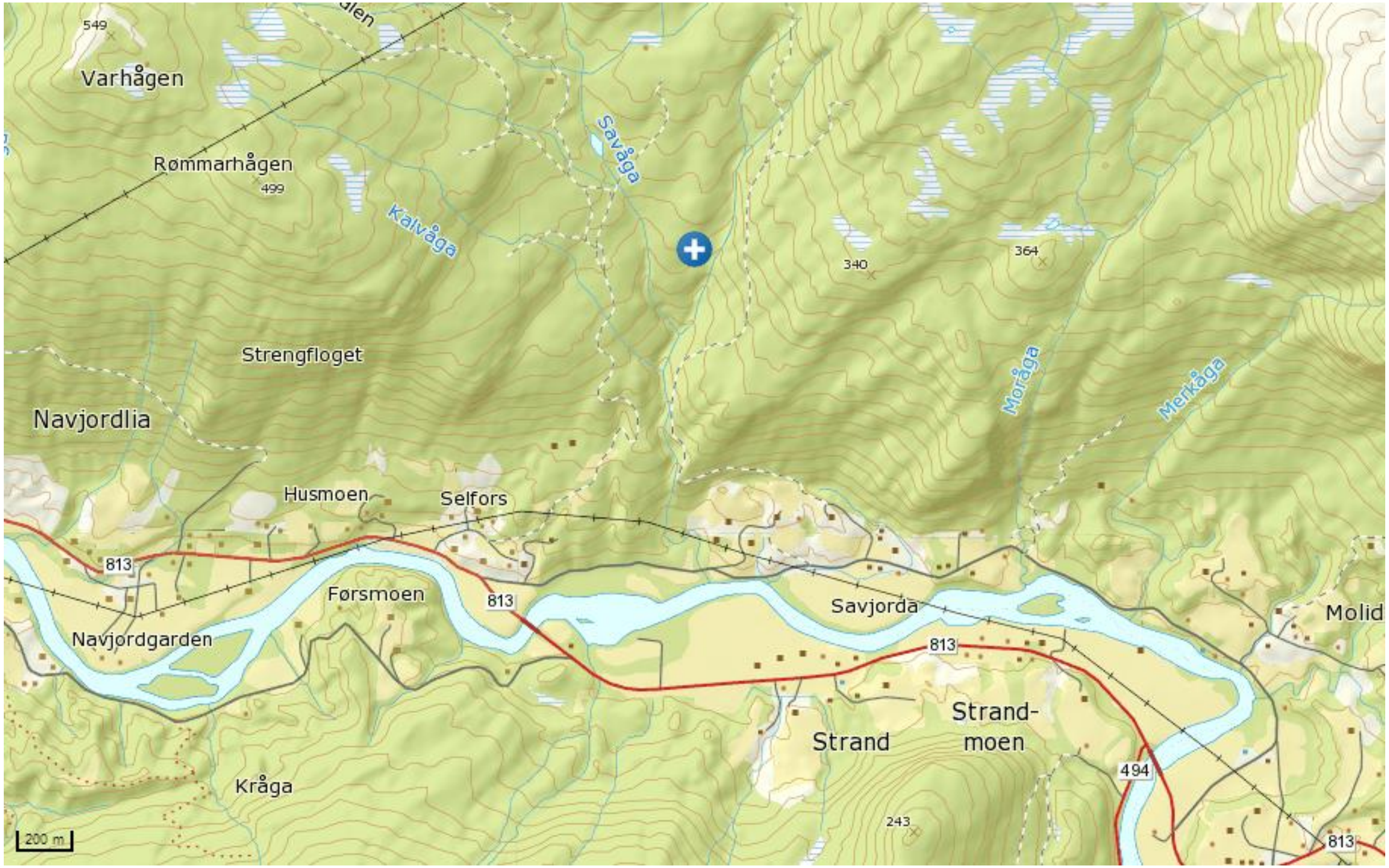
Appendix B: Map of selected SWECO AS station terrain Lillee Grataaga



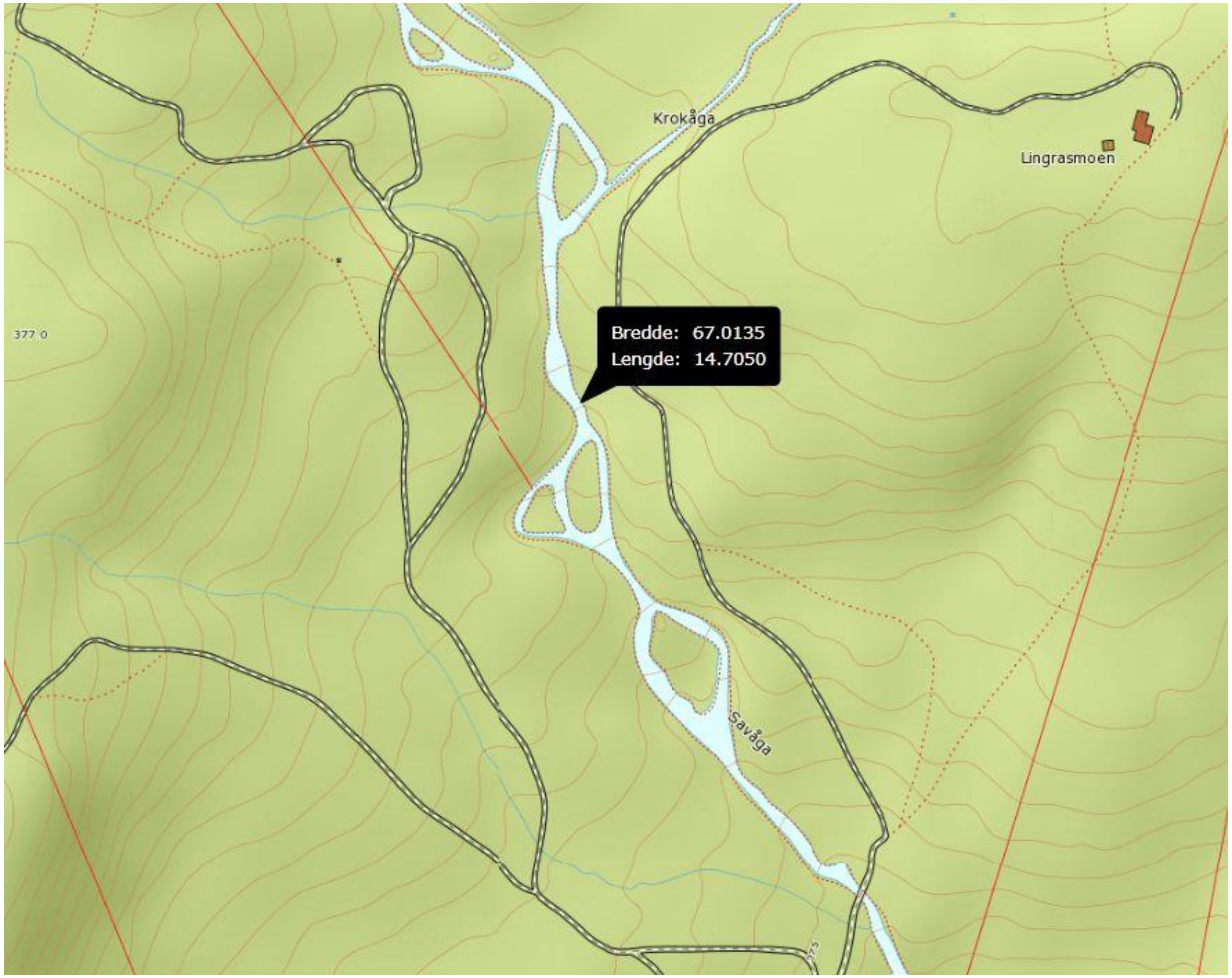
Appendix B: Map of selected SWECO AS station terrain Middal



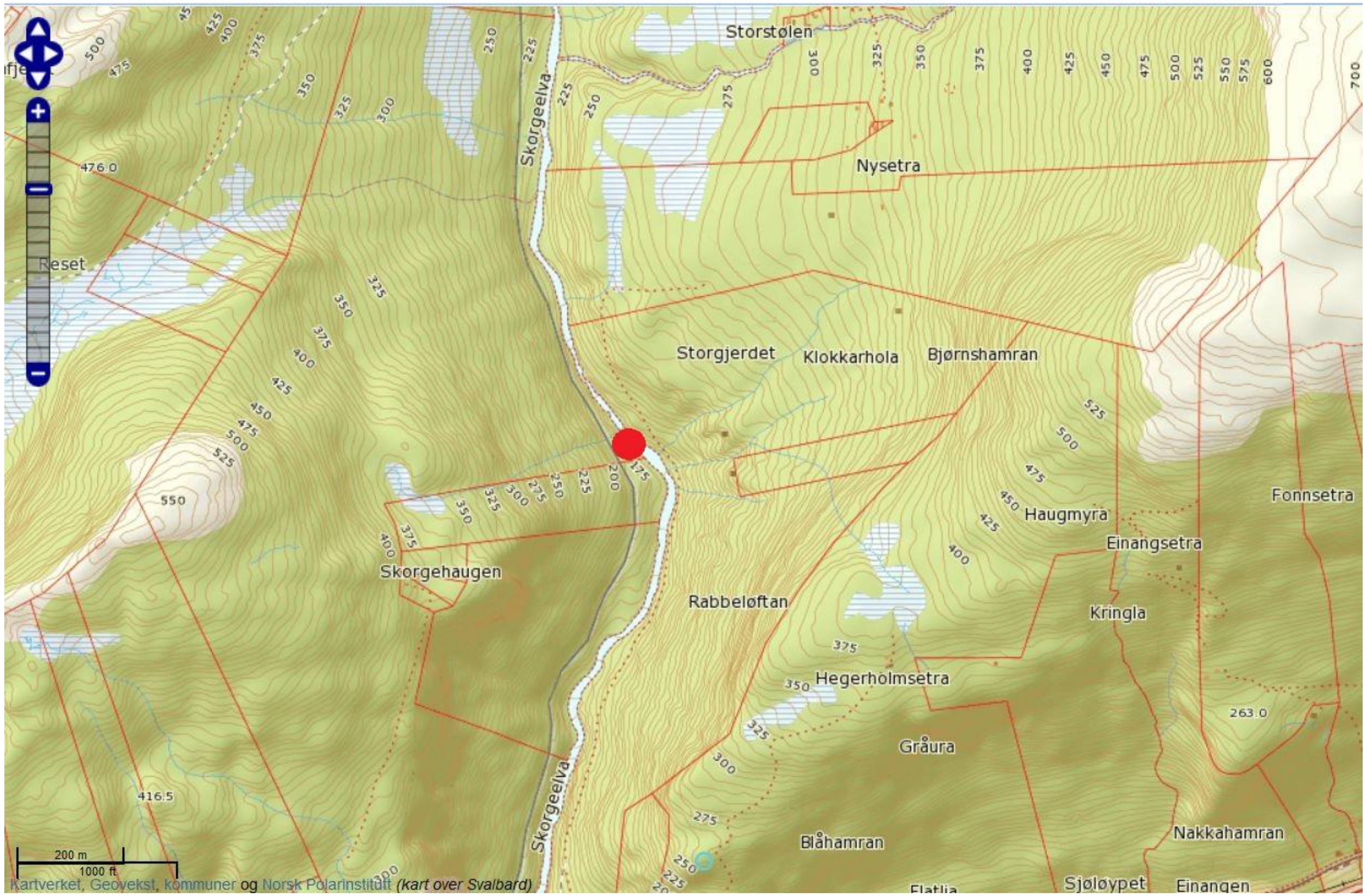
Appendix B: Map of selected SWECO AS station terrain Savjord Savaga



Appendix B: Map of selected SWECO AS station terrain Selfors Savaga



Appendix B: Map of selected SWECO AS station terrain Skorgeelva



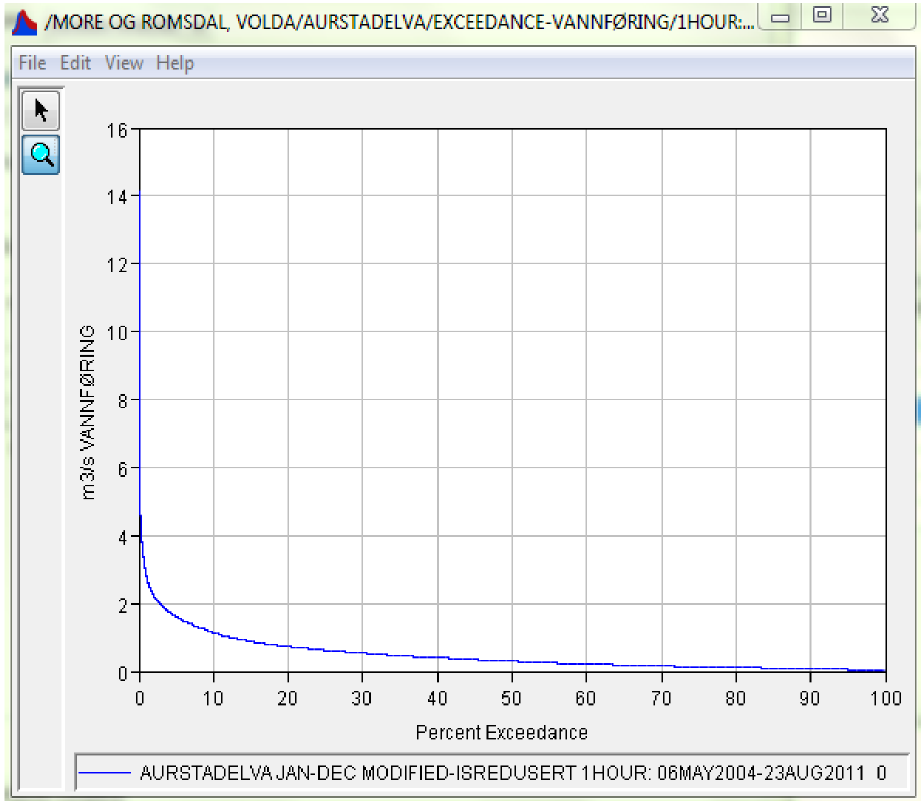
Appendix B: Map of selected SWECO AS station terrain Skromme

Appendix B: Map of selected SWECO AS station terrain Storfjelltjonna

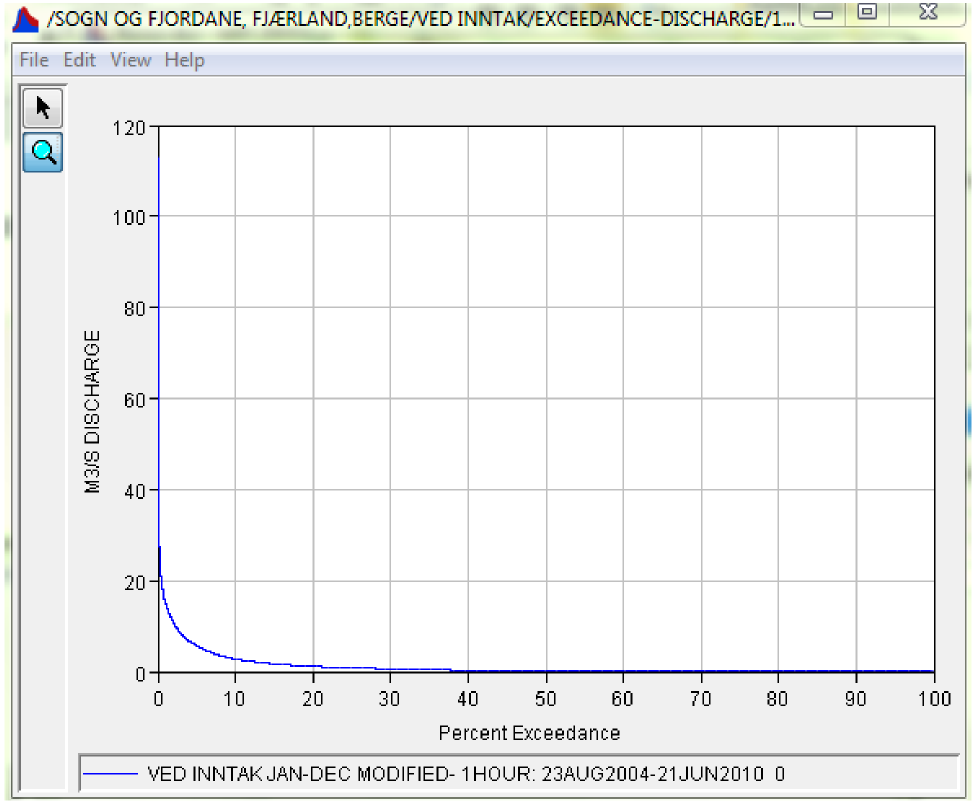
Appendix B: Map of selected SWECO AS station terrain Strandaana

Appendix C: Duration Curves for selected SWECO AS stations

Aurstadelva

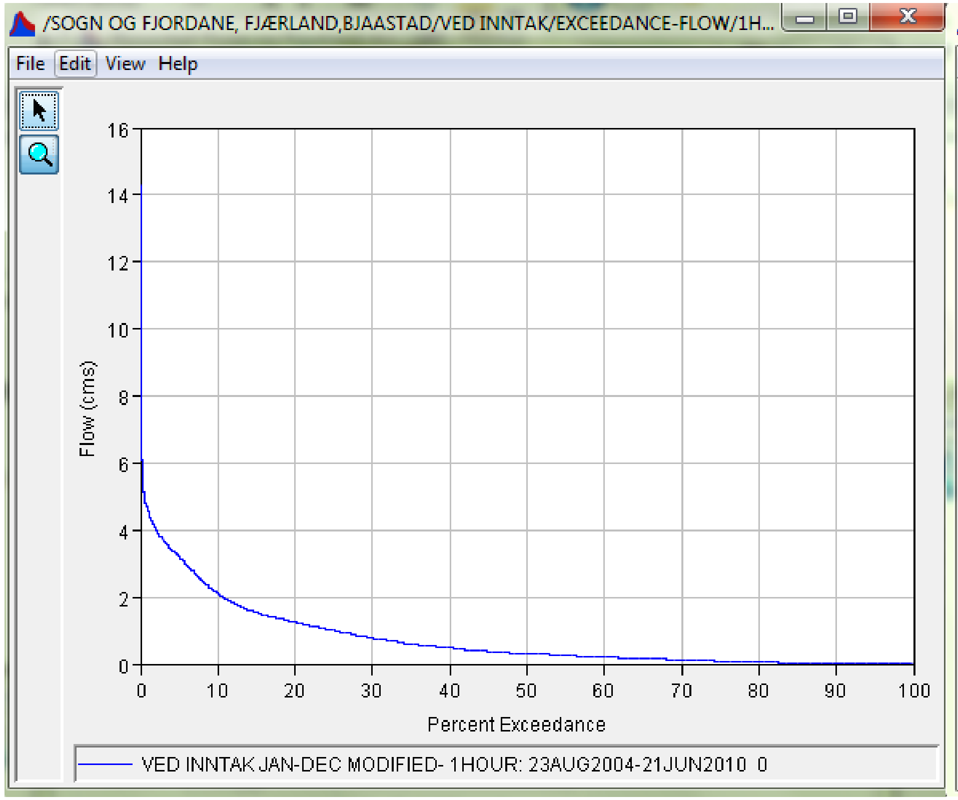


Berge

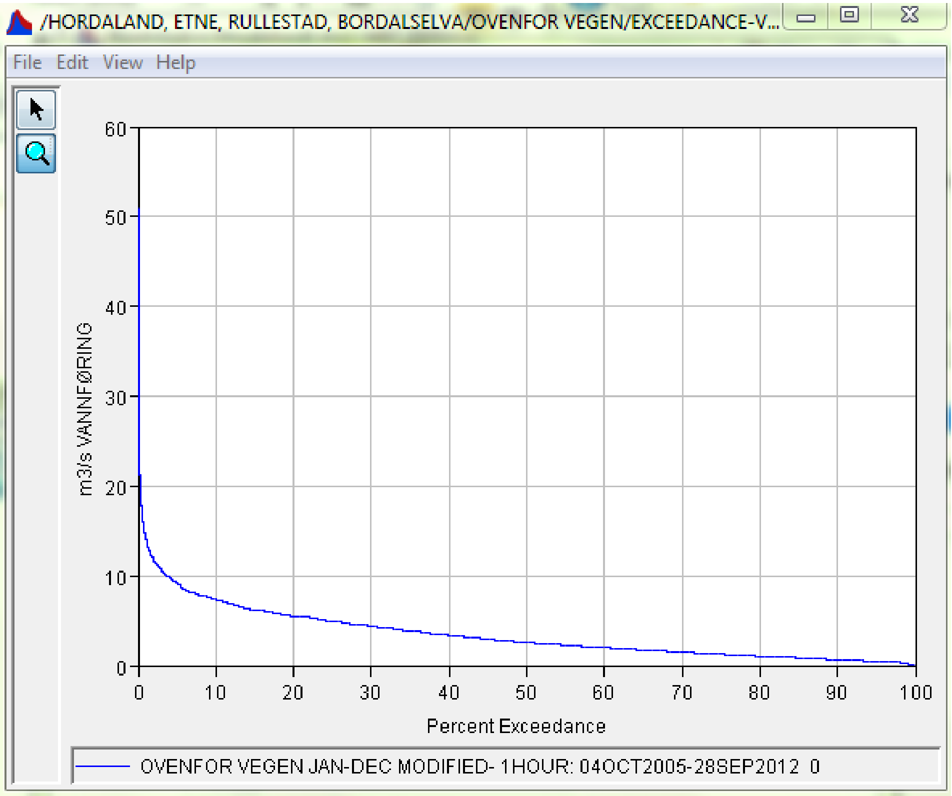


Appendix C: Duration Curves for selected SWECO AS stations

Bjaastad

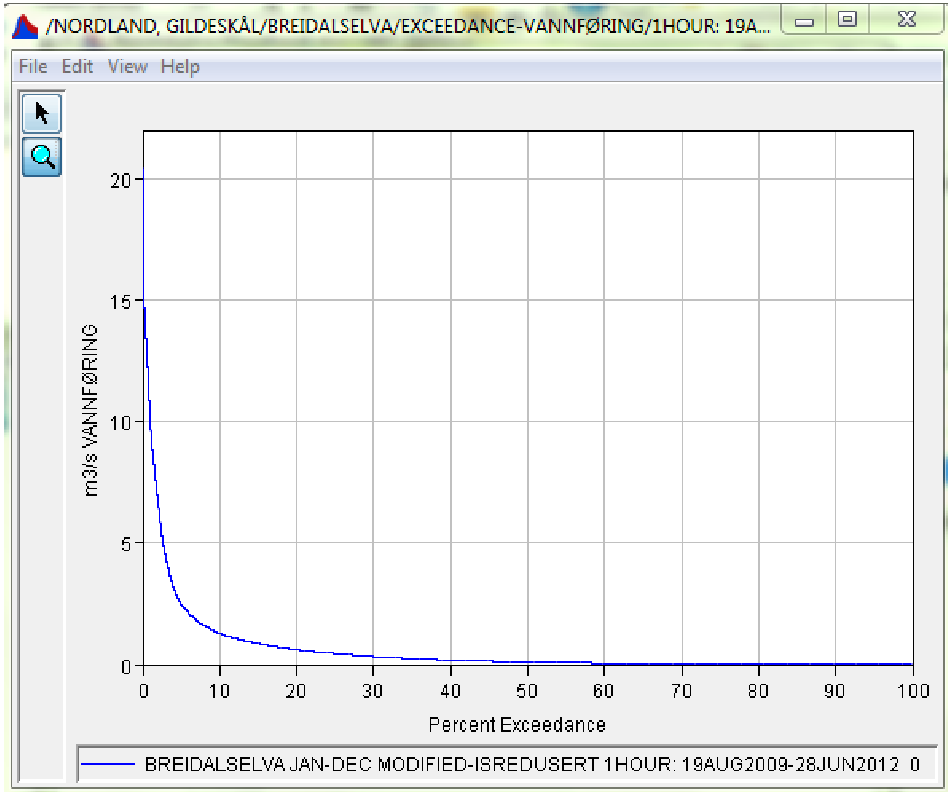


Bordalselva

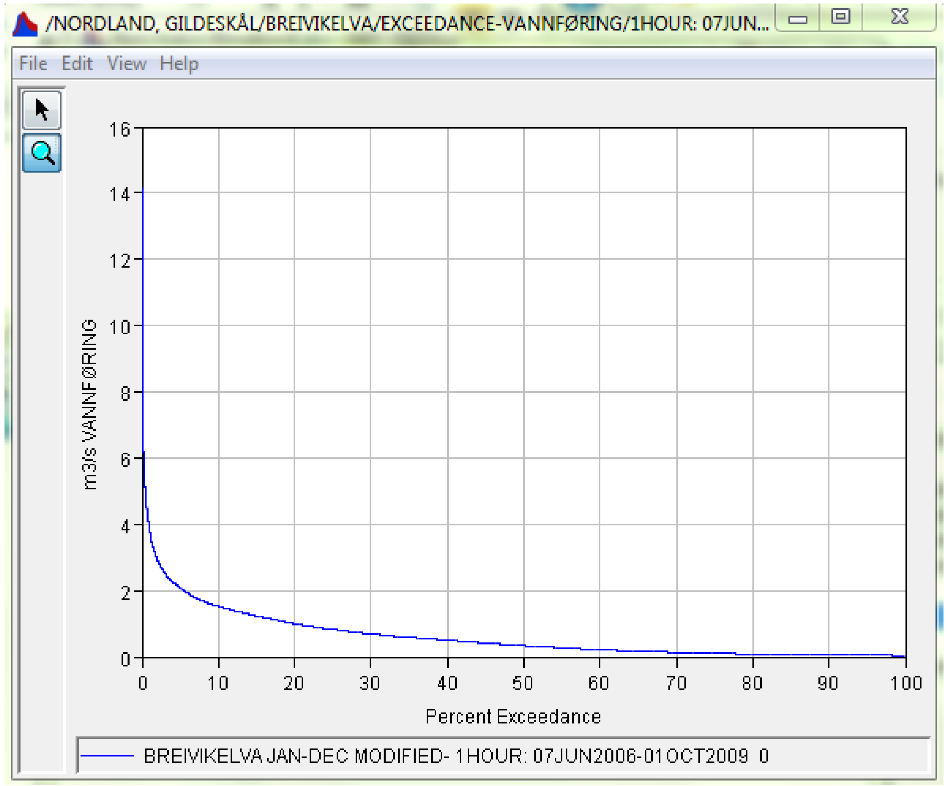


Appendix C: Duration Curves for selected SWECO AS stations

Breidalselva

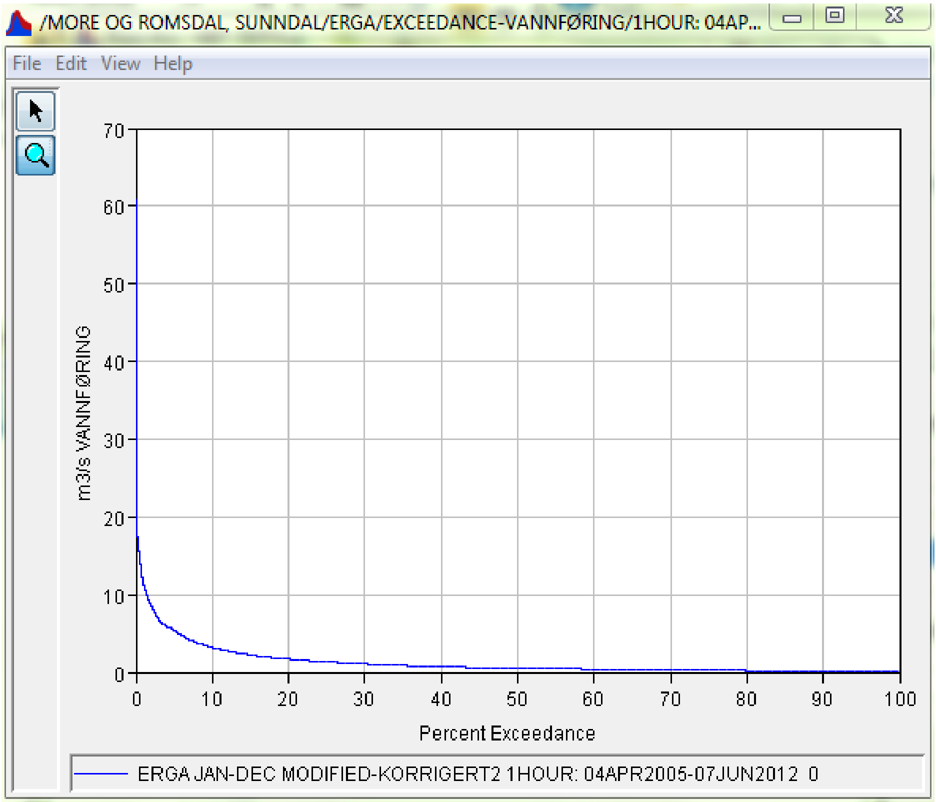


Breivikelva

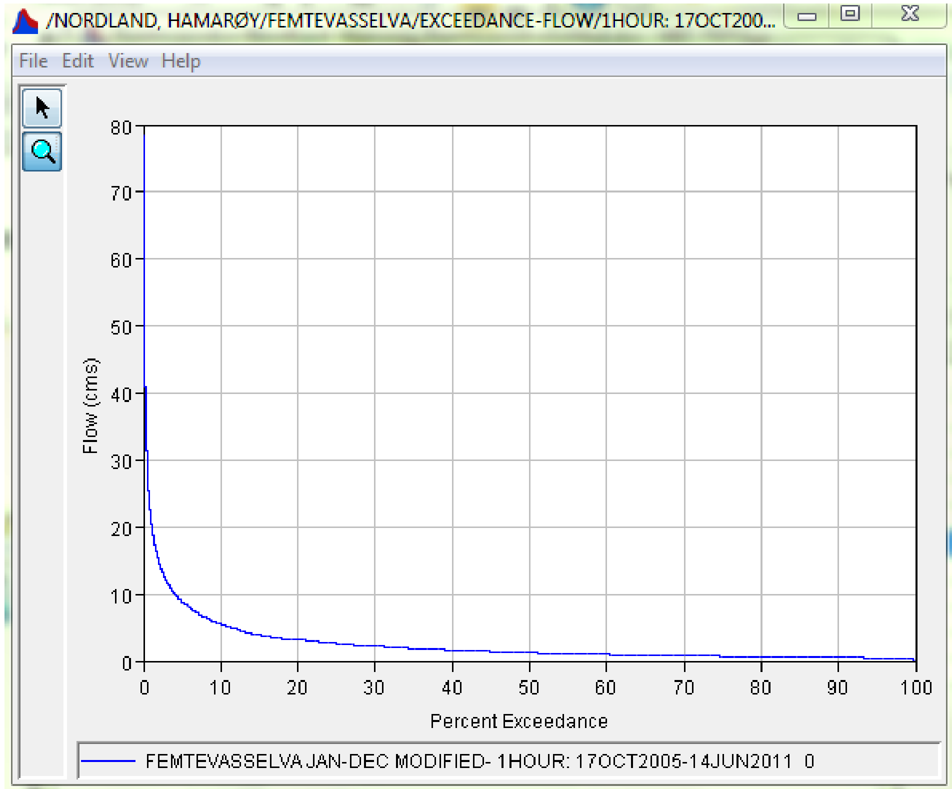


Appendix C: Duration Curves for selected SWECO AS stations

Erga

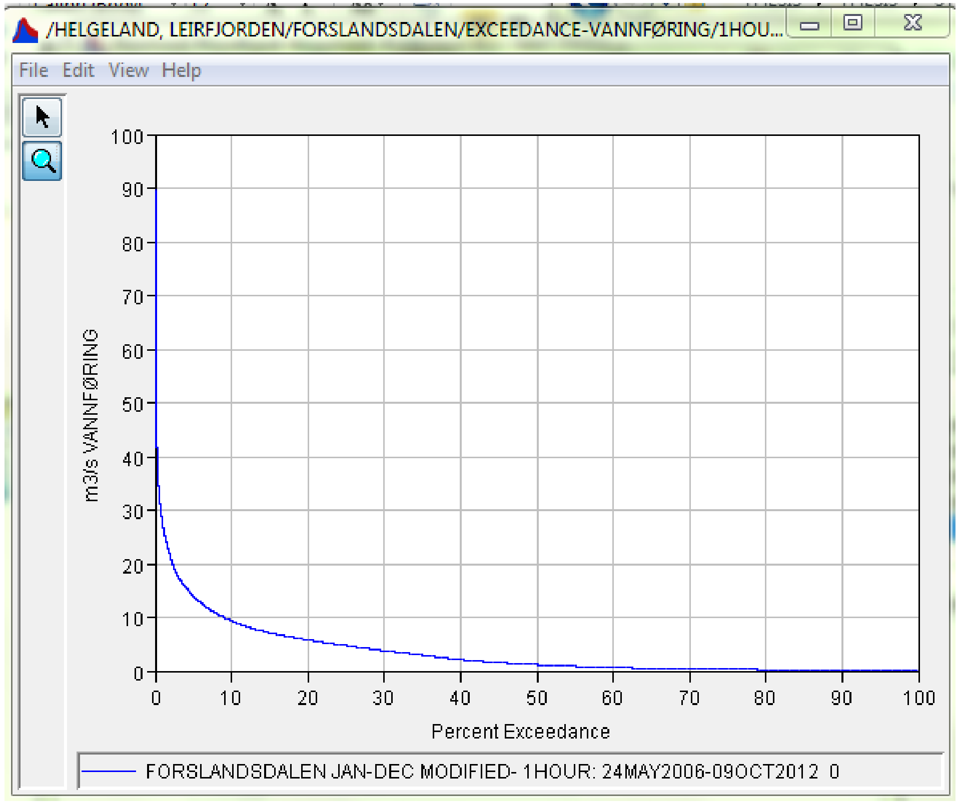


Femtevasselva

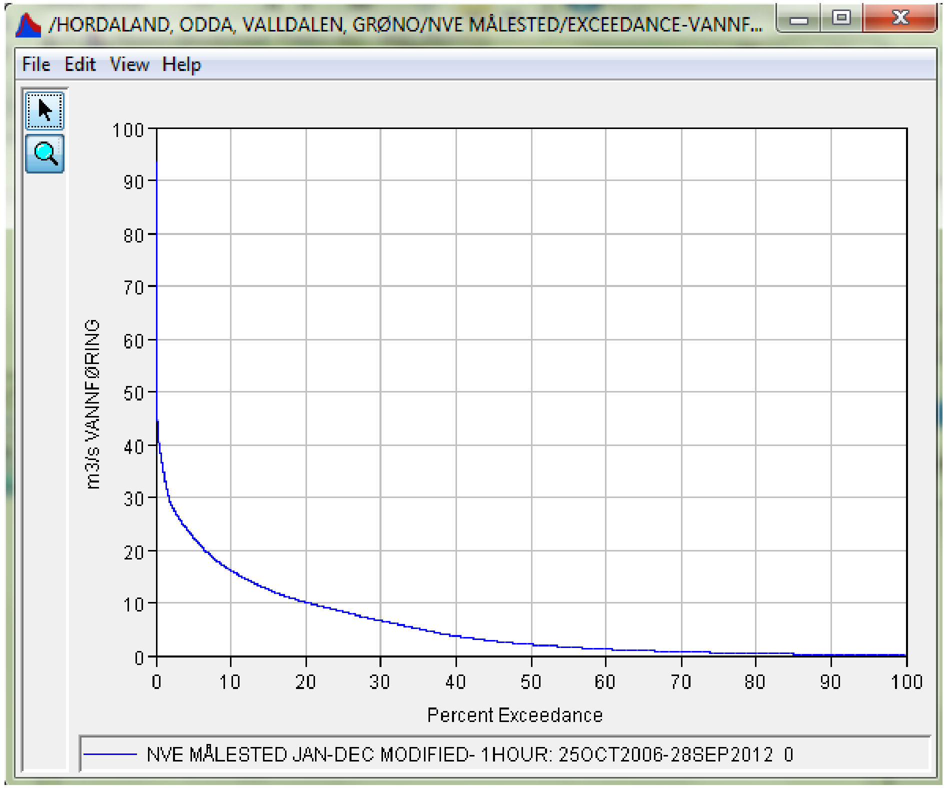


Appendix C: Duration Curves for selected SWECO AS stations

Forsland

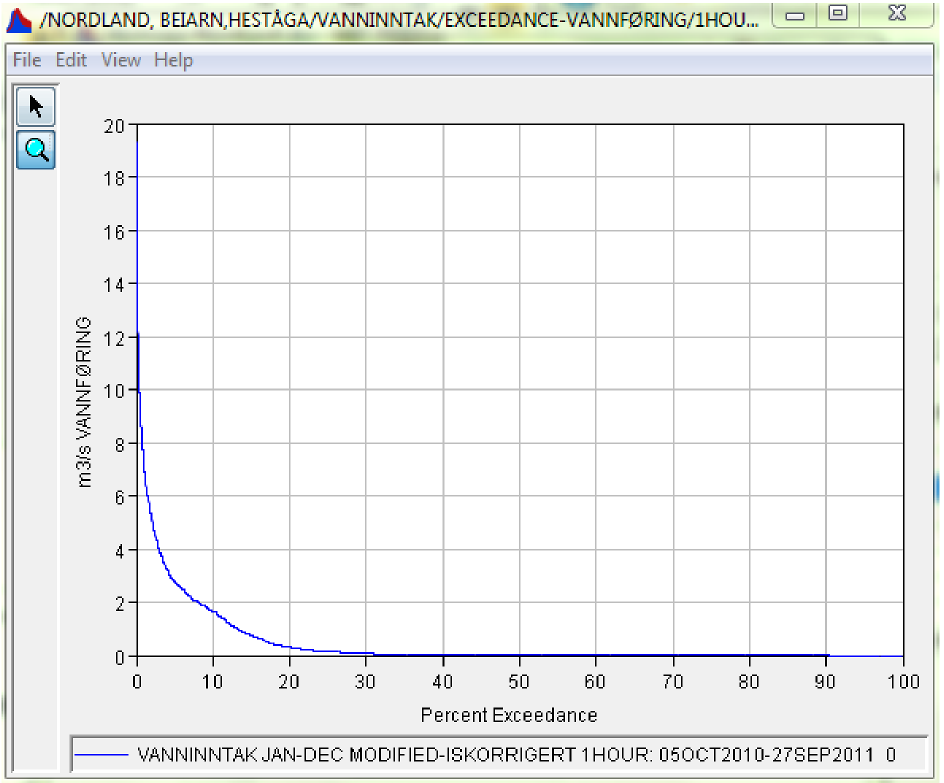


Grono

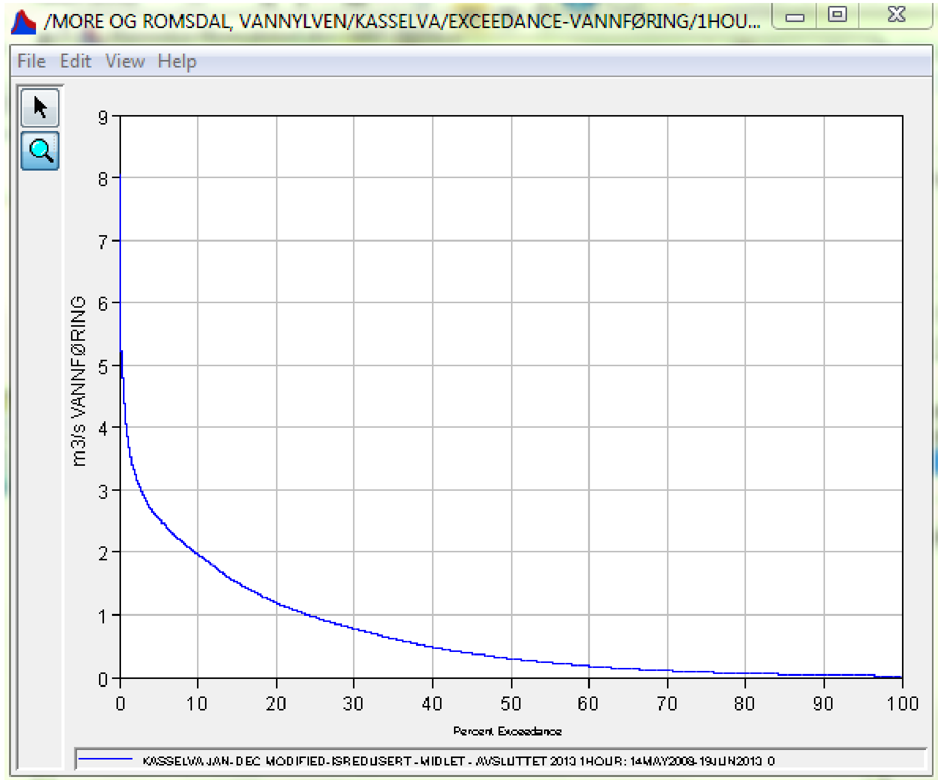


Appendix C: Duration Curves for selected SWECO AS stations

Hestaaga

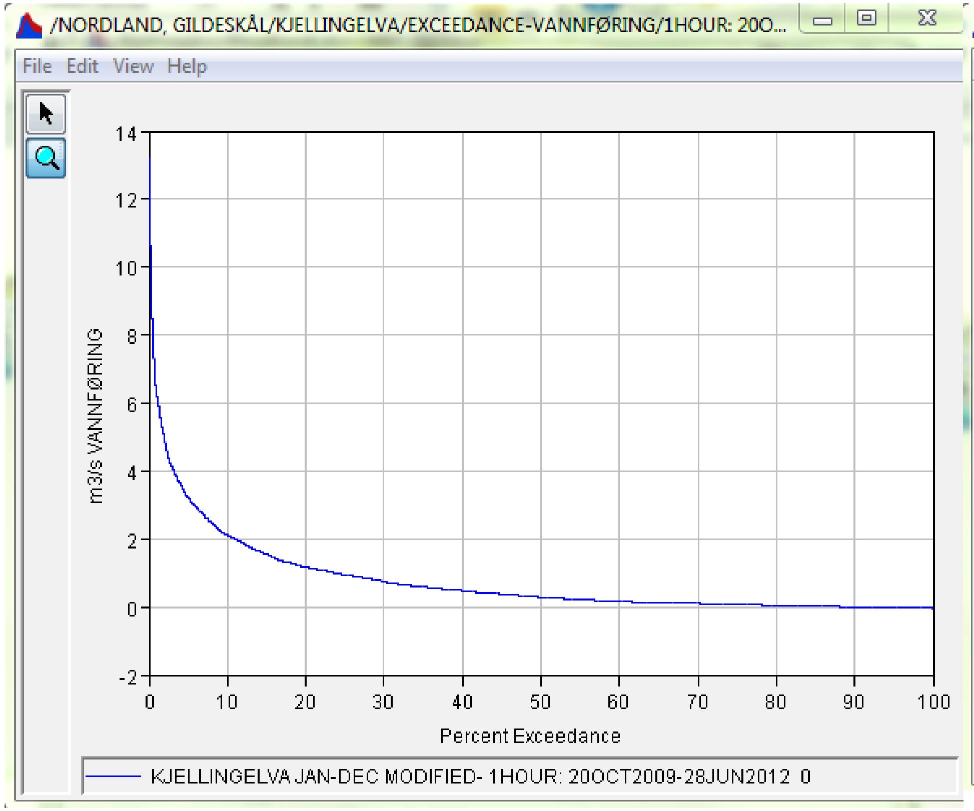


Kasseelva

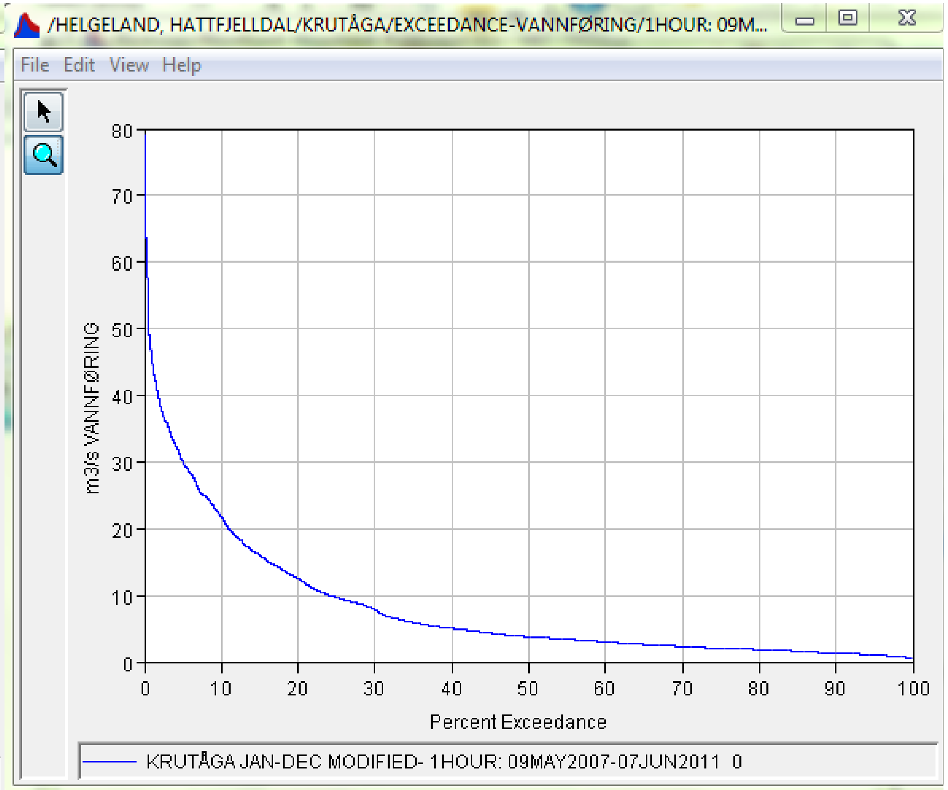


Appendix C: Duration Curves for selected SWECO AS stations

Kjellingelva

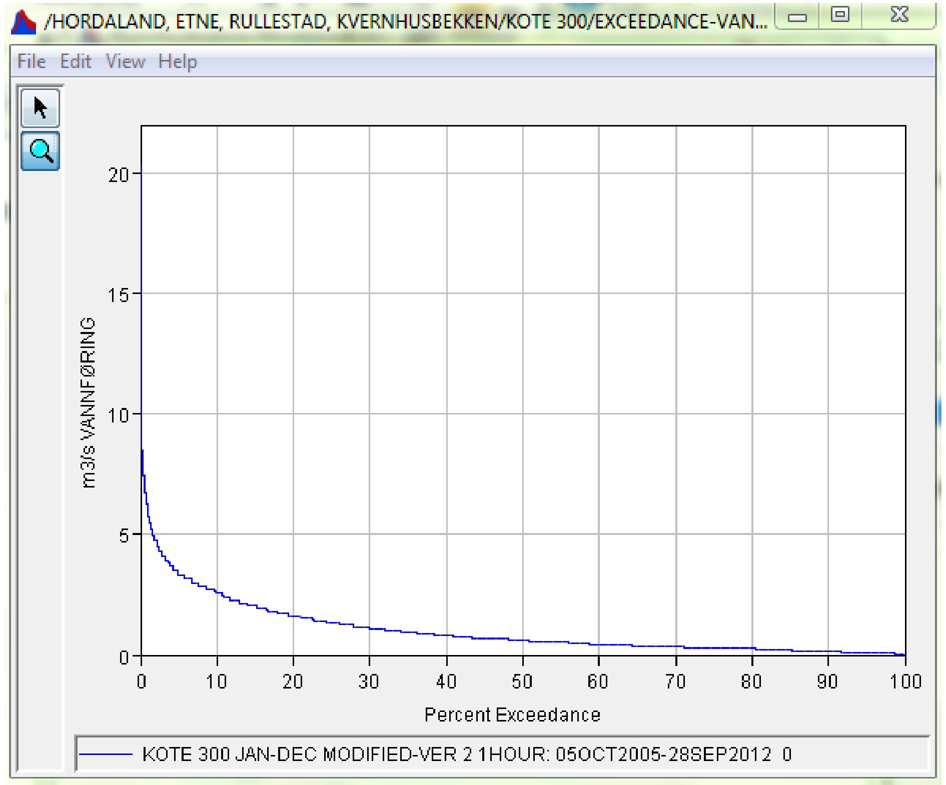


Krutaaga

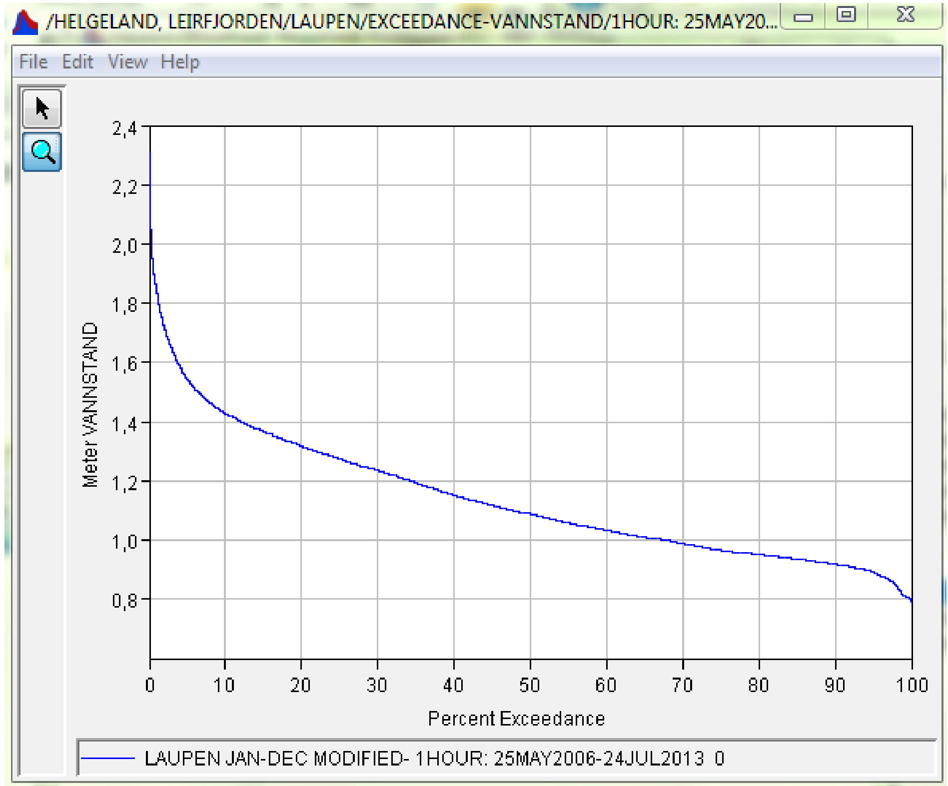


Appendix C: Duration Curves for selected SWECO AS stations

Kvernhusbekken

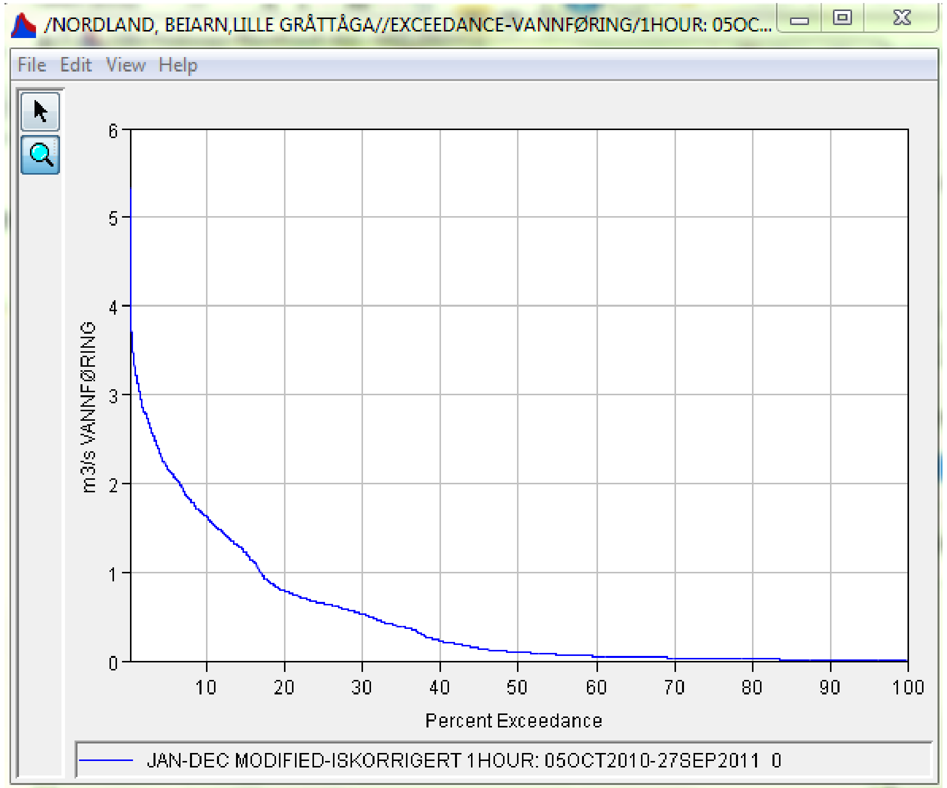


Laupen

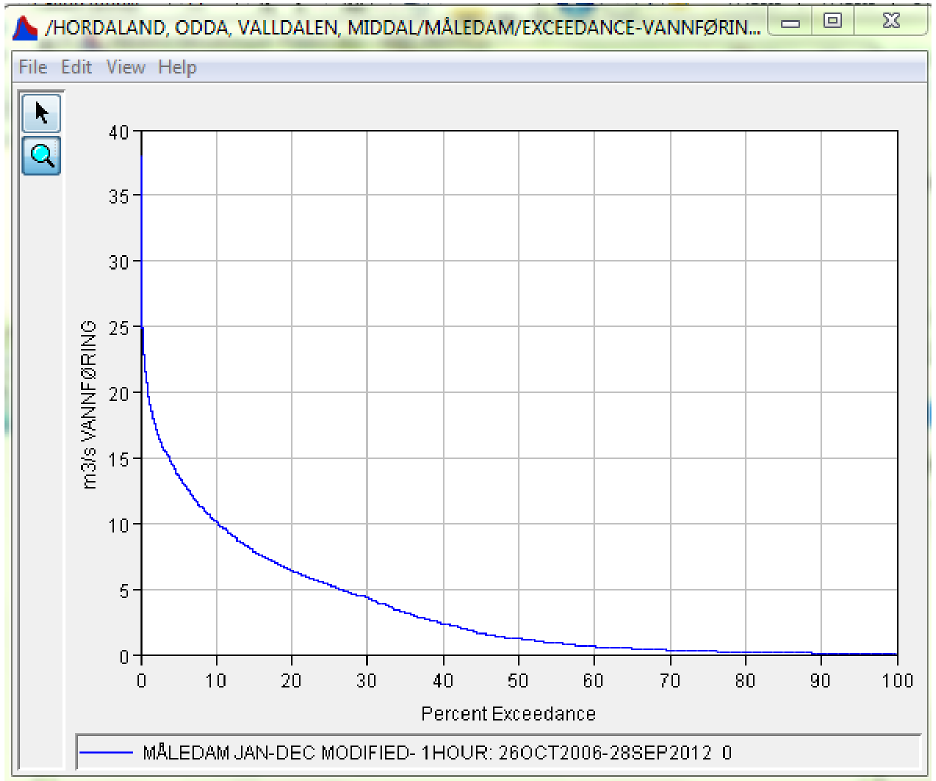


Appendix C: Duration Curves for selected SWECO AS stations

Lile Grataaga

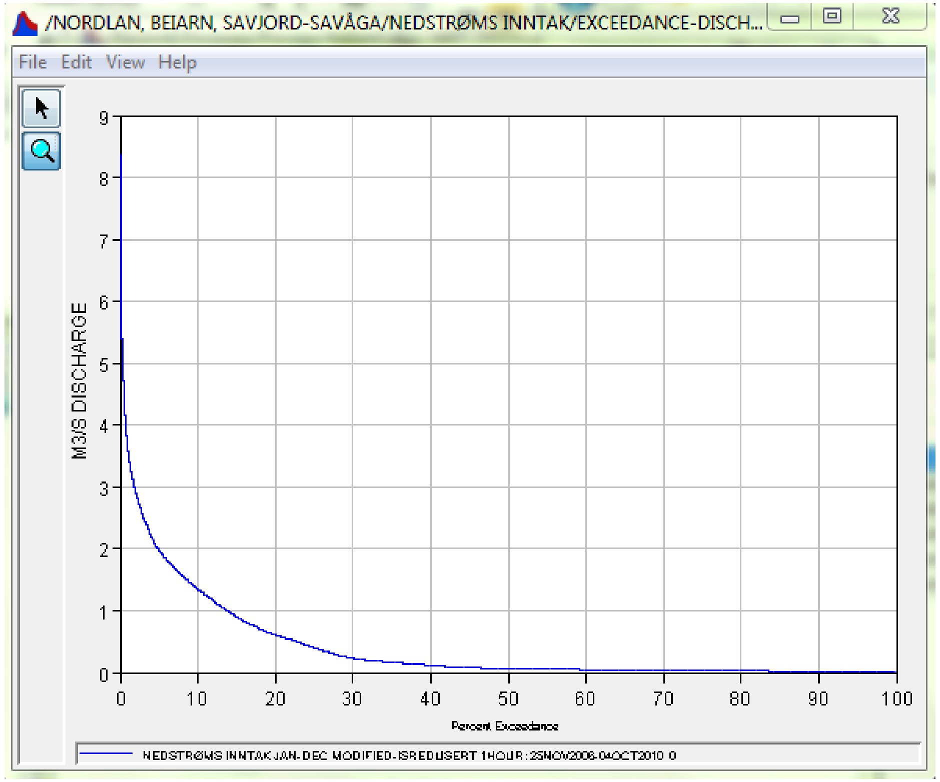


Middal

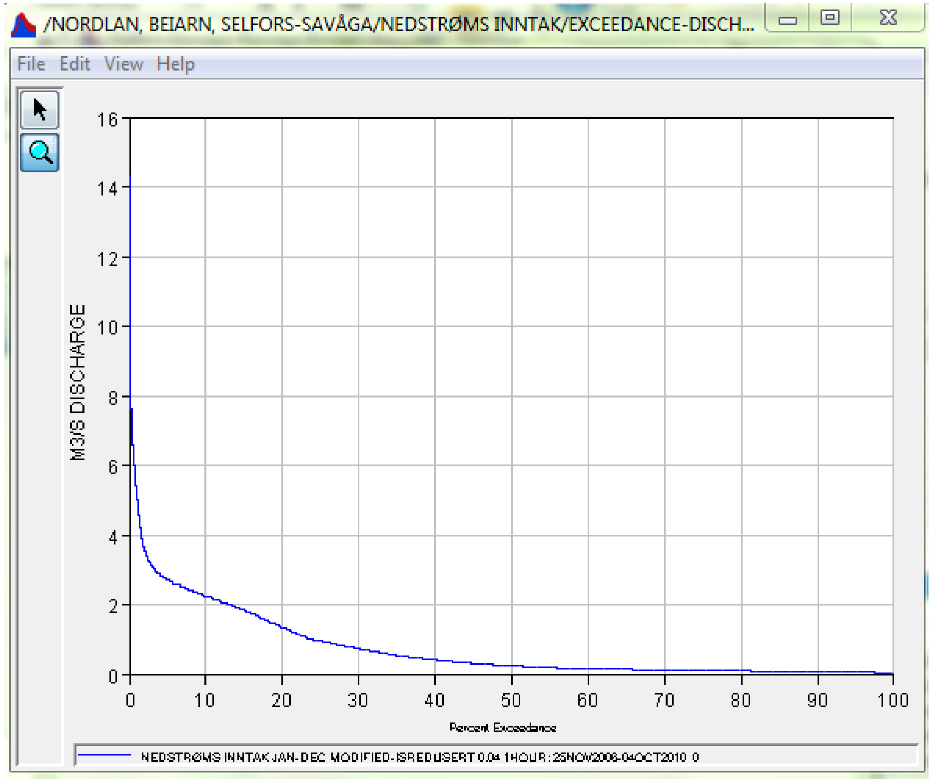


Appendix C: Duration Curves for selected SWECO AS stations

Savjord-Savaaga

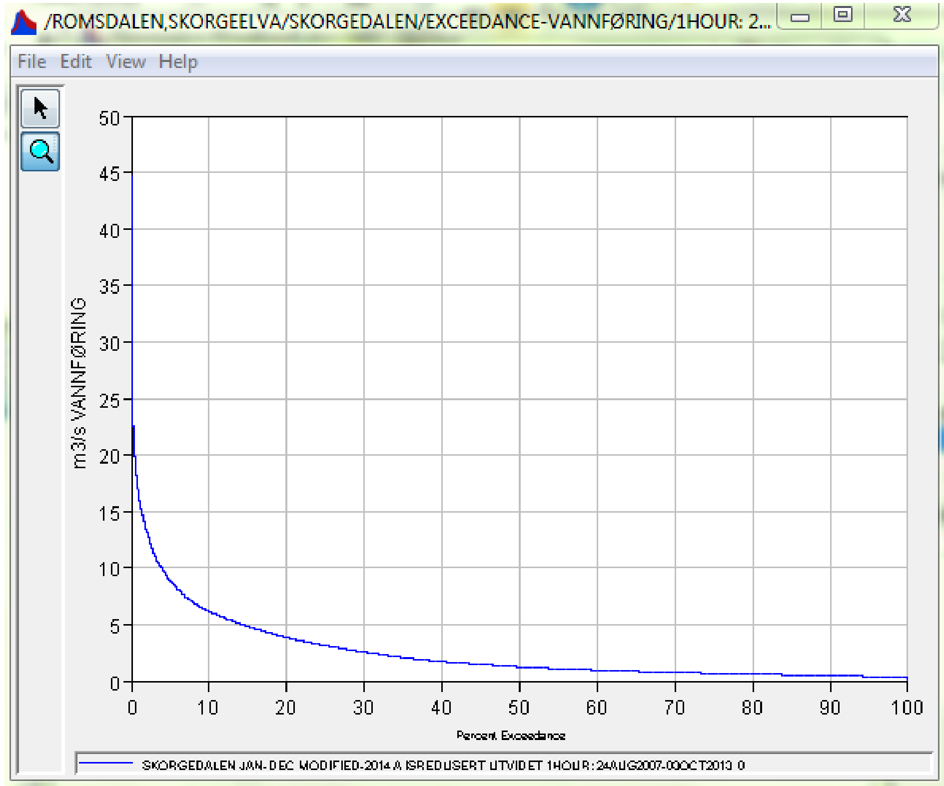


Selfors-Savaaga

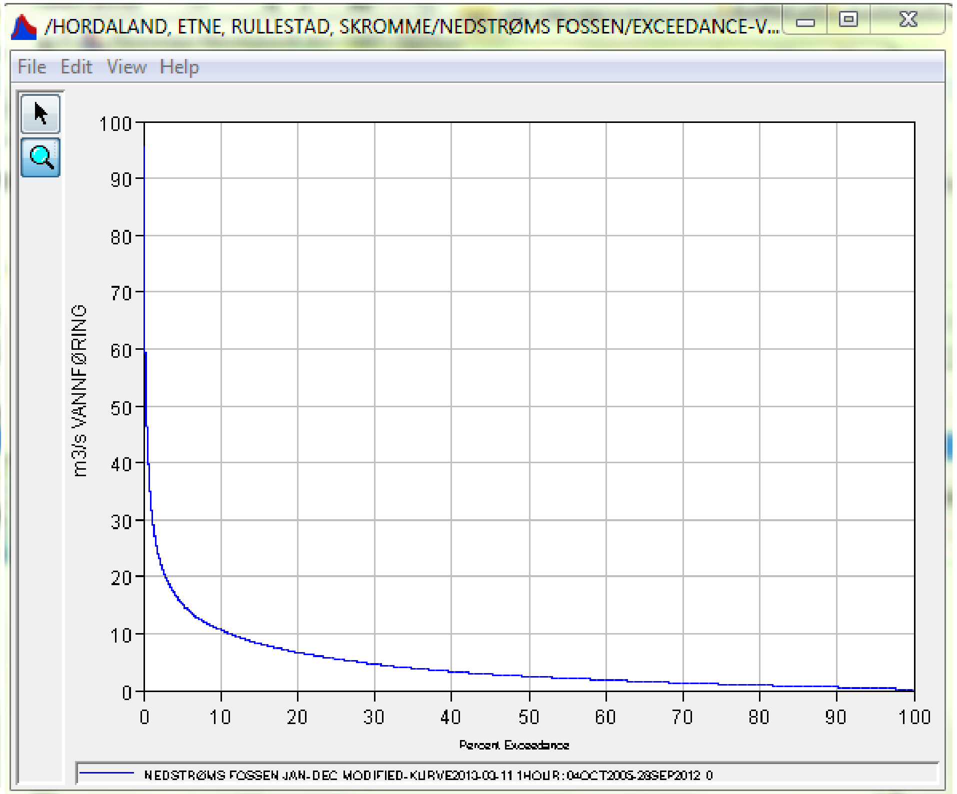


Appendix C: Duration Curves for selected SWECO AS stations

Skorgeelva

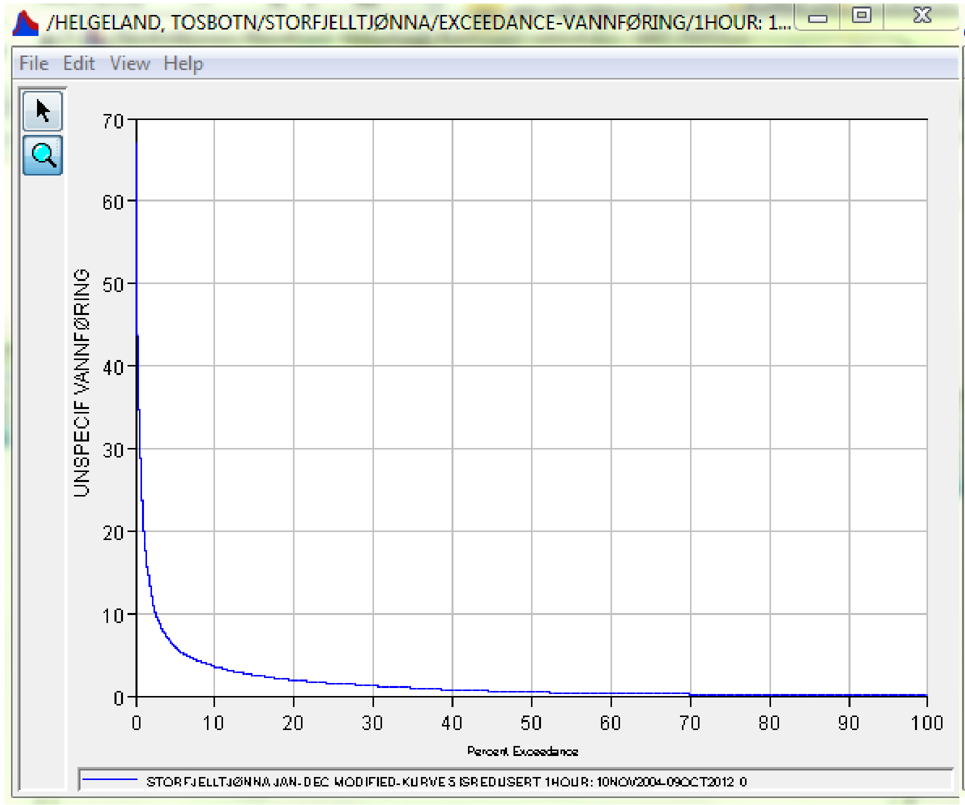


Skromme

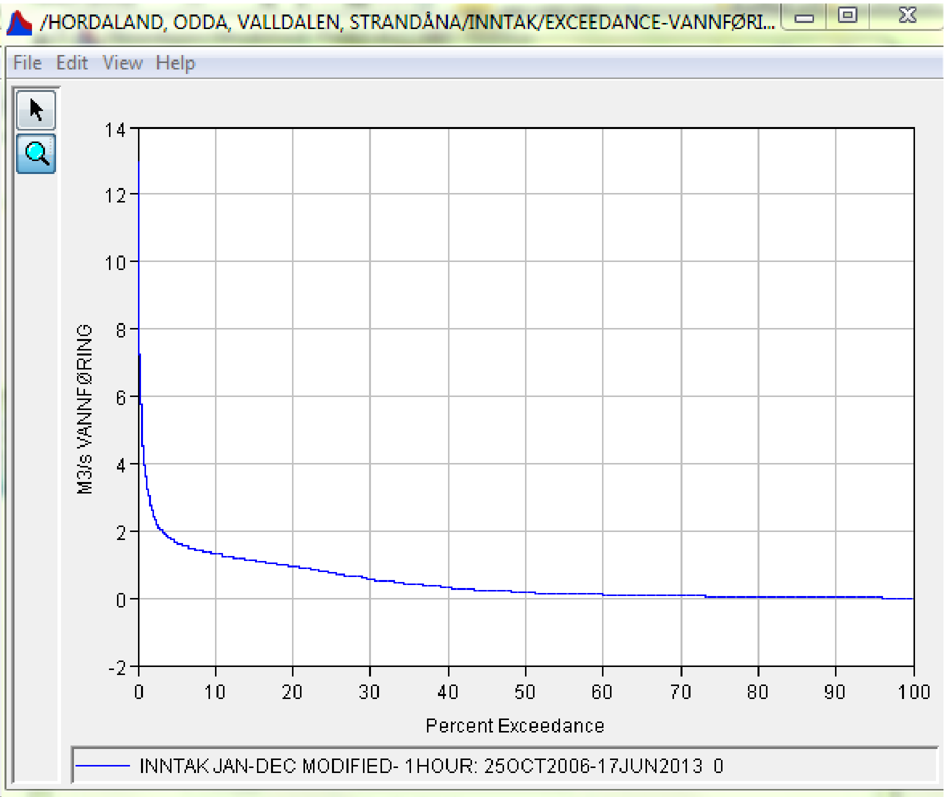


Appendix C: Duration Curves for selected SWECO AS stations

Storfjeltjonna

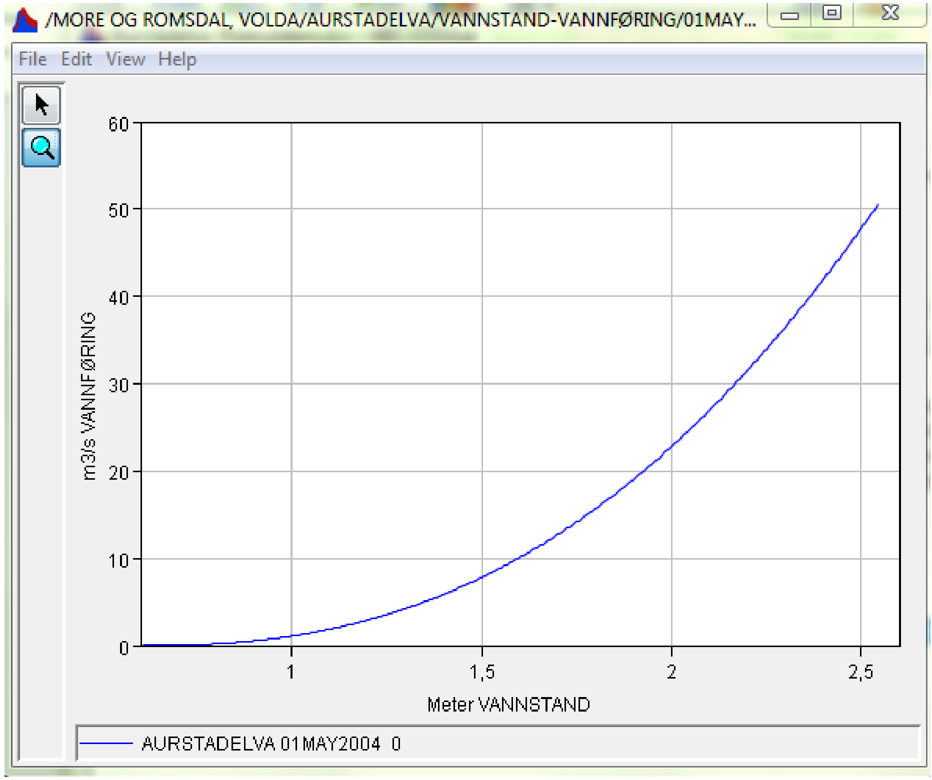


Strandana

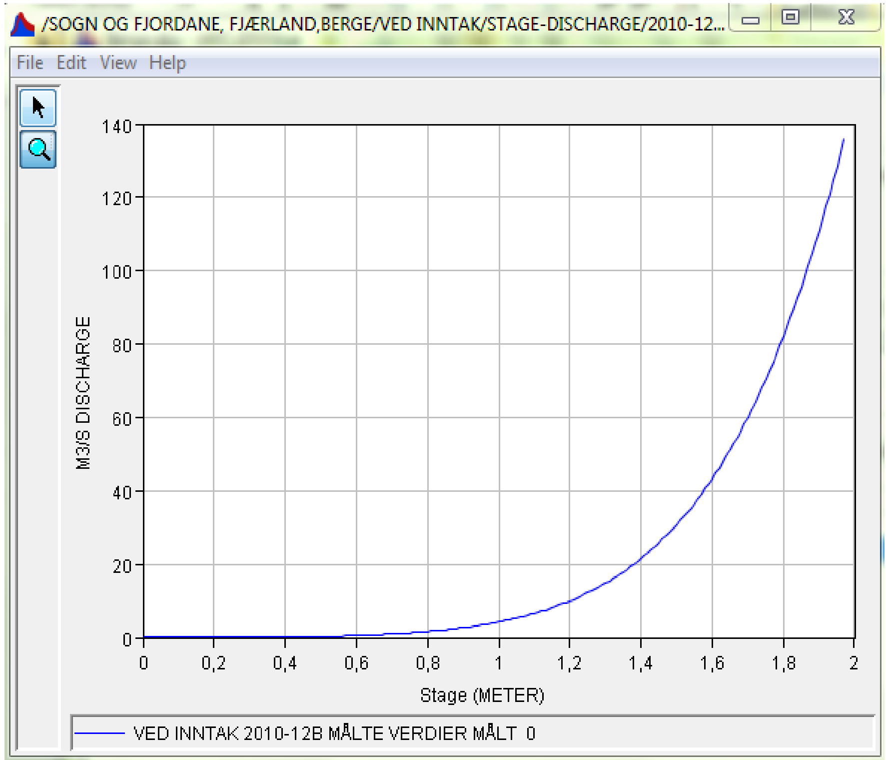


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Aurstadelva

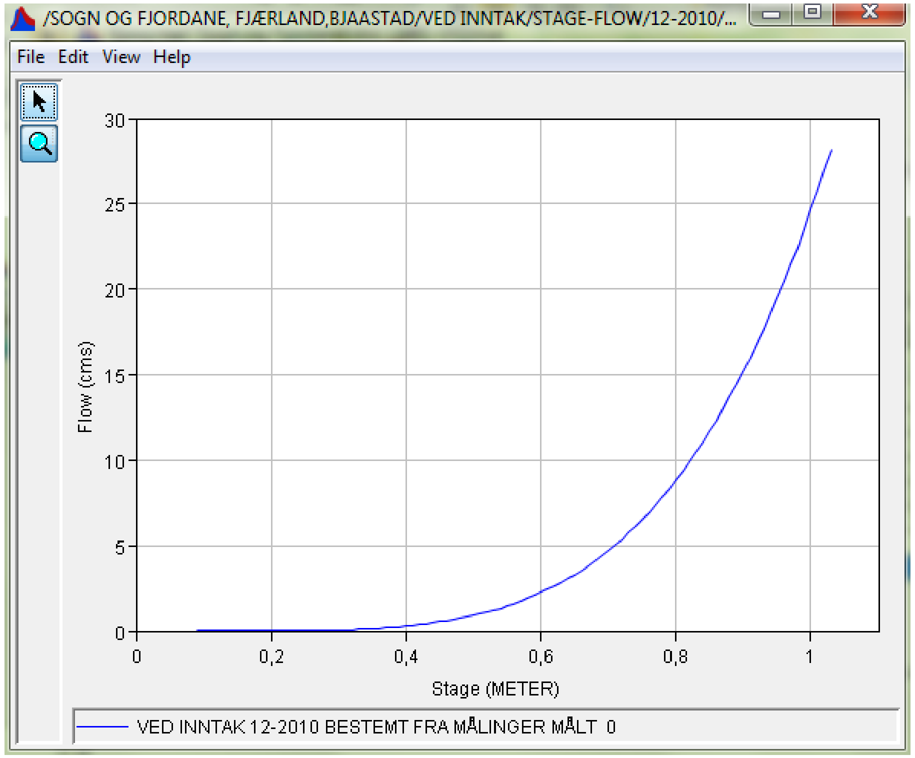


Berge

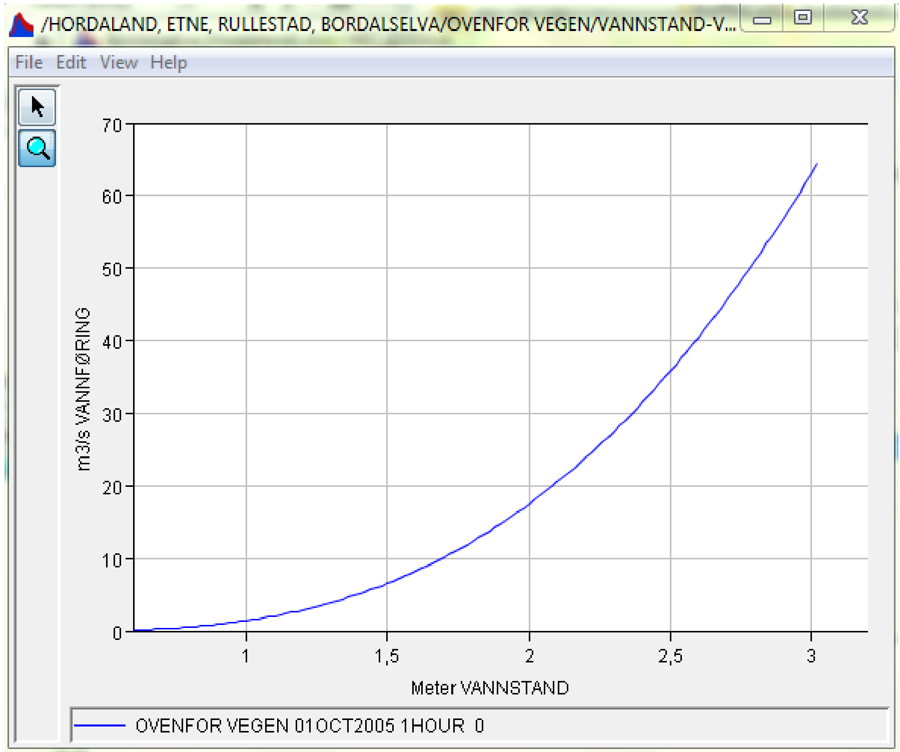


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Bjaastad

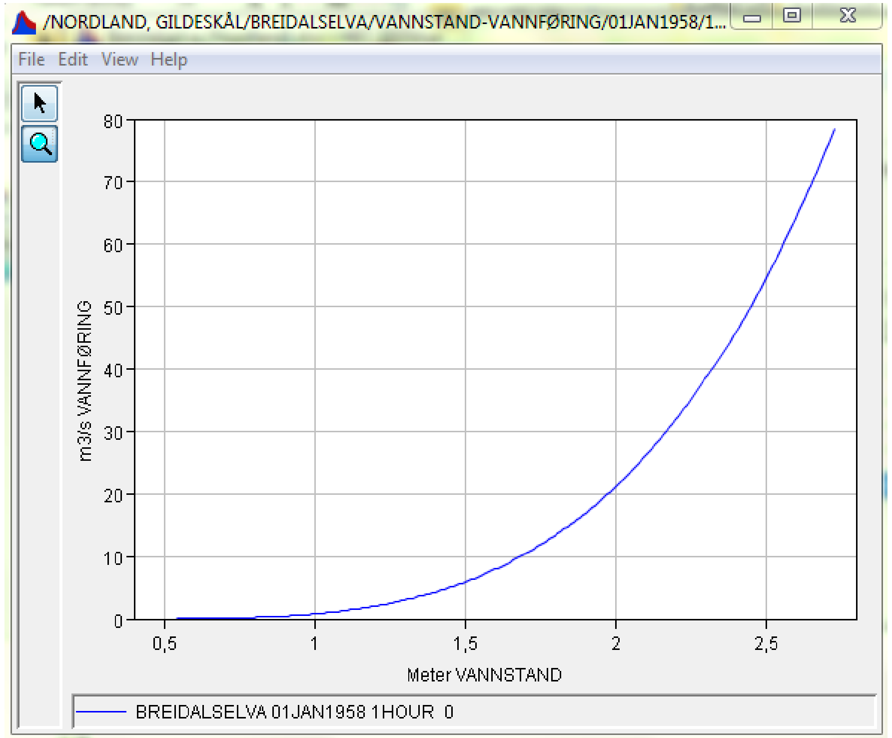


Bordalselva

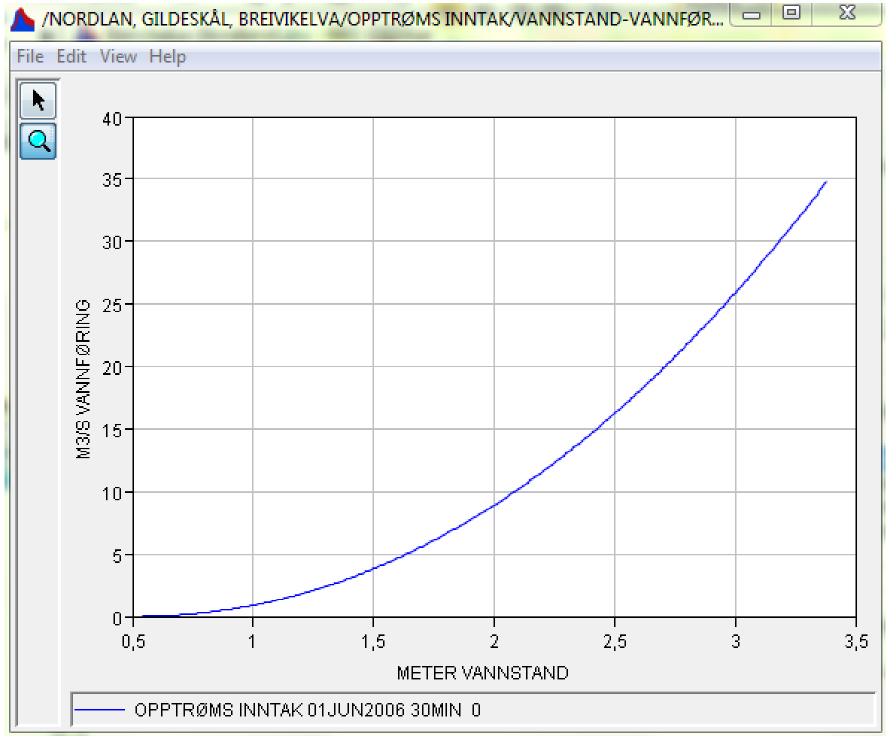


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Breidalselva

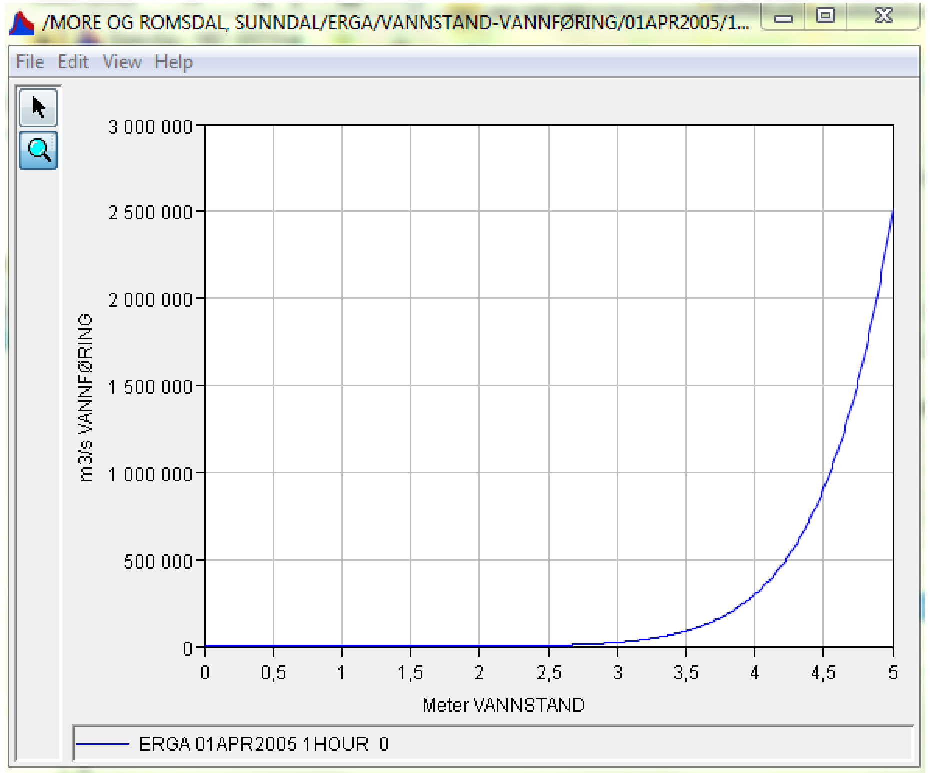


Breivikelva



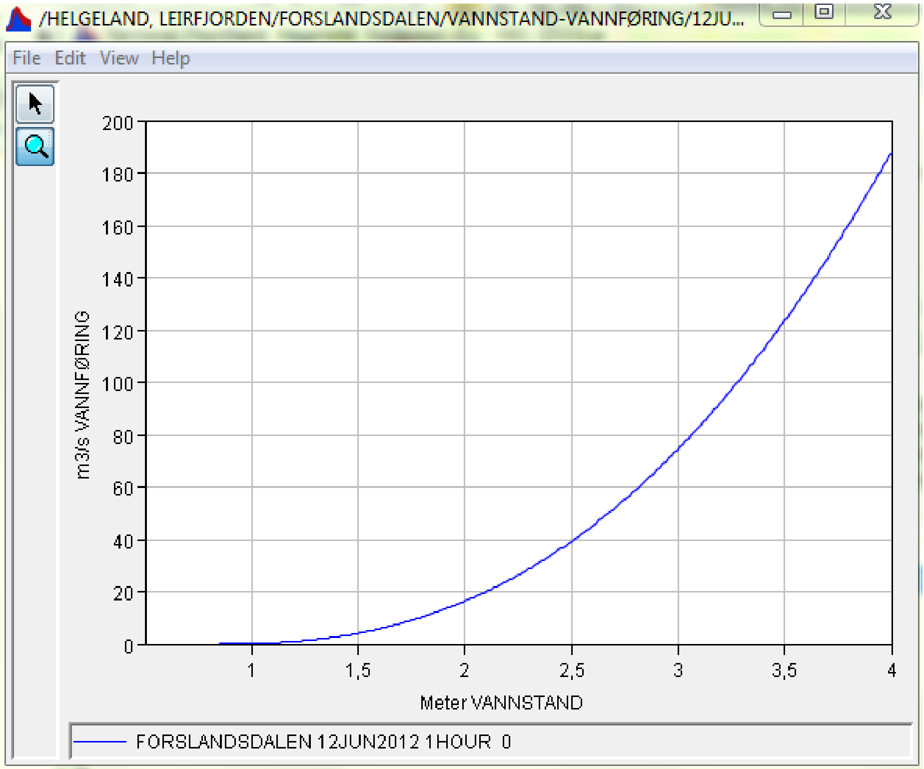
Appendix D: Stage Discharge Curve for selected SWECO AS stations

Erga

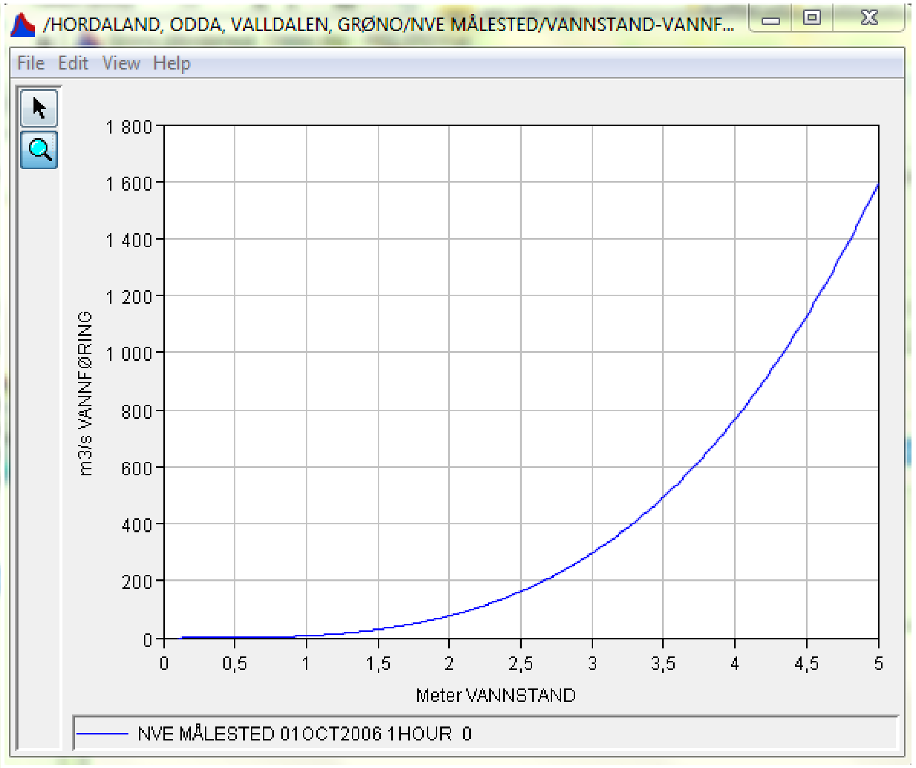


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Forsland

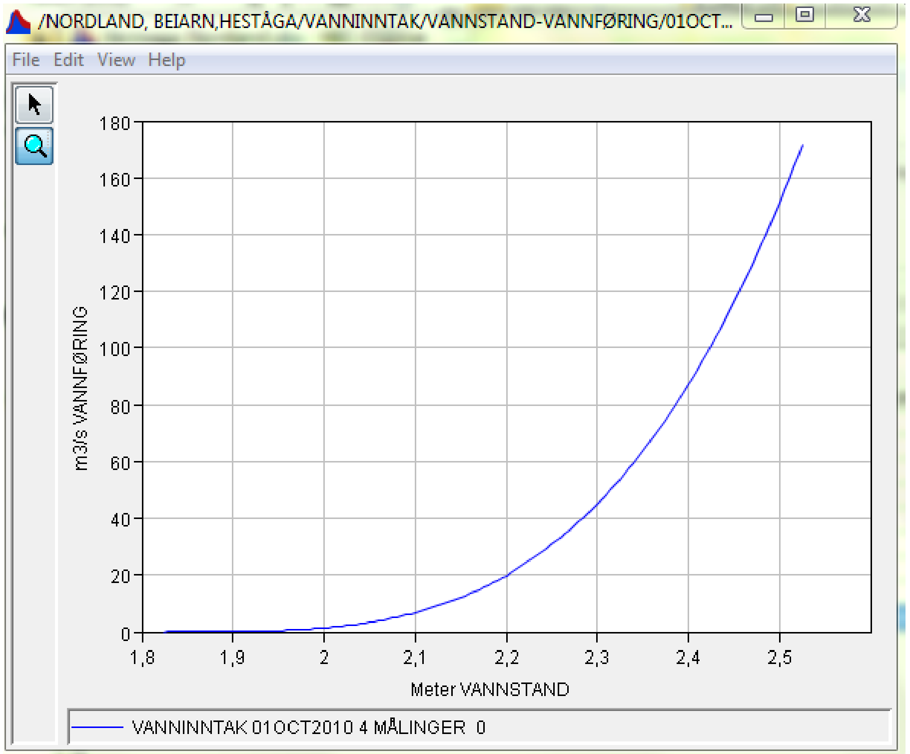


Grono

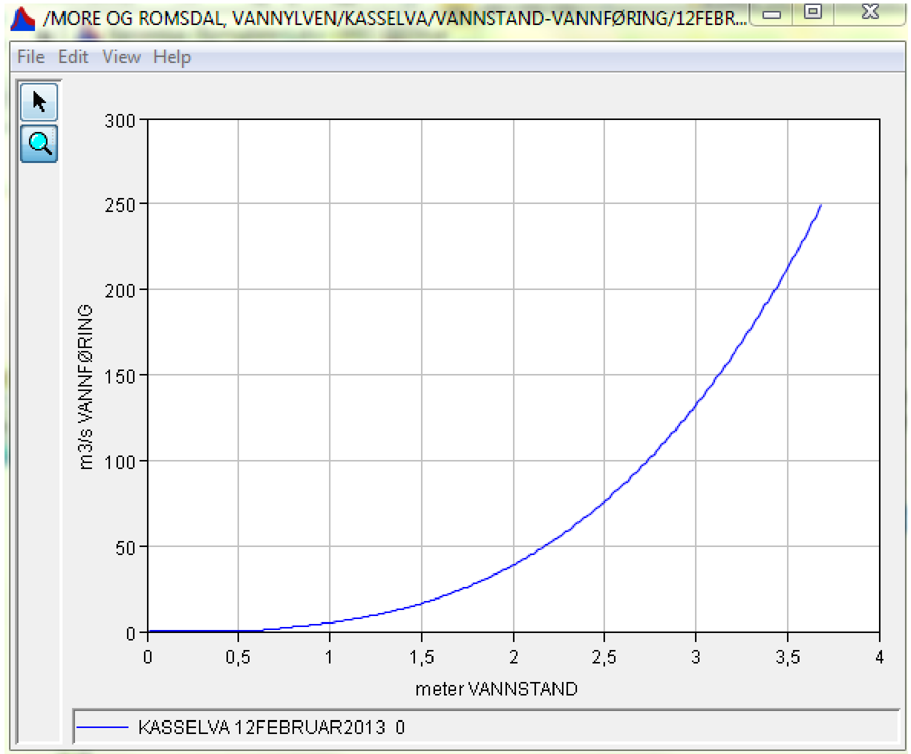


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Hestaaga

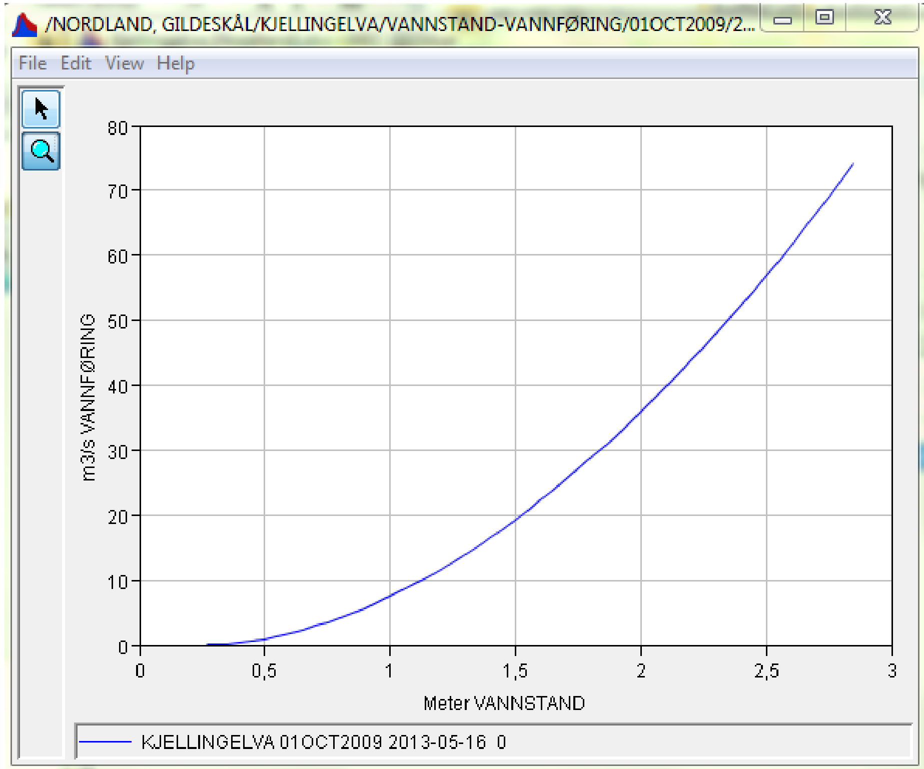


Kasseelva

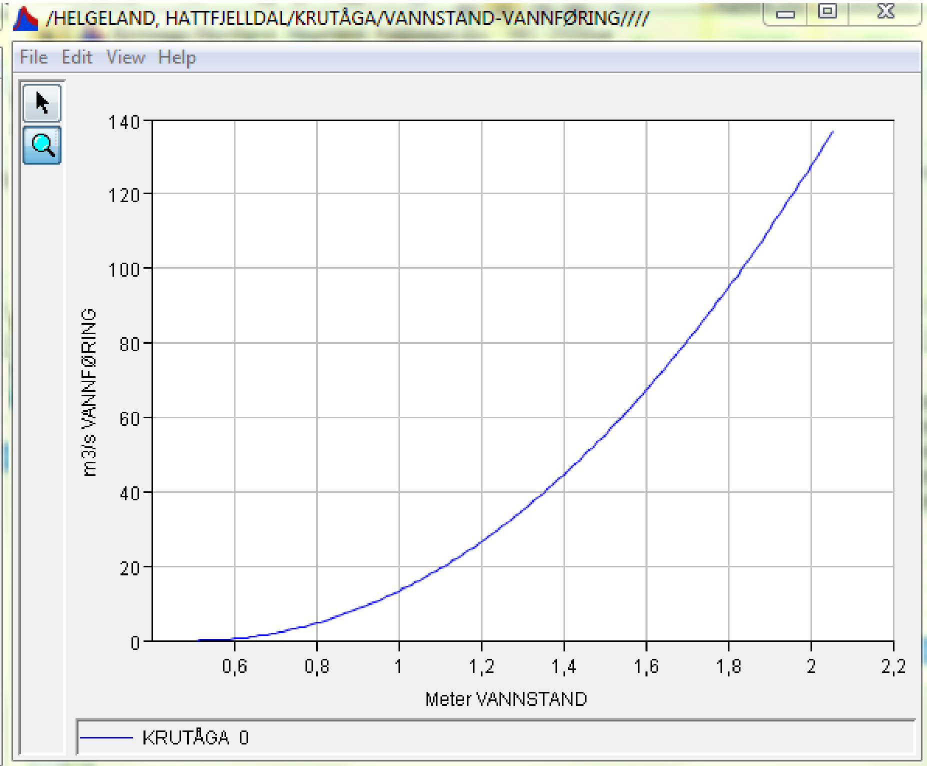


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Kjellingelva

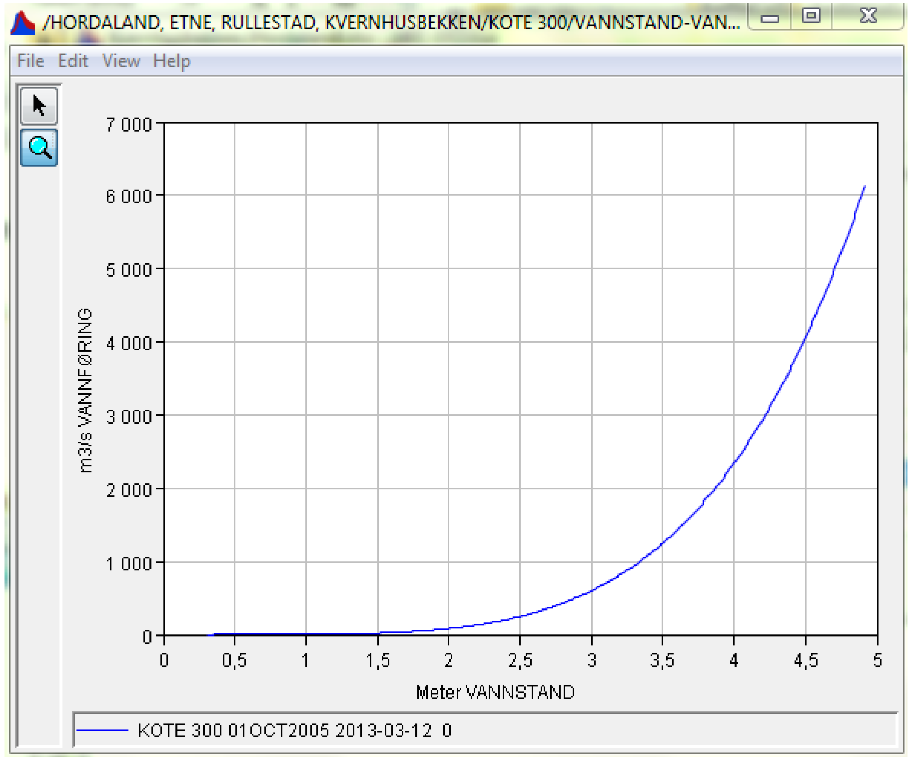


Krutaaga

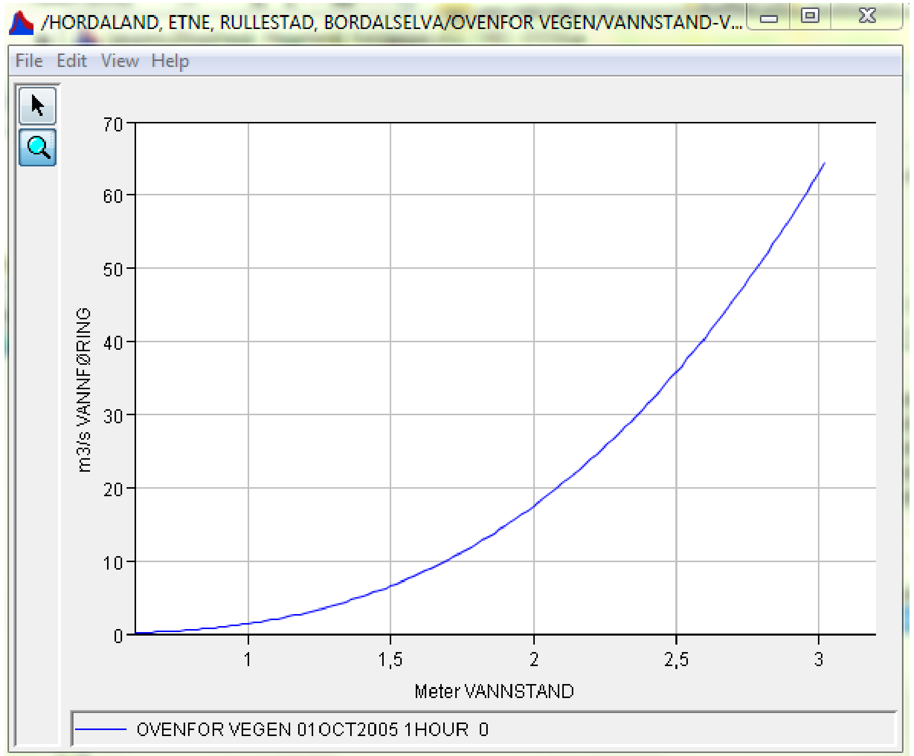


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Kvernhusbekken

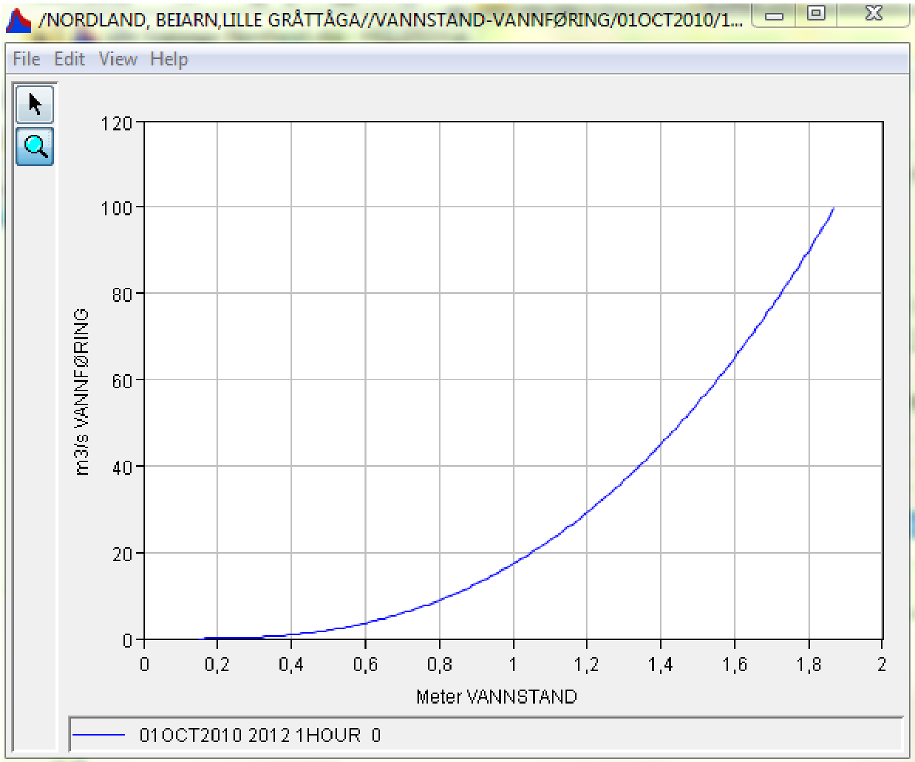


Laupen

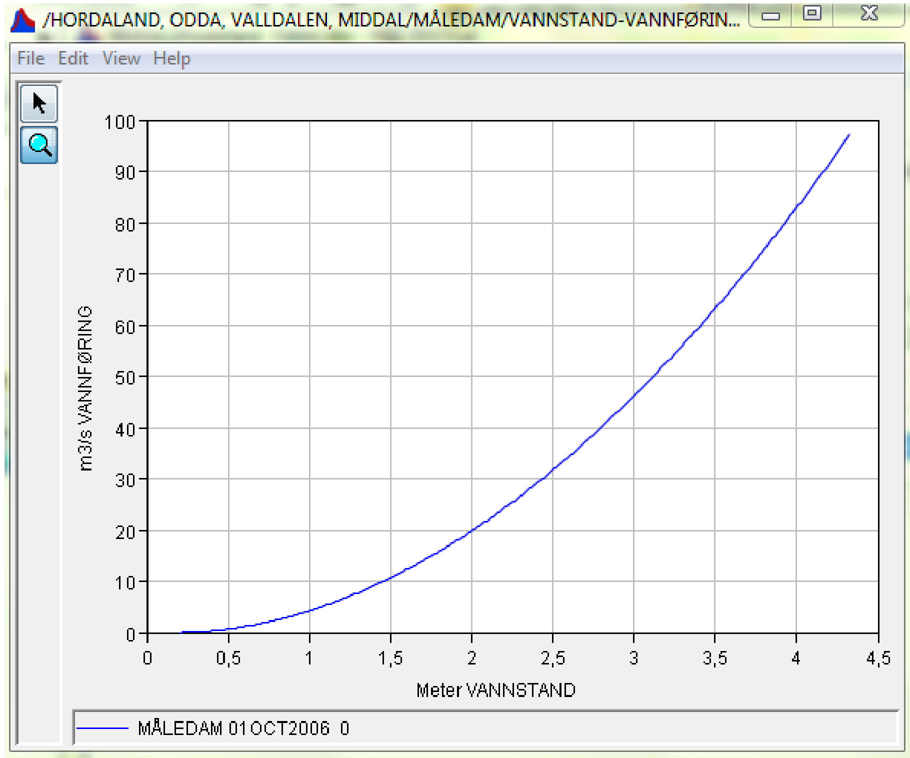


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Lile Grataaga

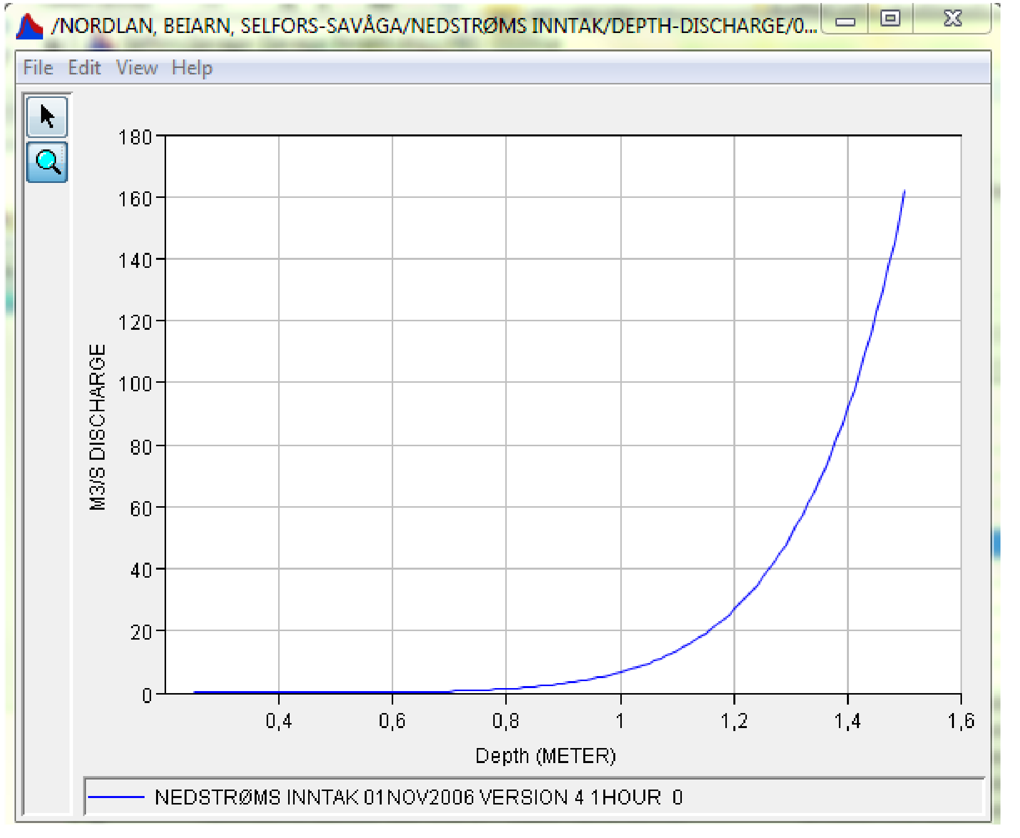


Middal



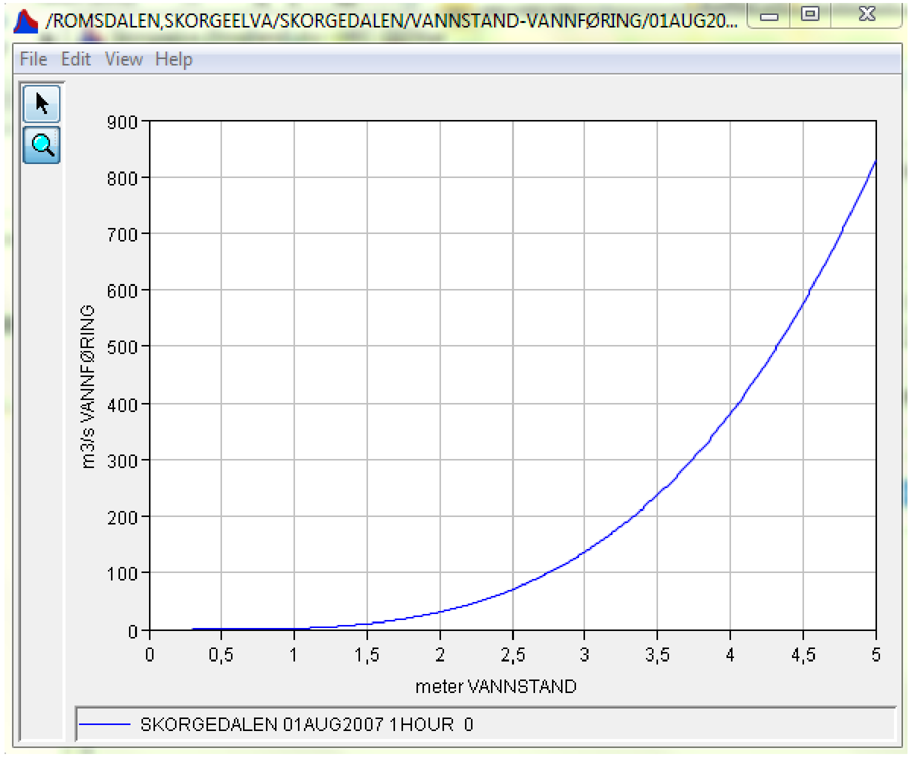
Appendix D: Stage Discharge Curve for selected SWECO AS stations

Selfors-Savaaga

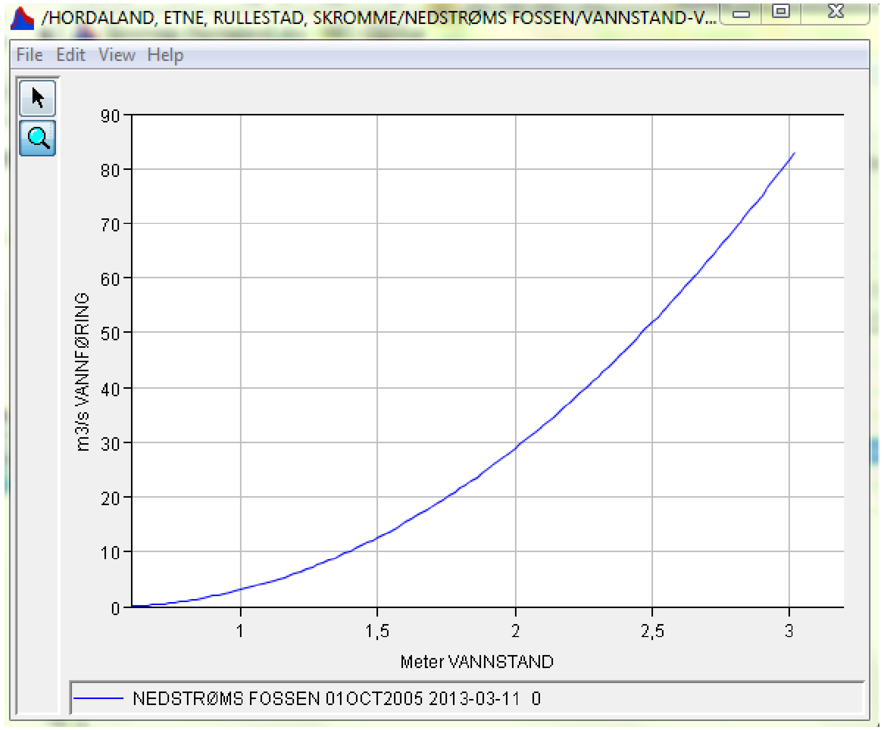


Appendix D: Stage Discharge Curve for selected SWECO AS stations

Skorgeelva

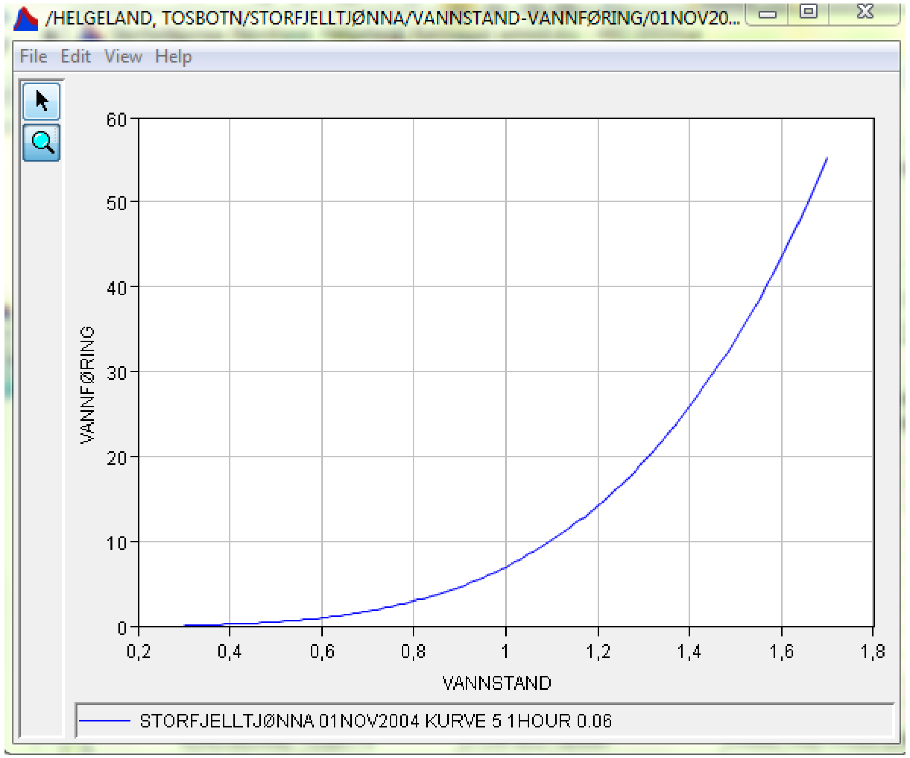


Skromme

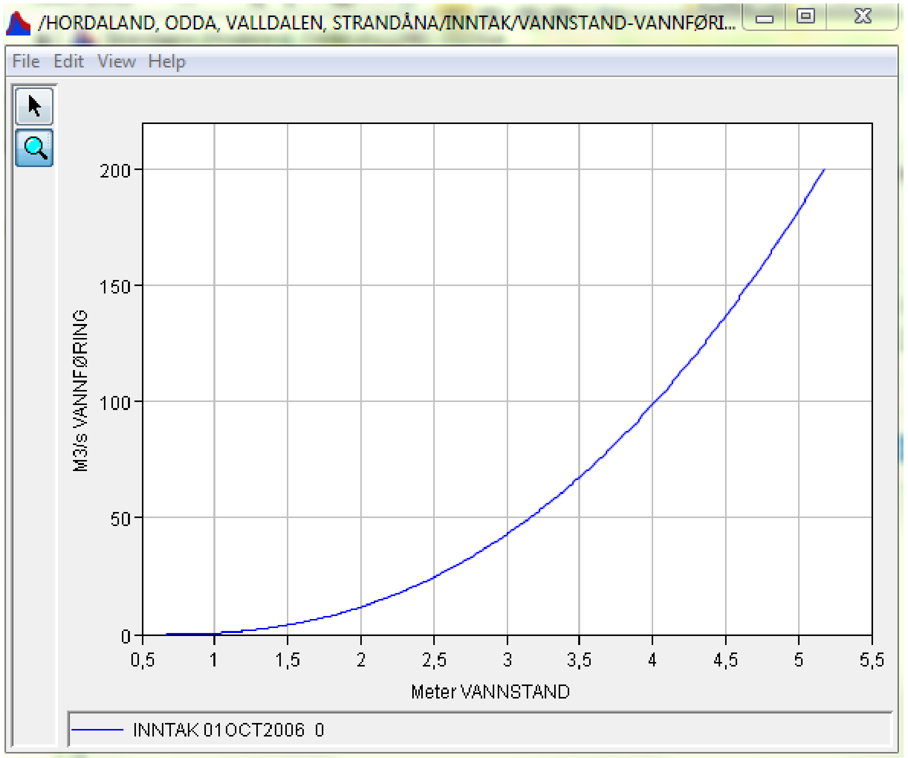


Appendix D: Stage Discharge Curve for selected SWECO AS stations

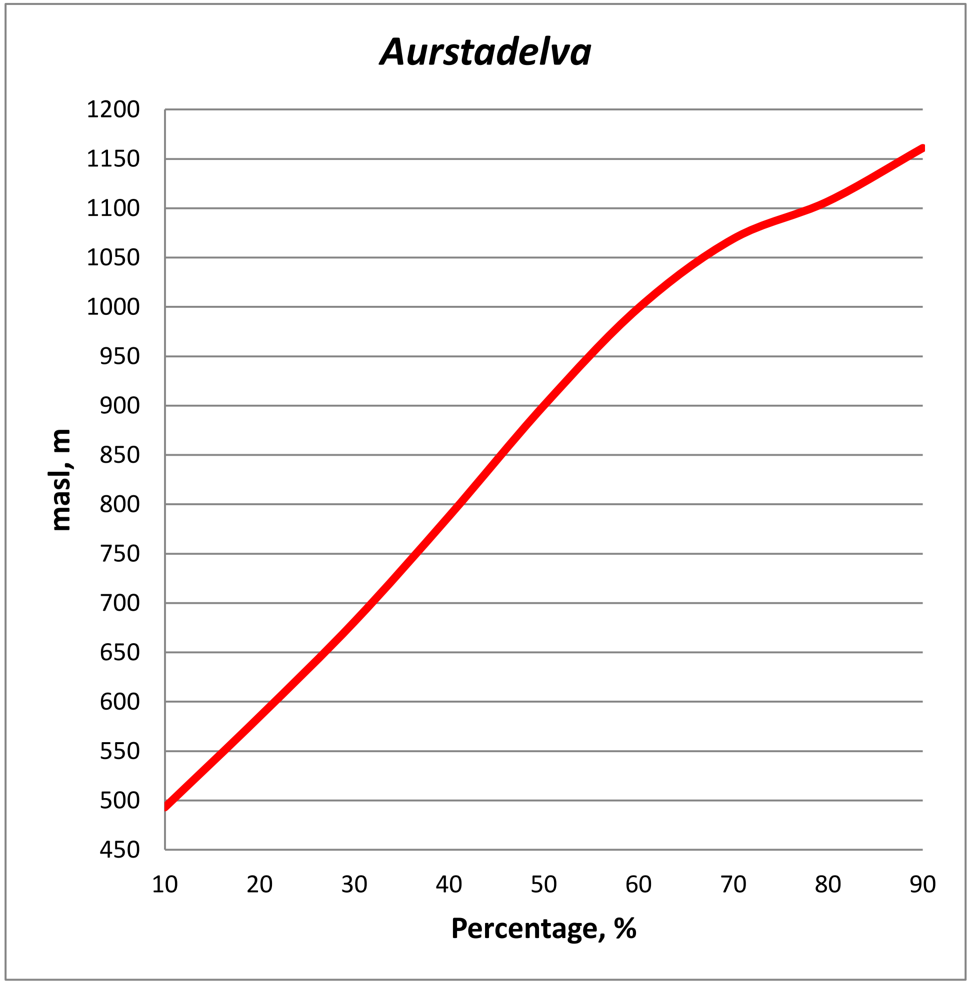
Storfjeltjonna

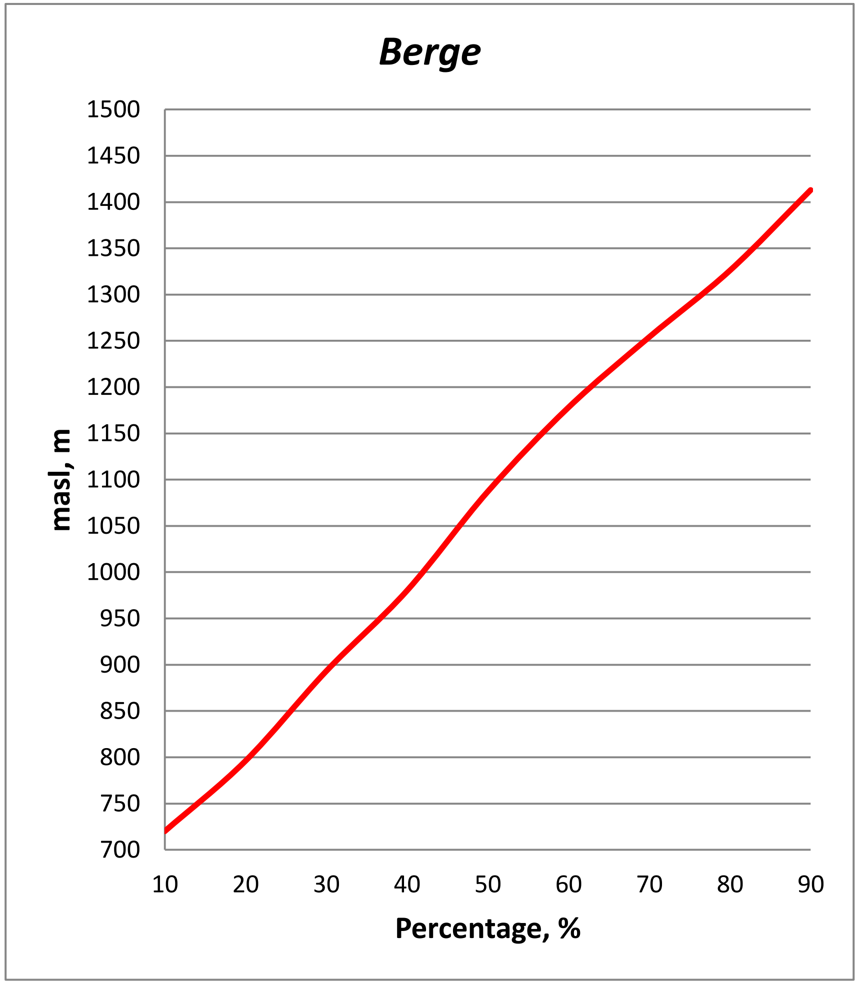


Strandana

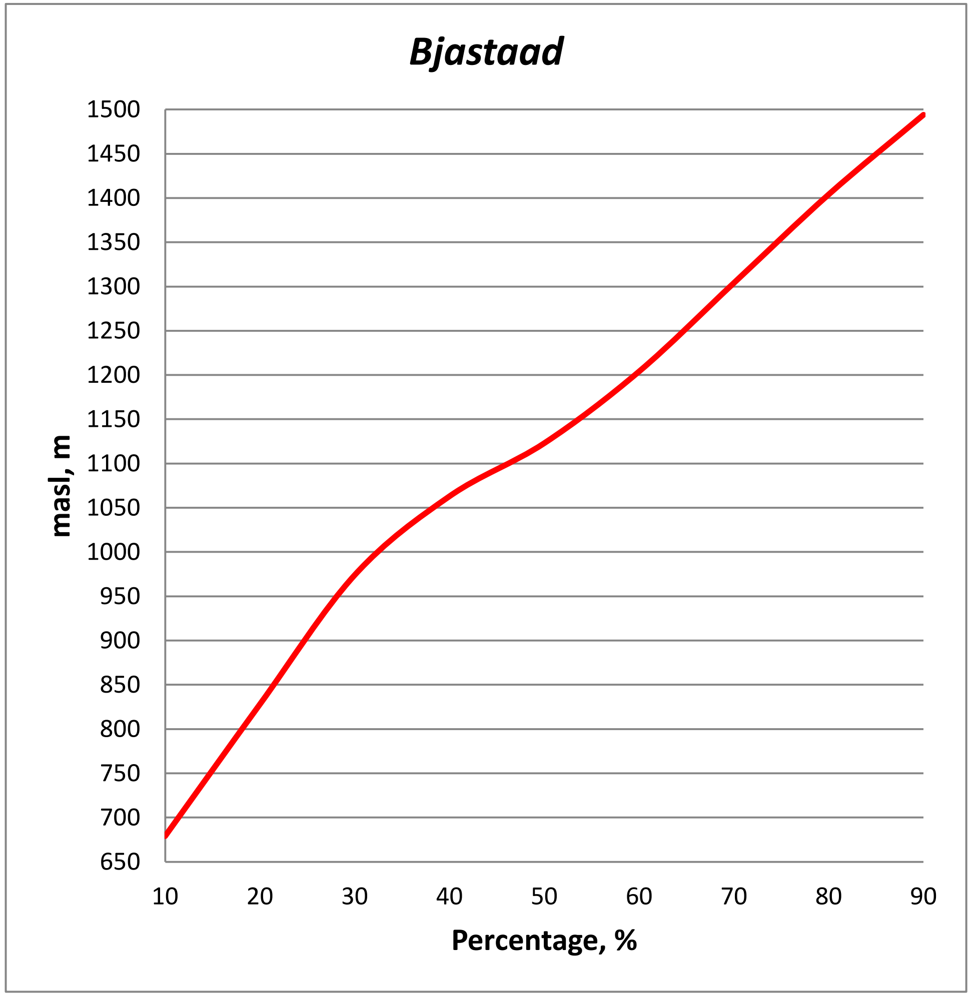


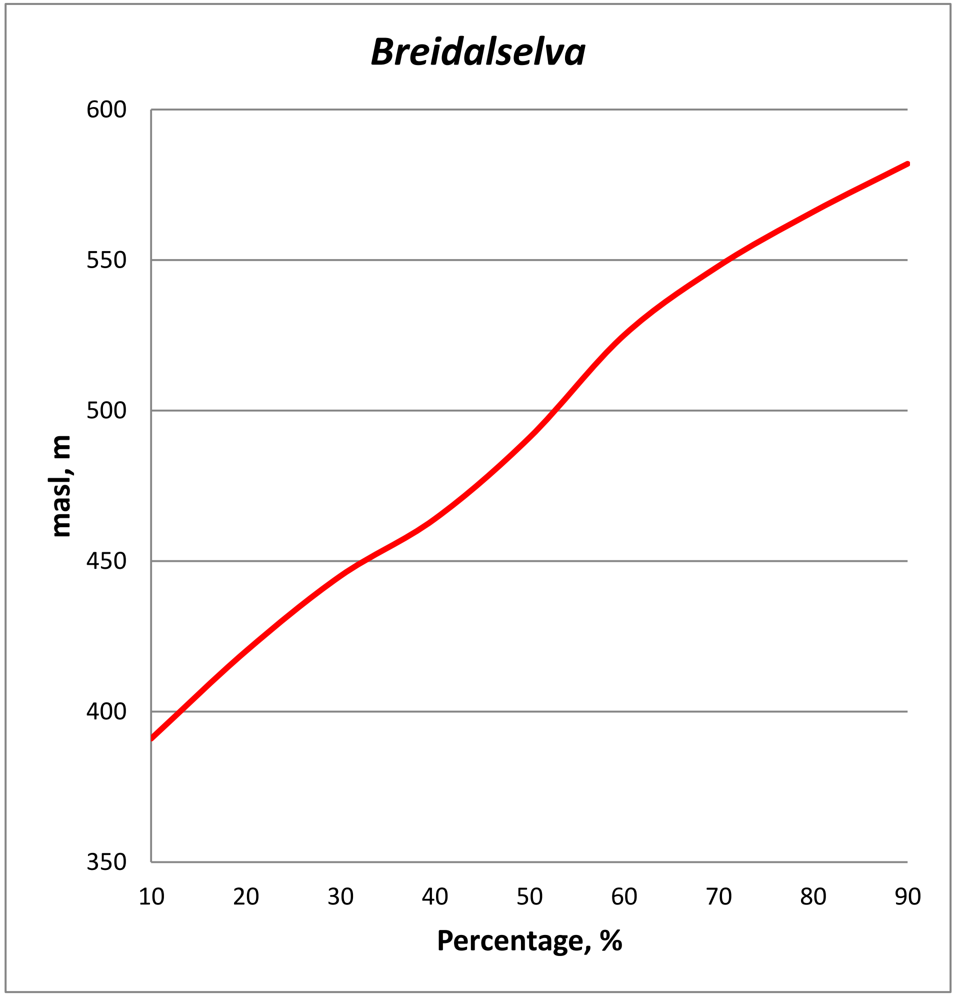
Appendix E: Hypsographic Curves for selected SWECO AS stations



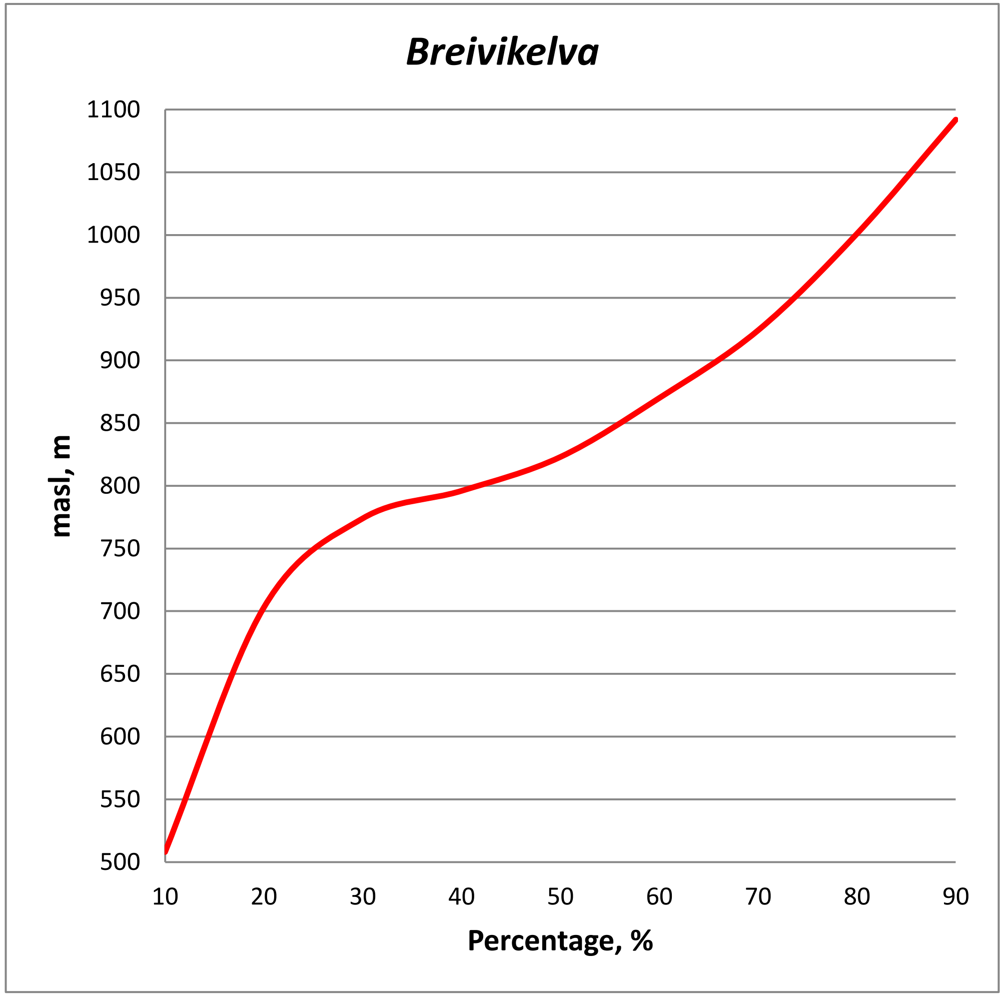


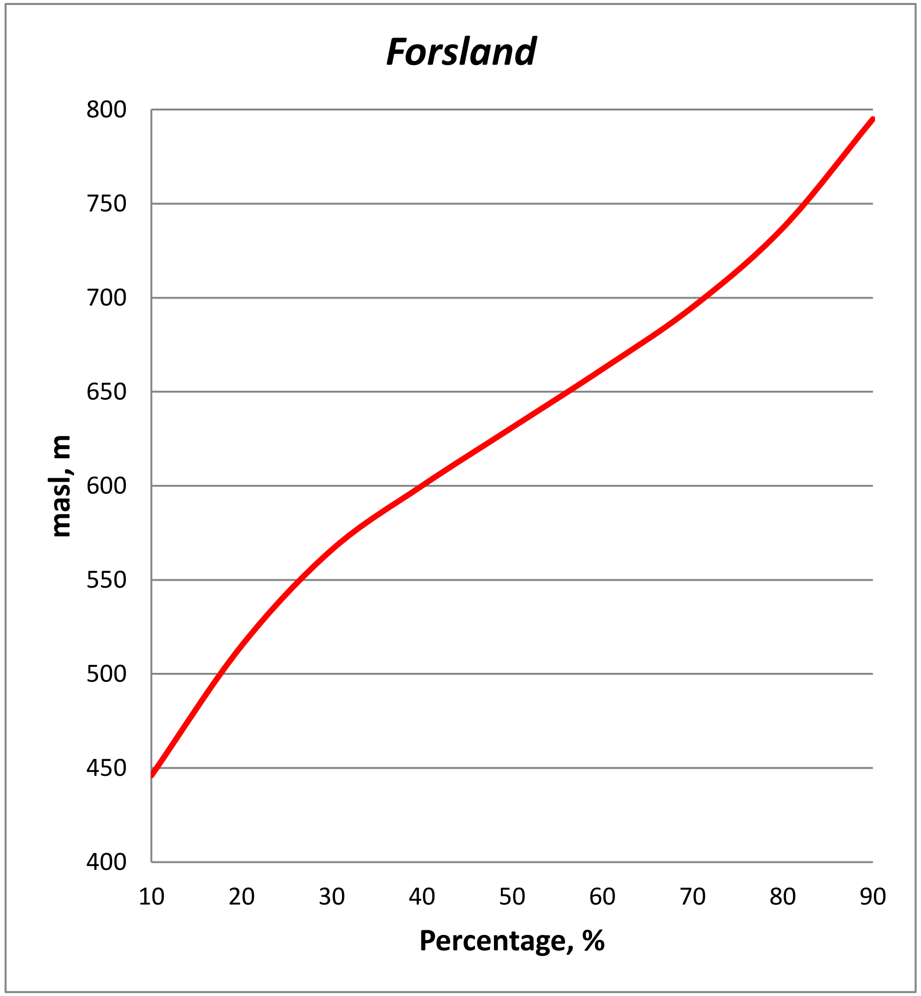
Appendix E: Hypsographic Curves for selected SWECO AS stations



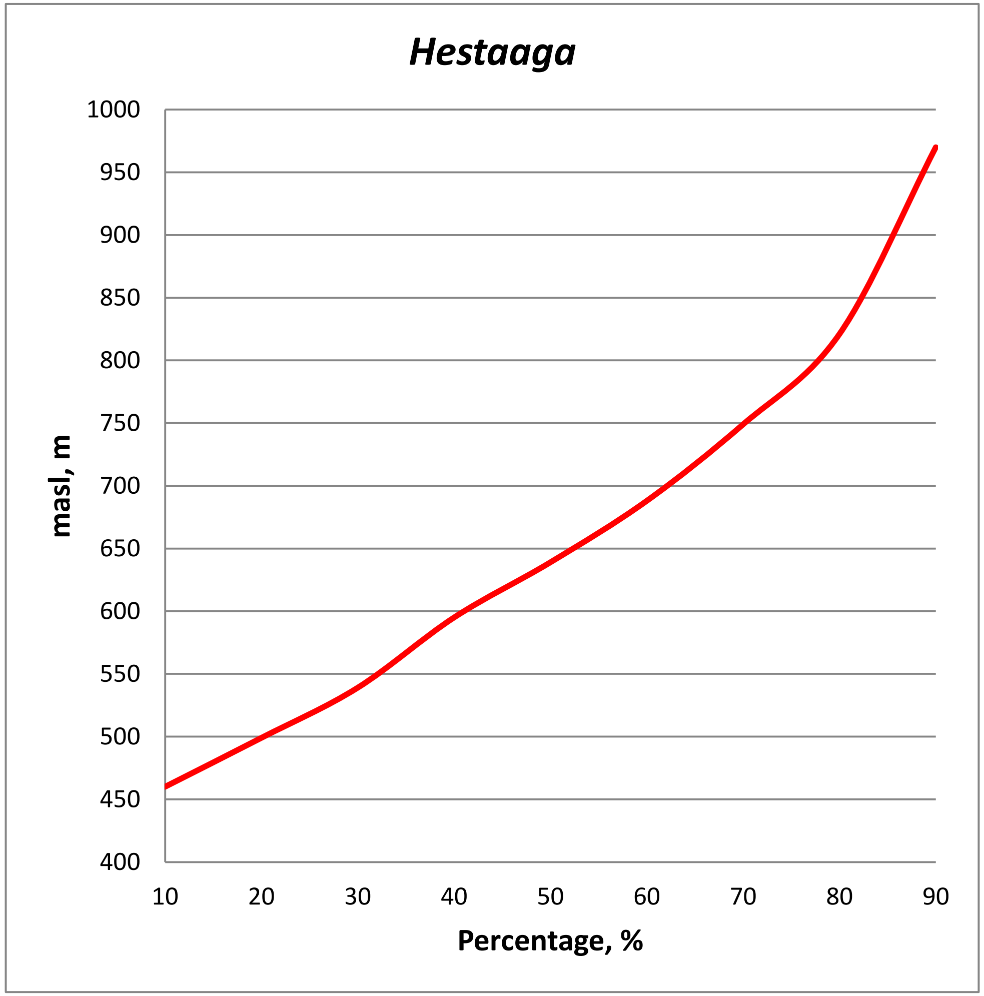


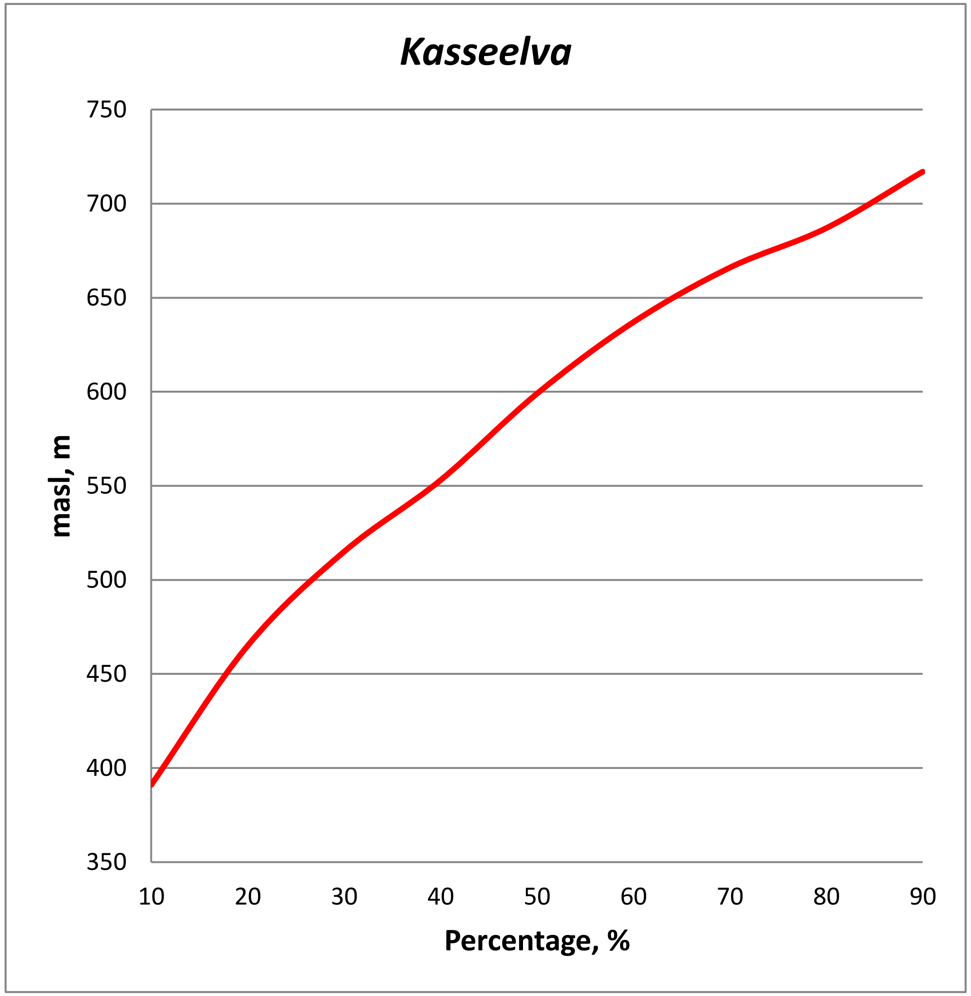
Appendix E: Hypsographic Curves for selected SWECO AS stations



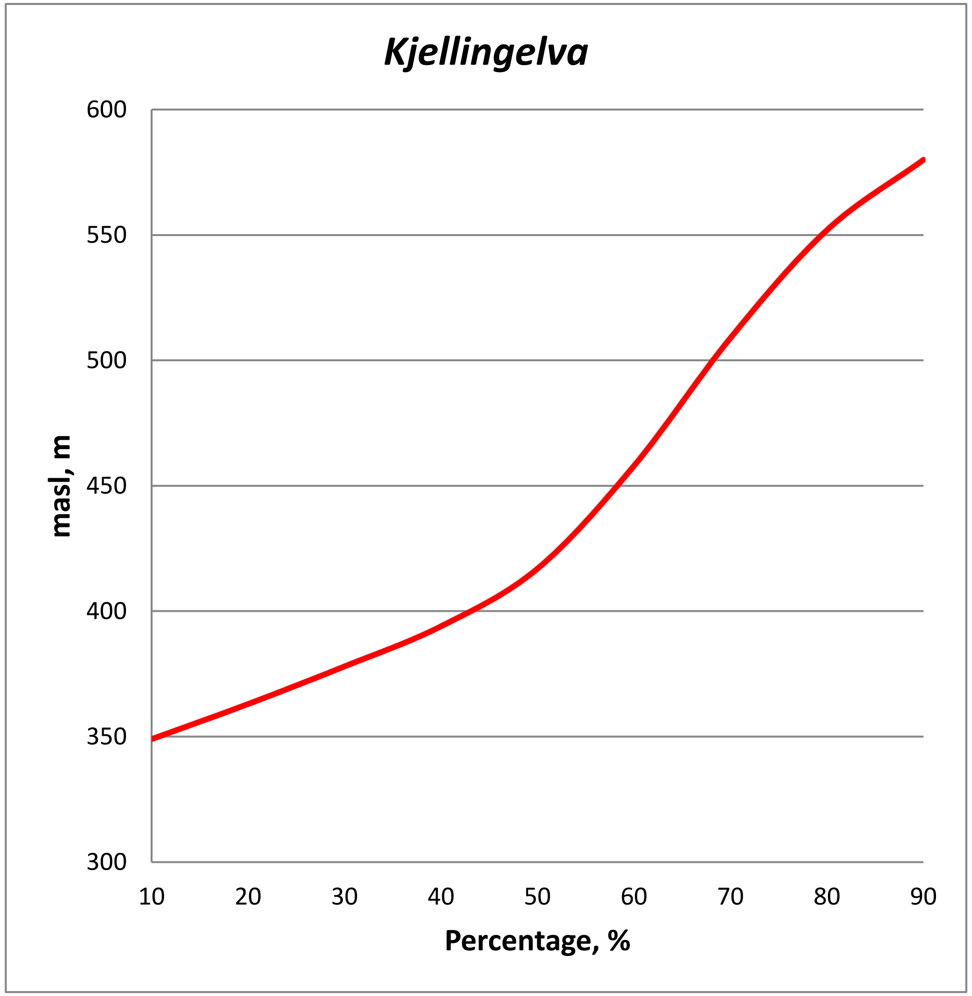


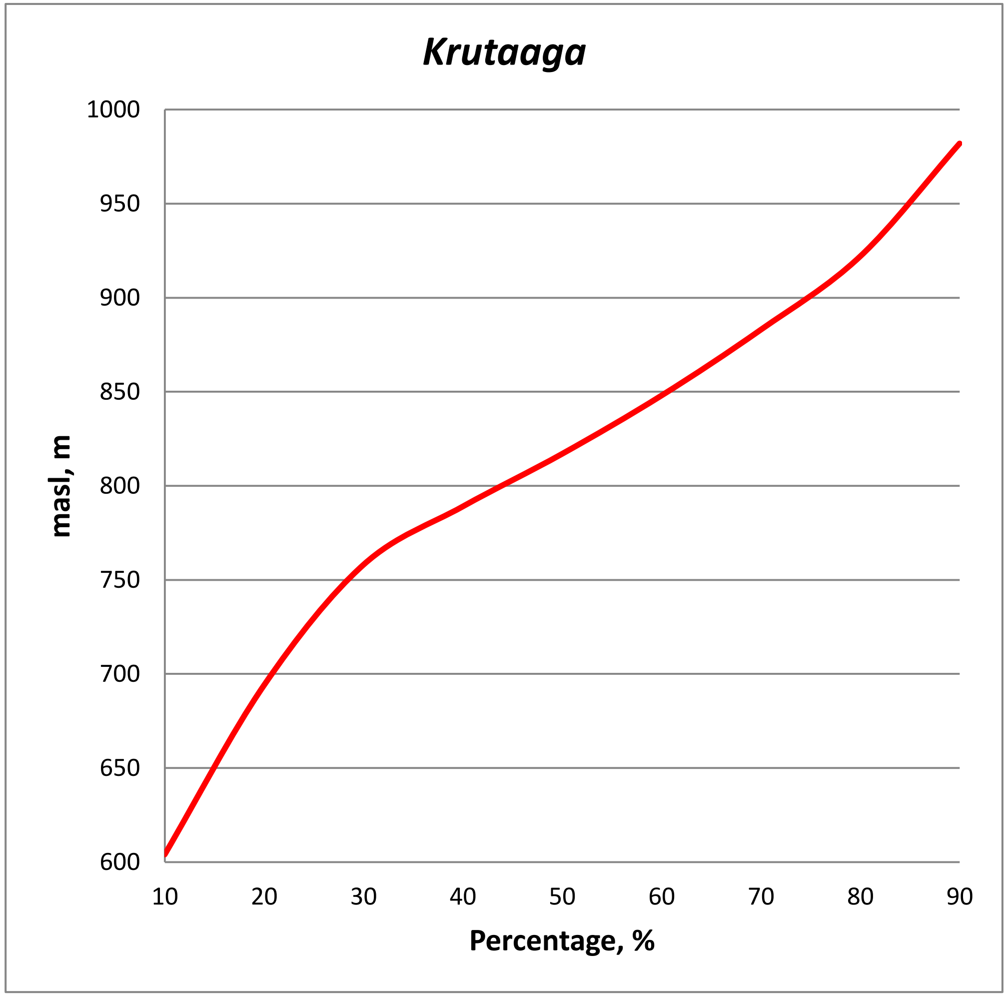
Appendix E: Hypsographic Curves for selected SWECO AS stations



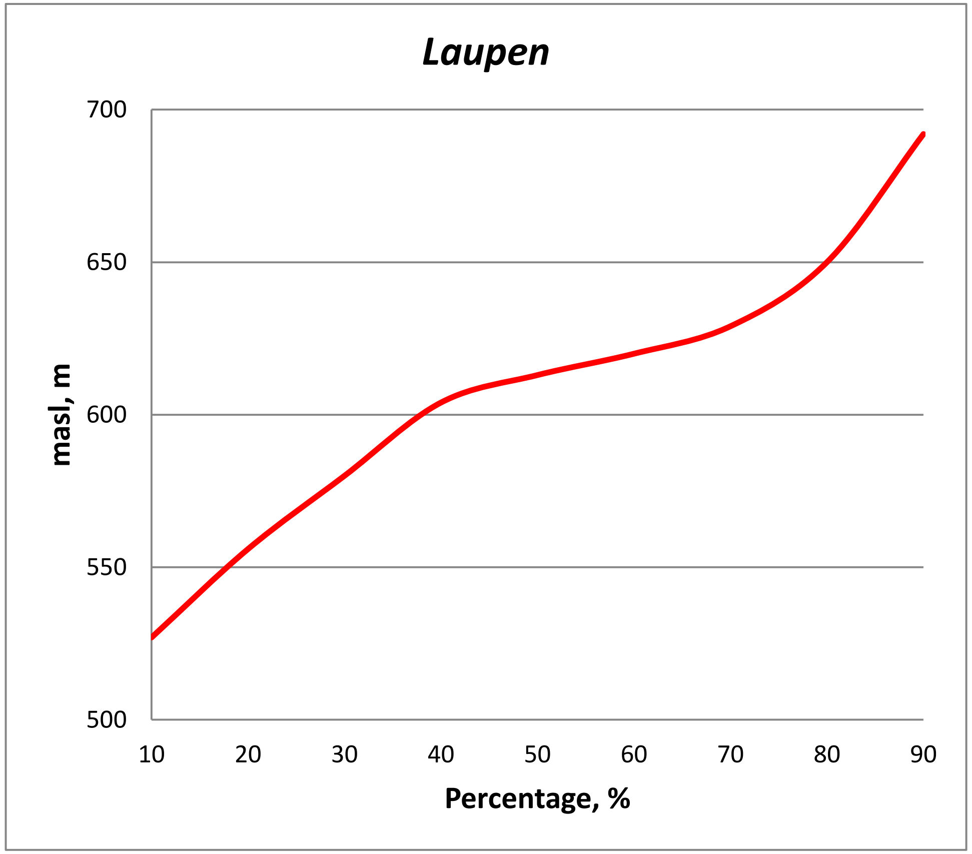


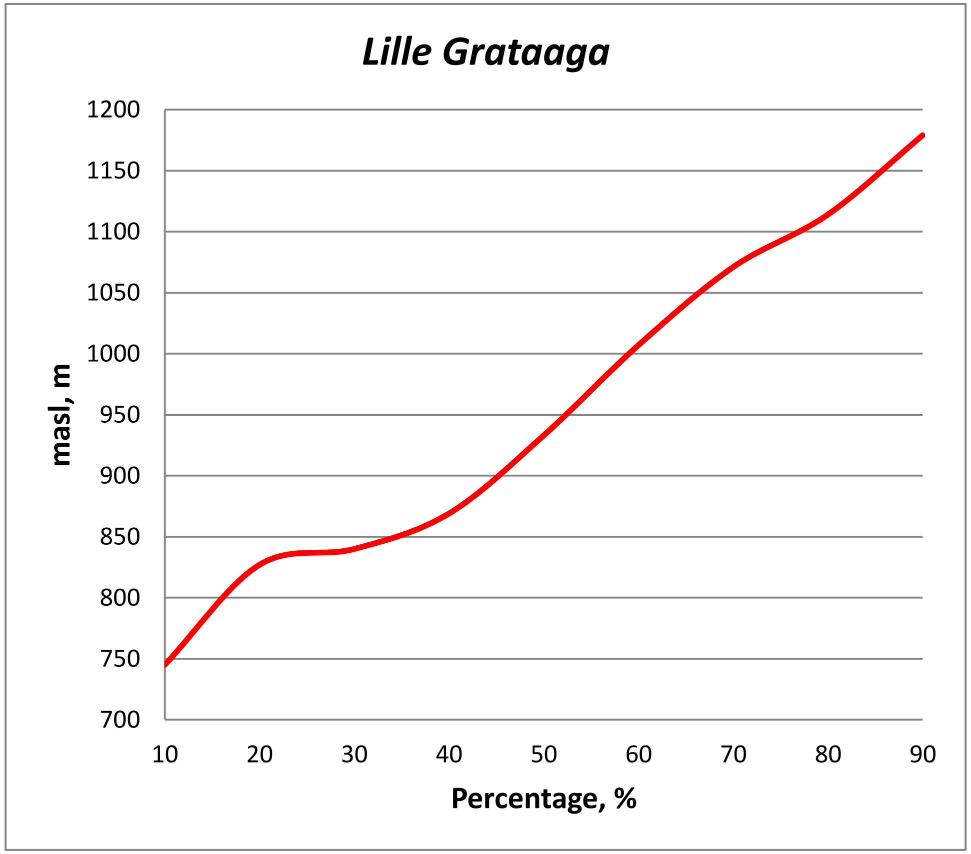
Appendix E: Hypsographic Curves for selected SWECO AS stations



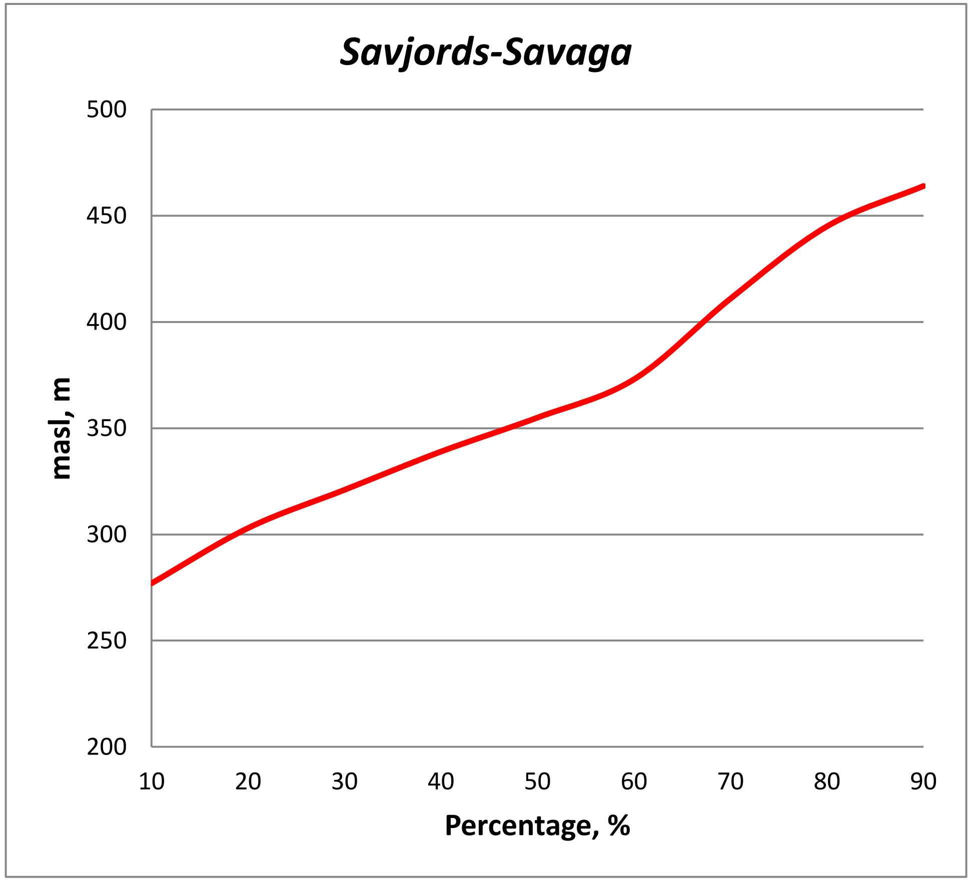


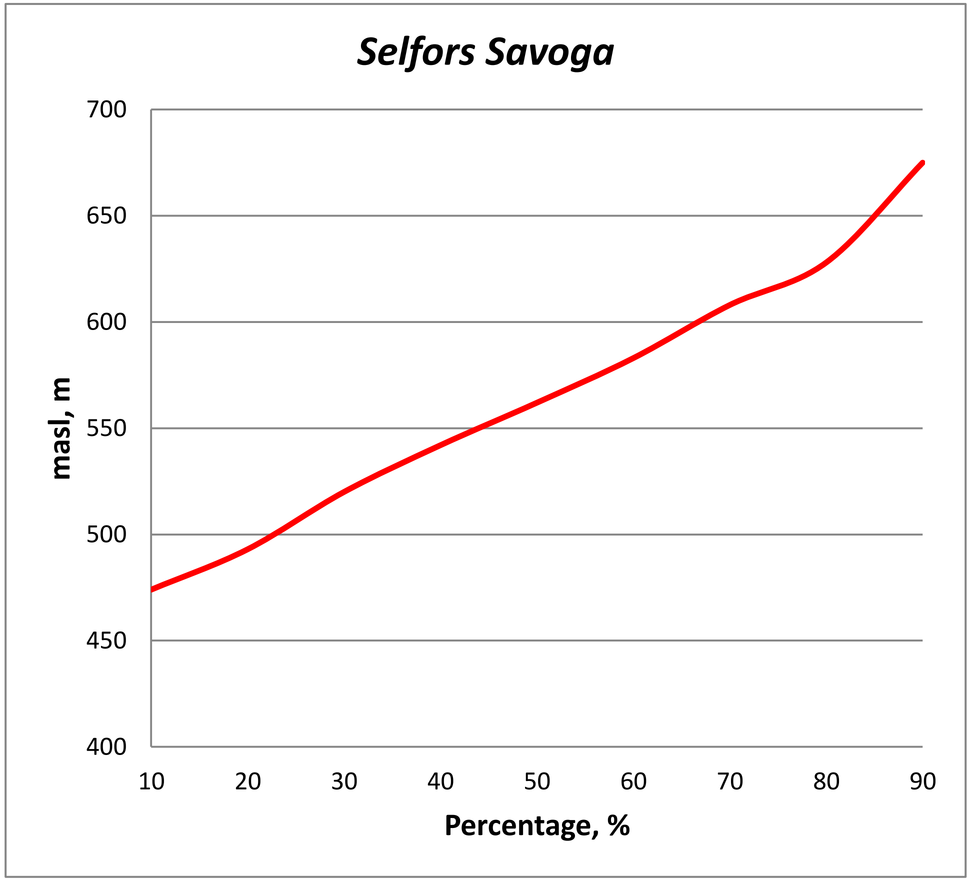
Appendix E: Hypsographic Curves for selected SWECO AS stations



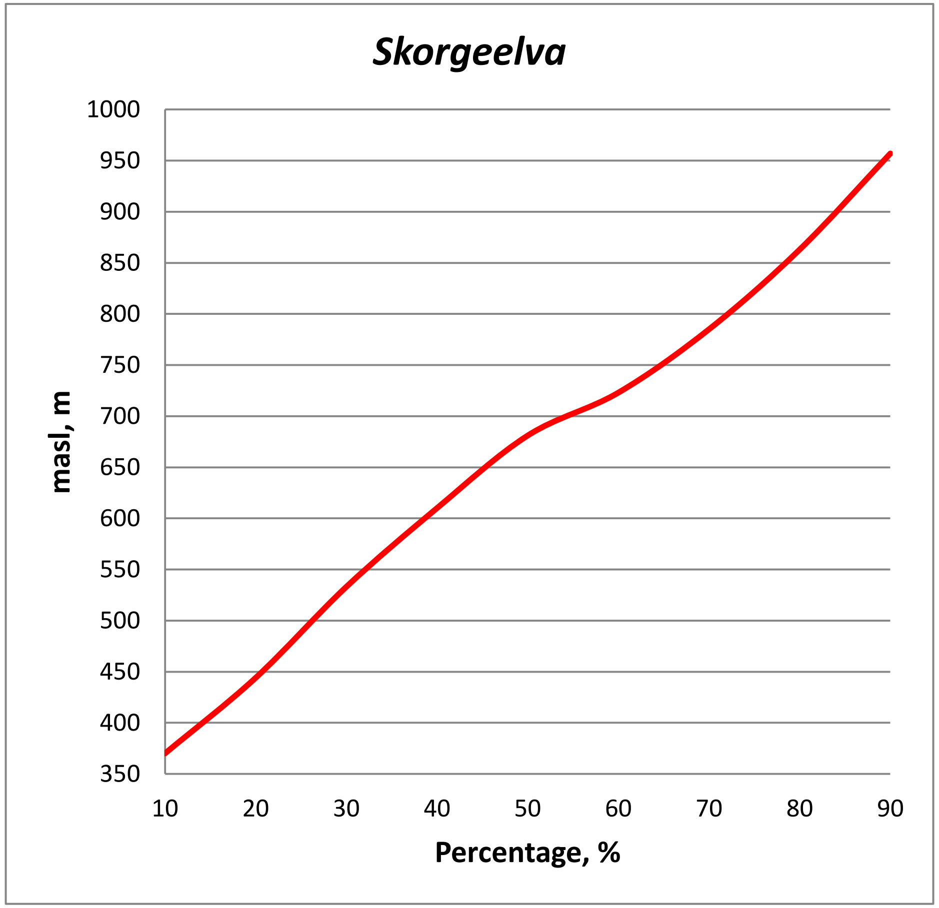


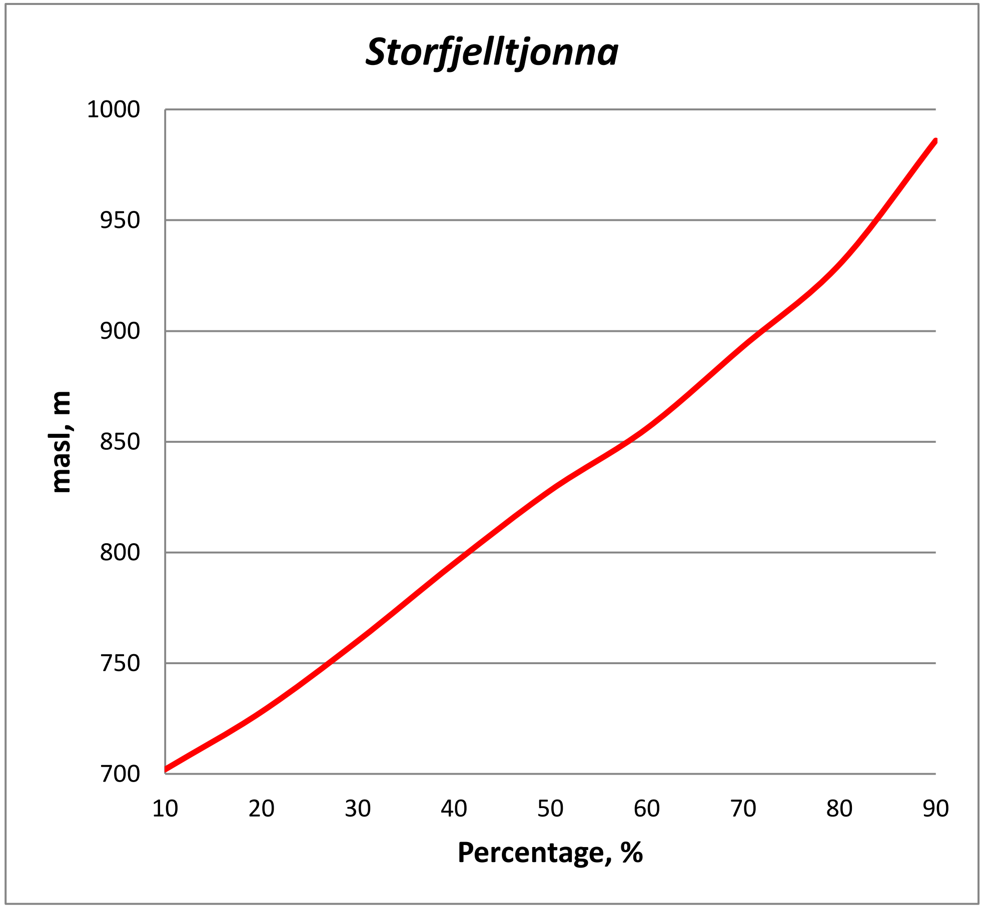
Appendix E: Hypsographic Curves for selected SWECO AS stations



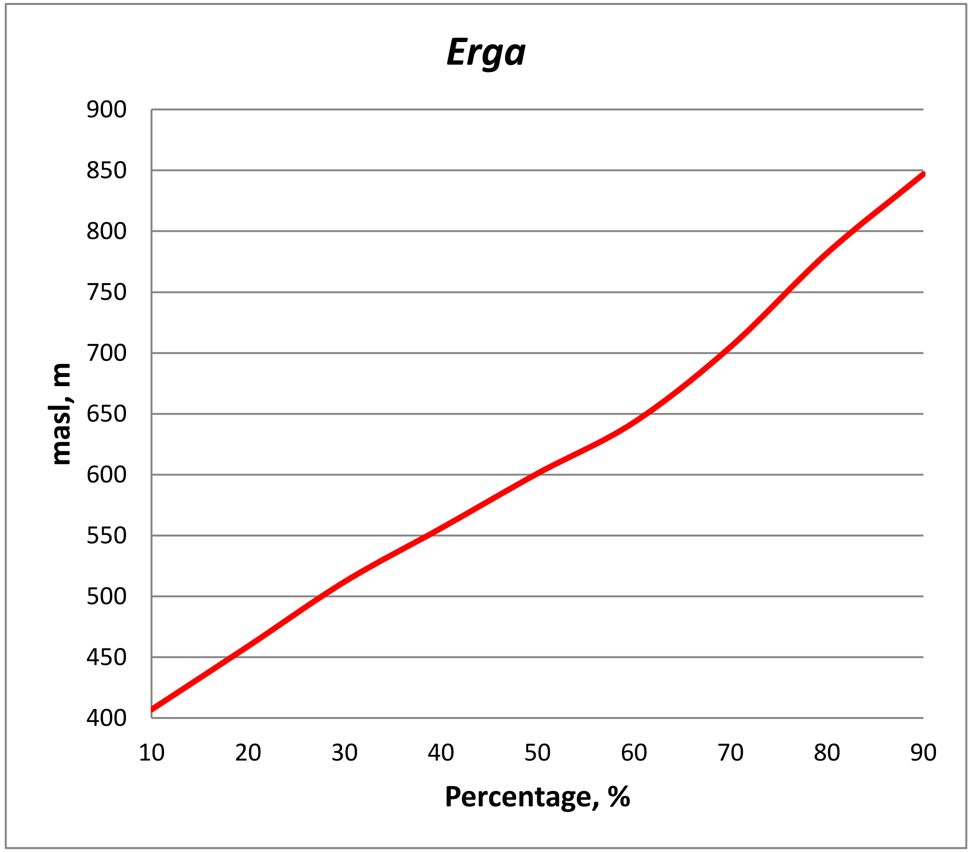


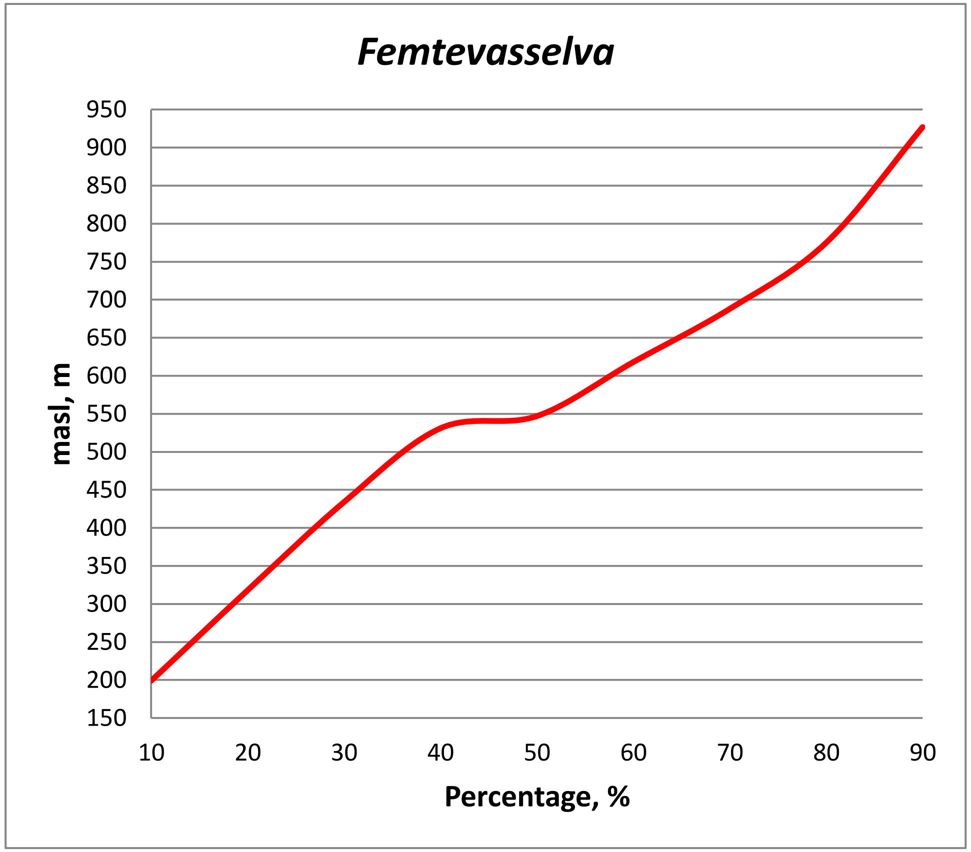
Appendix E: Hypsographic Curves for selected SWECO AS stations



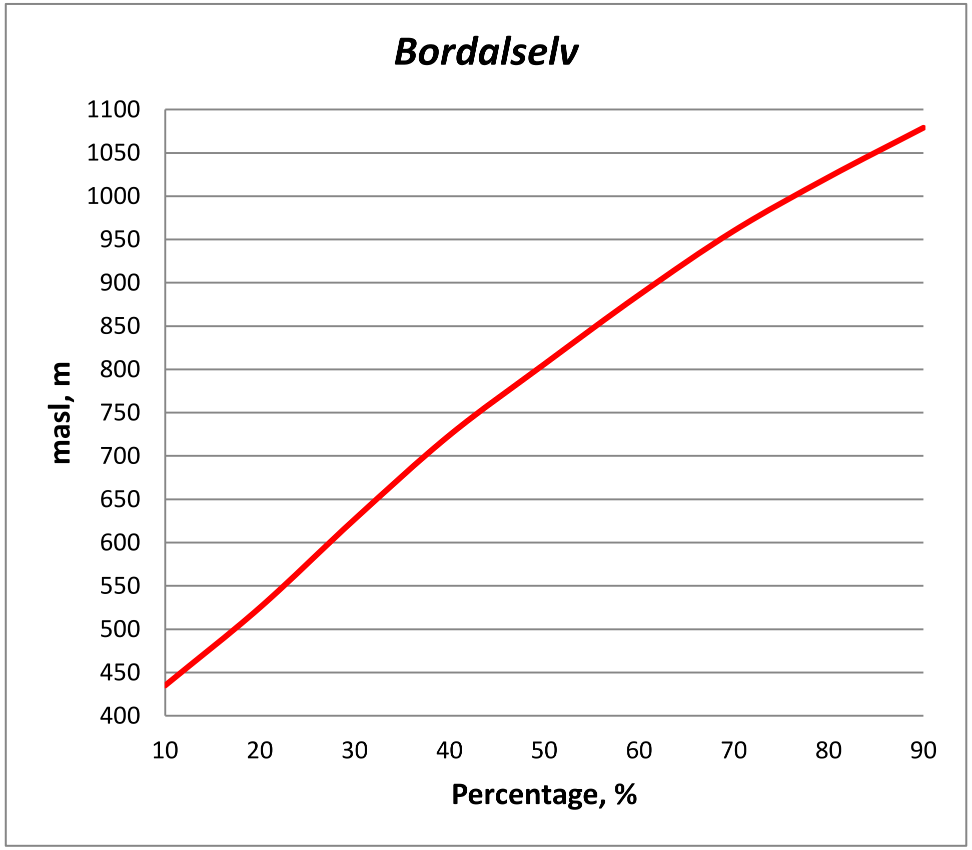


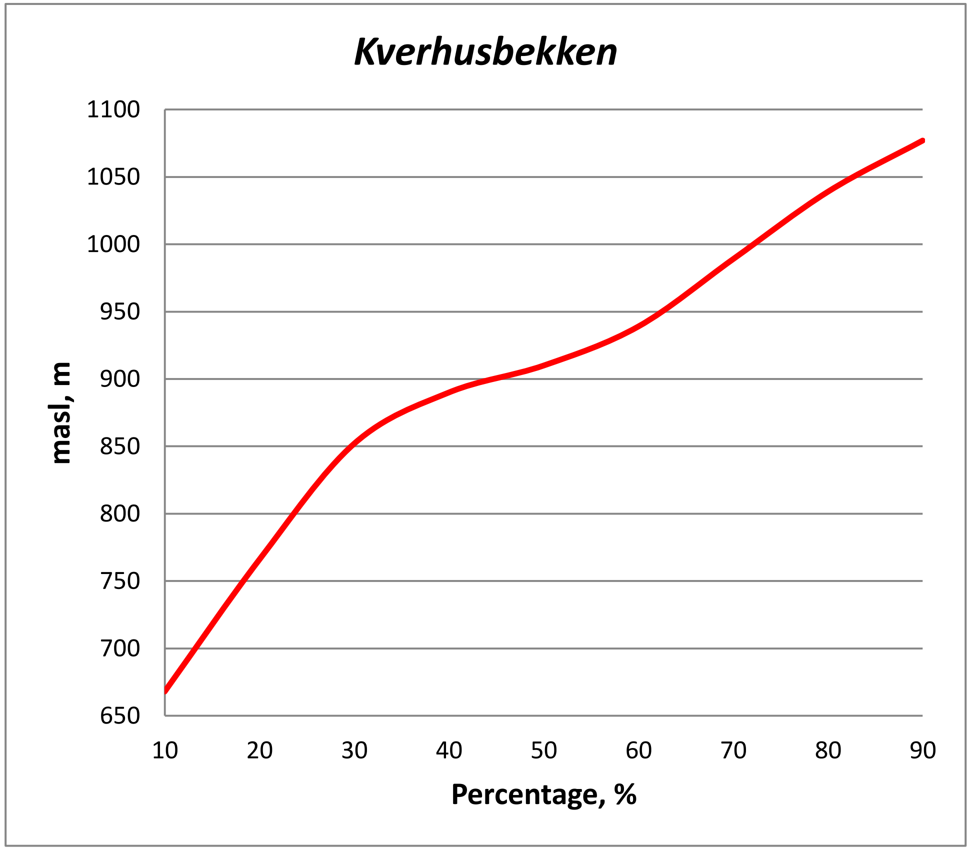
Appendix E: Hypsographic Curves for selected SWECO AS stations



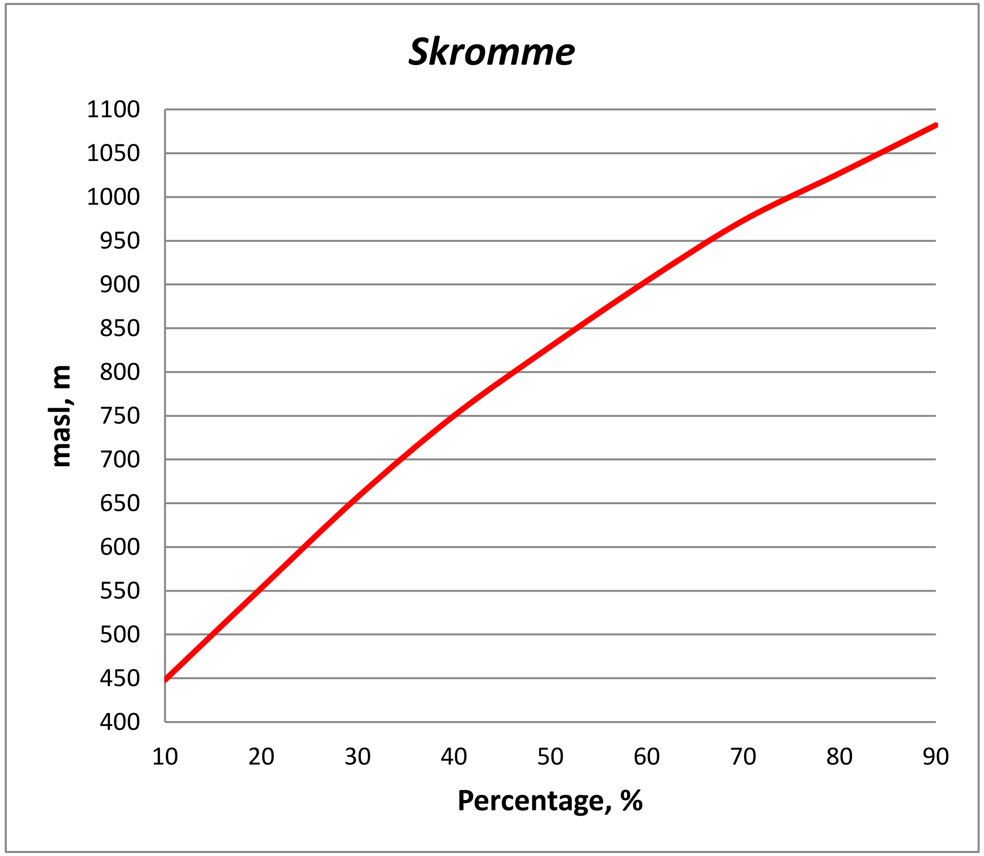


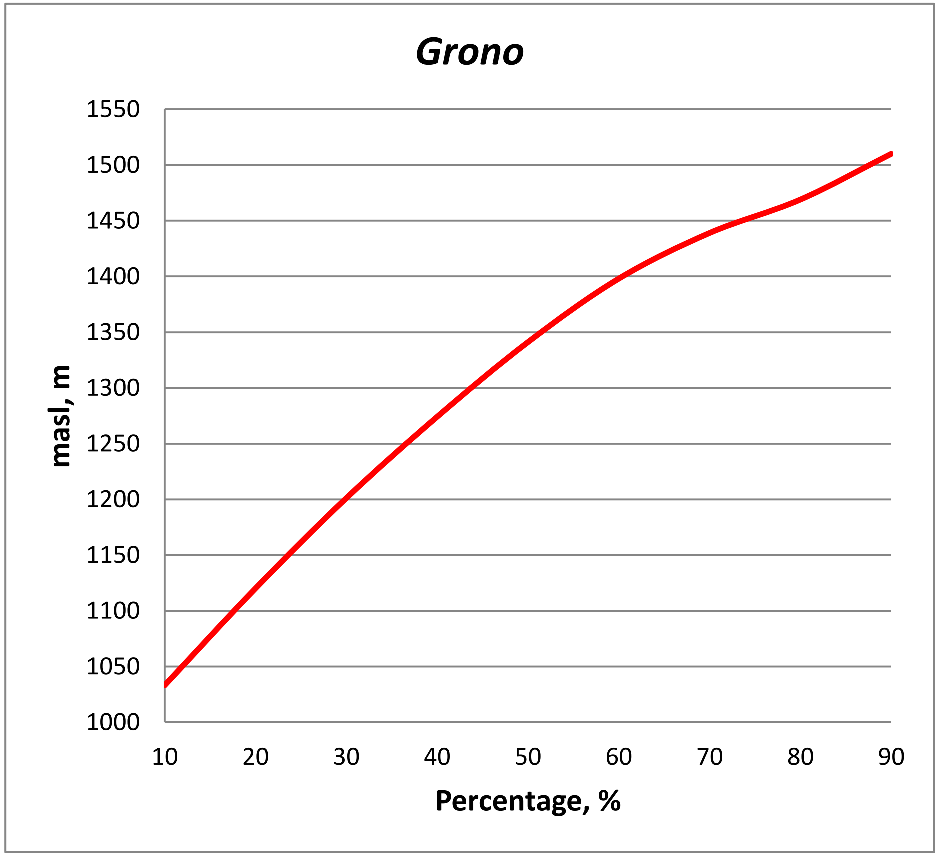
Appendix E: Hypsographic Curves for selected SWECO AS stations



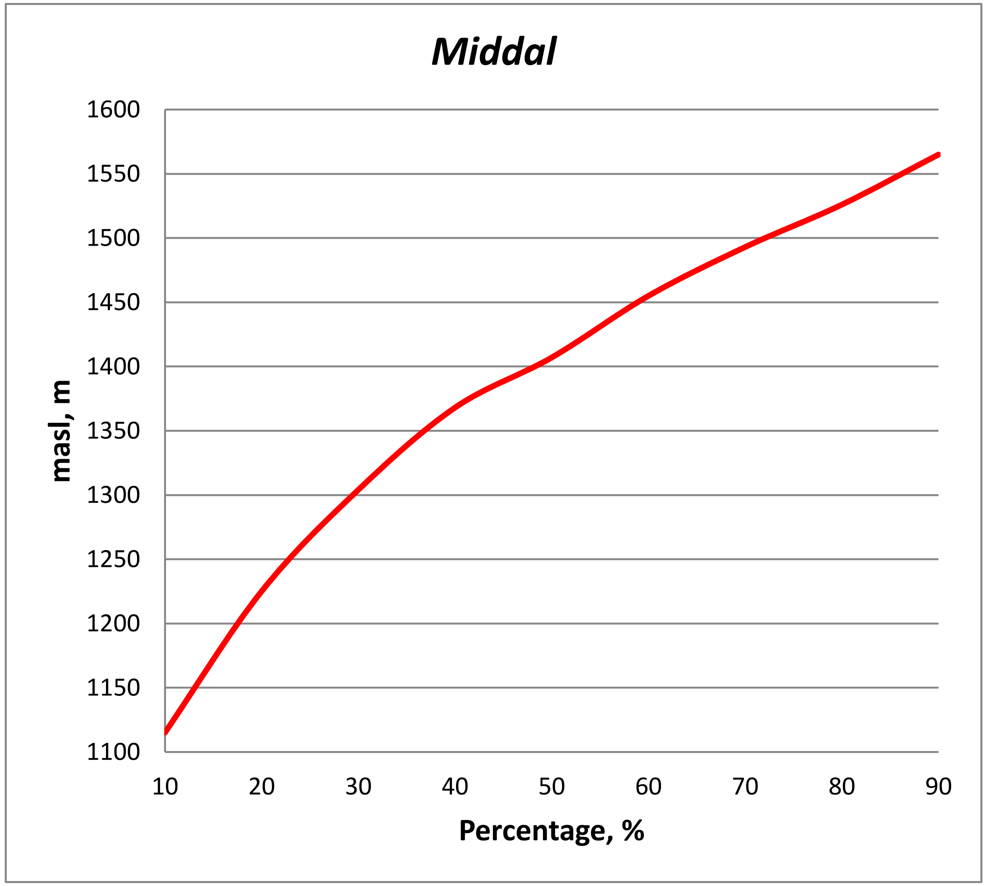


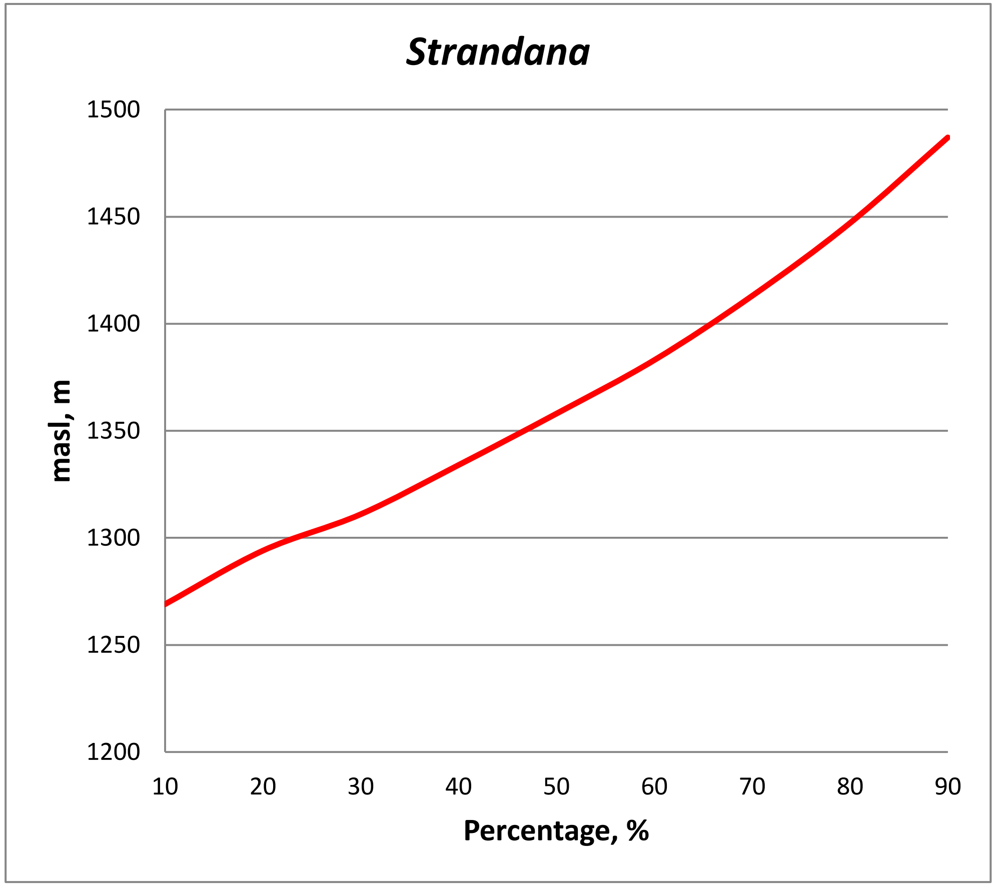
Appendix E: Hypsographic Curves for selected SWECO AS stations





Appendix E: Hypsographic Curves for selected SWECO AS stations





Appendix F: Enlarged topographic and climatic parameters of all SWECO stations

No.	Stasjonsnavn	Koordinat UTM	Middelavrenning 61-90, l/s/km2	KLIMAREG	REGION	AVRENNING
1	Amunddal	32 V 573994 7092235	56,8	Midt	Midt	1817,67
2	Aurstadelva	32 V 357949 6887457	98,9	Vest	Vest	3120,78
3	Berge	33 V 61951 6833462	100,4	Vest	Vest	3166,63
4	Bjåstad	32 V 380548 6806983	95,0	Vest	Vest	2997,29
5	Breidalselva	33 V 460916 7426464	83,3	Nord	Nord	2627,49
6	Breivikelva	33 V 468712 7431213	104,0	Bre-Nord	Nord	3282,48
7	Dalaåna	32 V 351913 6547242	89,1	Sor	Sor	2810,60
8	Eidåa	33 V 246926 6995437	35,1	Midt	Midt	1105,76
9	Fjerdingelva	33 V 391553 7171504	62,1	Midt	Midt	1960,34
10	Forsland	33 V 415298 7326234	103,5	Midt	Midt	3265,42
11	Geiranger 1	32 V 406514 6886233	61,7	Bre-Sor	Vest	1946,05
12	Geiranger 2	32 V 406489 6886285	61,7	Bre-Sor	Vest	1945,82
13	Grytbogelva	33 V 353406 7099957	31,4	Midt	Midt	990,62
14	Grytneselva	32 V 456773 6956274	69,1	Midt	Midt	2179,12
15	Grøndalselva	33 V 400210 7171798	59,7	Midt	Midt	1884,26
16	Hansfinnsvatn	33 V 423071 7336166	108,2	Midt	Midt	3415,02
17	Hanskijohka	34 V 499005 7704515	33,1	Finnmark	Finnmark	1043,43
18	Hestedalselva	33 V -39394 6804111	57,8	Vest	Vest	1823,79
19	Heståga	33 V 488225 7422073	57,7	Nord	Nord	1821,51
20	Instefjord	32 V 525093 7029092	39,7	Midt	Midt	1251,93
21	Jordalselvi	32 V 375841 6802645	90,3	Bre-Sor	Vest	2849,00
22	Kanndalen	32 V 459245 6950609	69,3	Midt	Midt	2186,23

23	Kasseelva	32 V 323528 6878261	106,0	Vest	Vest	3345,29
24	Kjellingelva	33 V 471175 7438758	73,0	Nord	Nord	2443,94
25	Kjerrslettelva	33 V 460815 7426649	77,5	Midt	Midt	4014,49
26	Krutåga	33 V 468727 7285912	44,5	Midt	Midt	1404,61
27	Kvernhuselva	32 V 310759 6765744	135,7	Vest	Vest	4280,73
28	Laupen	33 V 426249 7349646	115,9	Nord	Nord	3655,96
29	Lille Gråttåga	33 V 485126 7420022	82,1	Bre-Nord	Nord	2589,41
30	Lånivatn	33 V 736659 7747025	32,5	Finnmark	Finnmark	1026,21
31	Norddalselva	33 V -39394 6804111	57,8	Vest	Vest	1823,79
32	Nordåna	32 V 351355 6548069	92,9	Sor	Sor	2930,23
33	Osaelva	33 V 262365 7078998	54,9	Midt	Midt	1875,22
34	Ovre Forsland	33 V 415222 7326202	103,5	Midt	Midt	3265,16
35	Reinåga	33 V 449782 7325059	82,5	Midt	Midt	2601,79
36	Råna øvre	32 V 612827 7001789	37,2	Midt	Midt	1173,18
37	Råna nedre	32 V 613240 7001799	36,8	Midt	Midt	1161,24
38	Salhuselva	33 V 532643 7519260	60,4	Nord	Nord	1904,84
39	Sandslielva	32 V 597468 7093531	50,7	Midt	Midt	1598,05
40	Savjords-Savåga	33 V 487533 7432244	36,4	Nord	Nord	1148,83
41	Selforssagåga	33 V 487243 7432658	51,5	Nord	Nord	1625,25
42	Skorgeelva	32 V 430466 6939992	49,8	Midt	Midt	1569,95
43	Skorovasselva	33 V 401860 7172405	54,8	Midt	Midt	1729,58
44	Snøskar	33 V 594076 7564127	53,0	Bre-Nord	Nord	1670,63
45	Storfjelltjønna	33 V 408102 7240982	112,0	Midt	Midt	3531,87
46	Storrapet-Frostisen	33 V 593663 7569819	0,0			0,00
47	Sørelva	33 V 424743 7335267	140,4	Midt	Midt	4430,43
48	Tangvella	32 V 583409 7013268	31,4	Midt	Midt	989,80

49	Tindaaga	33 V 469329 7435077	86,0	Nord	Nord	2712,69
50	Toven 1	33 V 423061 7331618	125,2	Midt	Midt	3949,09
51	Toven 2	33 V 421463 7330708	127,2	Midt	Midt	4014,49
52	Trøkna	32 V 511285 6996050	57,9	Midt	Midt	1826,83
53	Tungelva	32 V 336590 6877350	128,5	Vest	Vest	4053,25
54	Tunselva	32 V 596073 7092948	46,2	Midt	Midt	1455,97
55	Tverråga	33 V 405863 7247779	84,4	Midt	Midt	2661,76
56	Tvinna	32 V 362199 6861899	76,8	Vest	Vest	2423,22
58	Usma	32 V 613424 6995895	38,6	Midt	Midt	1217,49
59	Usma Økendal	32 V 464467 6942631	72,0	Midt	Midt	2270,26
60	Vassdalselva	32 V 491627 6994813	57,5	Midt	Midt	1814,48
61	Vesterskarelva	33 V 593441 7565122	56,3	Bre-Nord	Nord	1776,91
62	Øvre Fagervollvatn	33 V 435707 7365066	110,9	Bre-Nord	Nord	3497,31
63	Åfjord	32 V 556663 7087536	58,9	Midt	Midt	1856,78
64	Erga	32 V 507318 6938389	30,6	Midt	Midt	965,00
65	Storelvi	32 V 357758 6690496	100,9	Vest	Vest	3181,80
66	Herand-Fodnasetvatnet	32 V 357680 6690292	100,9	Vest	Vest	3182,38
67	Stolaelva	31 V 657174 6687443	175,9	Vest	Vest	5549,81
68	Øyseteelva	32 V 344112 6700155	119,5	Vest	Vest	3769,98
69	Malmedalselva	33 V 104238 6986364	64,9	Midt	Midt	2048,85
70	Roggejavri	33 V 550737 7521374	70,5	Nord	Nord	2223,00
71	Musken	33 V 549629 7530151	66,2	Nord	Nord	2089,53
72	Femtevasselva	33 V 540786 7520564	66,4	Nord	Nord	2095,10
73	Gjerdalen	33 V 544195 7506425	44,3	Nord	Nord	1398,04
74	Tennvatnet	33 V 538284 7532144	55,7	Nord	Nord	1758,75

75	Leirbuktelva	34 V 685877 7722573	59,4	Finnmark	Finnmark	1875,34
76	Rasteelva	34 V 452320 7715041	73,6	Finnmark	Finnmark	2323,02
77	Markenesdalen	34 V 435350 7676852	30,2	Nord	Nord	953,56
78	Moråga	33 V 489151 7433009	58,5	Nord	Nord	1845,59
79	Savåga	33 V 487414 7431984	50,2	Nord	Nord	1584,97
80	Eiteråga	33 V 484391 7429761	73,8	Bre-Nord	Nord	2329,07
81	Bordalselv	32 V 357733 6640295	83,9	Vest	Vest	2645,86
82	Kverhusbekken	32 V 356392 6641474	5,3	Vest	Vest	3216,99
83	Skromme	32 V 358120 6641174	84,8	Vest	Vest	2675,68
84	Grøno	32 V 386543 6648002	71,4	Sor	Sor	2253,29
85	Holddøla	32 V 382702 6644303	82,5	Bre-Sor	Sor	2601,65
86	Middal	32 V 387291 6648021	62,2	Sor	Sor	1961,63
87	Strandåna	32 V 383606 6647882	81,8	Sor	Sor	2579,36

Appendix F: Enlarged topographic and climatic parameters of all SWECO stations (contin. 1)

No	Stasjonsnavn	HEIGHT _MIN	HEIGHT _10	HEIGHT _20	HEIGHT _30	HEIGHT _40	HEIGHT _50	HEIGHT _60	HEIGHT _70	HEIGHT _80	HEIGHT _90	HEIGHT _MAX
1	Amunddal	202	254	302	334	359	391	427	467	504	538	660
2	Aurstadelva	398	493	585	681	788	900	999	1069	1107	1161	1297
3	Berge	440	720	796	893	980	1087	1178	1254	1326	1413	1595
4	Bjåstad	159	679	828	974	1063	1123	1204	1304	1404	1494	1607
5	Breidalselva	284	391	420	445	464	491	525	548	566	582	640
6	Breivikelva	257	508	703	774	796	823	870	924	1001	1092	1325
7	Dalaåna	343	517	583	650	702	746	789	824	852	883	962
8	Eidåa	537	657	709	741	765	791	824	867	919	984	1140
9	Fjerdingelva	162	287	321	377	406	441	486	543	612	722	1153
10	Forsland	246	446	515	566	600	631	662	695	737	795	910
11	Geiranger 1	69	631	867	1001	1082	1163	1260	1342	1435	1545	1770
12	Geiranger 2	46	630	867	1001	1082	1163	1259	1342	1435	1545	1770
13	Grytbogelva	254	274	278	283	287	292	295	299	302	305	326
14	Grytneselva	614	716	743	776	802	823	850	892	954	1073	1279
15	Grøndalselva	280	423	475	520	563	612	656	697	742	799	947
16	Hansfinnsvatn	500	500	0	522	549	577	615	643	682	723	834
17	Hanskijohka	597	680	703	715	724	740	761	797	866	925	1060
18	Hestedalselva	2	45	65	79	85	92	100	107	117	131	151
19	Heståga	356	460	499	539	595	639	688	749	821	970	1164
20	Instefjord	61	308	344	363	382	403	421	437	452	478	561
21	Jordalselvi	155	460	646	752	871	966	1058	1141	1226	1313	1530
22	Kanndalen	440	590	701	775	830	882	941	1025	1135	1263	1705

23	Kasseelva	177	391	465	515	553	599	637	666	687	717	787
24	Kjellingelva	285	349	363	378	394	417	458	509	552	580	610
25	Kjerrslettelva	731	749	766	786	802	820	834	840	847	856	870
26	Krutåga	575	604	694	758	789	817	848	883	922	982	1237
27	Kvernhuselva	393	413	454	500	541	575	607	631	681	740	812
28	Laupen	405	527	556	580	604	613	620	629	650	692	837
29	Lille Gråttåga	377	745	827	840	869	933	1007	1071	1114	1179	1349
30	Lånivatn	209	272	411	515	523	551	584	639	709	785	1023
31	Norddalselva	2	45	65	79	85	92	100	107	117	131	151
32	Nordåna	445	560	574	596	629	672	719	767	807	864	955
33	Osaelva	100	186	242	283	305	329	355	378	407	454	608
34	Ovre Forsland	246	446	514	566	600	631	662	695	737	795	910
35	Reinåga	699	708	724	745	763	783	803	833	859	890	964
36	Råna øvre	462	588	621	648	678	701	727	750	769	808	1040
37	Råna nedre	409	580	613	643	672	697	724	748	768	806	1040
38	Salhuselva	246	280	320	357	393	439	518	621	728	854	1069
39	Sandslielva	137	272	341	395	425	449	469	490	512	556	625
40	Savjords-Savåga	222	277	303	321	339	355	373	411	445	464	490
41	Selforssagåga	300	474	493	520	542	562	583	608	628	675	778
42	Skorgeelva	174	370	444	533	610	681	723	785	863	957	1202
43	Skorovasselva	320	373	432	467	500	540	585	634	710	811	947
44	Snøskar	483	617	685	728	781	841	923	1018	1124	1215	1326
45	Storfjelltjønna	679	702	728	760	795	828	856	893	930	986	1092
46	Storrapet-Frostisen	0	0	0	0	0	0	0	0	0	0	0
47	Sørelva	546	597	673	753	813	853	872	887	900	917	990
48	Tangvella	356	413	456	493	527	566	588	631	683	748	929

49	Tindaaga	426	458	507	544	591	626	652	694	781	884	1116
50	Toven 1	726	735	739	744	751	758	767	782	803	822	865
51	Toven 2	731	749	766	786	802	820	834	840	847	856	870
52	Trøkna	156	501	562	586	610	639	672	728	778	827	928
53	Tungelva	721	753	798	858	879	917	966	1007	1039	1092	1250
54	Tunselva	177	240	293	329	359	382	404	419	437	468	609
55	Tverråga	127	216	335	446	541	653	742	785	834	905	1131
56	Tvinna	490	614	668	702	744	785	819	854	894	946	1129
58	Usma	447	585	620	656	697	736	768	803	846	905	1061
59	Usma Økendal	345	846	963	1026	1076	1133	1177	1234	1301	1386	1798
60	Vassdalselva	203	421	456	502	531	557	587	640	698	757	912
61	Vesterskarelva	544	677	767	874	974	1011	1049	1086	1147	1201	1322
62	Øvre Fagervollvatn	424	427	458	518	586	648	712	764	828	945	1190
63	Åfjord	171	180	214	235	258	278	297	317	340	391	472
64	Erga	330	407	459	512	556	601	643	705	782	847	924
65	Storelvi	555	763	826	919	1006	1061	1119	1211	1314	1393	1568
66	Herand-Fodnasetvatnet	560	764	827	920	1007	1062	1119	1211	1314	1393	1568
67	Stolaelva	56	759	865	930	950	989	1027	1077	1113	1157	1245
68	Øyseteelva	266	388	540	661	750	825	891	960	1038	1137	1326
69	Malmedalselva	115	185	237	262	294	352	411	480	559	662	968
70	Roggejavri	662	665	669	670	674	677	679	683	685	687	693
71	Musken	246	378	480	497	536	593	653	724	809	893	1165
72	Femtevasselva	146	199	318	434	531	547	618	688	775	927	1230
73	Gjerdalen	121	196	224	241	267	320	370	434	540	699	888

74	Tennvatnet	330	360	394	423	458	480	497	519	537	555	662
75	Leirbuktelva	221	365	407	425	481	511	551	621	700	883	1335
76	Rasteelva	236	332	455	598	708	784	881	1005	1145	1307	1569
77	Markenesdalen	312	393	433	487	553	632	718	808	924	1058	1394
78	Moråga	408	572	594	611	632	649	669	690	718	789	1089
79	Savåga	138	417	477	504	532	554	575	603	623	669	778
80	Eiteråga	148	500	579	651	721	793	867	937	993	1068	1307
81	Bordalselv	239	435	525	627	724	806	886	960	1022	1079	1358
82	Kverhusbekken	352	668	766	852	890	910	939	989	1039	1077	1151
83	Skromme	317	448	553	657	750	829	904	973	1027	1082	1358
84	Grøno	780	1033	1120	1201	1274	1341	1398	1439	1469	1510	1666
85	Holddøla	759	1126	1191	1249	1325	1376	1416	1447	1486	1529	1631
86	Middal	833	1115	1225	1304	1368	1407	1455	1493	1526	1565	1684
87	Strandåna	1221	1269	1294	1311	1334	1358	1383	1413	1447	1487	1564

Appendix F: Enlarged topographic and climatic parameters of all SWECO stations (contin. 2)

No.	Stasjonsnavn	SJOPRO	BREPRO	SKOGPRO	JBRUKPRO	MYRPRO	SNAUPRO	URBANPRO	EFFSJOPRO	TAMSOMMER	TAMVINTER	RRSOMMER	RRVINTER	TAMJUL	TAMAUG	TAMAAR	DELTAHMAX
1	Amunddal	5,67	0,00	23,87	1,35	9,30	57,65	0,01	0,46	9,05	-0,34	653,70	1304,29	10,90	10,95	3,57	298,40
2	Aurstadelva	4,31	0,00	4,98	0,00	1,58	89,05	0,00	1,48	7,18	-0,52	850,53	1644,13	8,93	9,02	2,69	664,00
3	Berge	0,39	3,74	15,69	0,00	1,71	65,75	0,00	0,01	5,17	-3,37	641,24	1195,74	7,13	7,70	0,19	820,00
4	Bjåstad	5,56	4,28	15,24	0,00	0,36	70,43	0,00	2,32	4,81	-3,06	613,47	1153,90	6,74	7,17	0,22	1104,62
5	Breidalselva	2,28	0,00	2,08	0,00	0,35	72,48	0,00	0,00	7,70	-0,31	731,90	1358,94	9,93	9,81	3,03	225,16
6	Breivikelva	2,73	13,17	0,20	0,00	0,00	74,53	0,00	0,68	5,43	-1,97	816,91	1365,32	7,73	7,72	1,11	538,20
7	Dalaåna	3,76	0,00	16,23	0,00	1,02	64,00	0,00	0,35	7,94	-0,38	716,38	1374,83	9,57	10,18	3,09	443,91
8	Eidåa	3,35	0,00	19,23	0,03	3,68	73,51	0,00	0,31	6,68	-3,00	426,83	513,47	8,53	9,04	1,03	400,30
9	Fjerdingelva	1,47	0,00	33,42	0,00	14,21	46,45	0,00	0,20	8,08	-4,15	430,79	688,52	10,46	10,50	0,95	307,84
10	Forsland	3,77	0,00	0,26	0,00	0,05	92,76	0,00	0,73	6,69	-2,98	731,66	1300,42	9,05	8,93	1,05	439,63
11	Geiranger 1	4,52	6,75	9,43	0,86	0,62	73,09	0,03	0,30	4,94	-0,89	466,77	969,63	6,42	7,44	1,54	1189,17
12	Geiranger 2	4,52	6,75	9,44	0,86	0,62	73,07	0,03	0,30	4,94	-0,88	466,76	969,62	6,42	7,44	1,55	1207,17
13	Grytbogelva	0,19	0,00	65,37	0,00	26,66	0,00	0,00	0,00	9,52	-2,20	459,77	682,80	11,70	11,66	2,68	10,00
14	Grytneselva	1,54	0,00	0,00	0,00	1,68	96,76	0,00	0,26	6,54	-0,48	533,71	946,30	8,00	8,40	2,45	278,00
15	Grøndalselva	3,78	0,00	14,48	0,00	5,80	67,66	0,00	0,73	7,00	-4,87	412,82	626,36	9,42	9,55	0,08	75,46
16	Hansfinnsvatn	20,85	0,00	0,00	0,00	0,00	79,23	0,00	20,42	6,90	-2,69	759,41	1321,41	9,27	9,12	1,31	144,11
17	Hanskijohka	2,92	0,00	0,00	0,00	1,82	95,21	0,00	1,16	4,28	-8,02	250,30	385,17	7,68	7,24	-2,90	108,00
18	Hestedalselva	0,45	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,76	3,89	791,30	1362,82	13,31	13,56	7,17	0,00
19	Heståga	0,25	3,55	20,35	0,00	1,36	74,44	0,00	0,00	6,50	-3,67	446,18	840,43	8,96	9,19	0,57	573,10
20	Instefjord	0,42	0,00	19,58	0,00	14,18	37,75	0,00	0,01	9,23	-1,04	571,93	1118,24	11,14	11,18	3,24	372,32
21	Jordalselvi	0,89	9,97	18,41	0,04	0,00	68,50	0,00	0,06	6,66	-1,57	599,23	1137,11	8,61	8,92	1,86	1004,5
22	Kanndalen	3,30	3,92	7,39	0,00	1,77	73,09	0,00	0,68	6,61	-0,09	501,50	894,68	8,02	8,46	2,70	595,99
23	Kasseelva	4,55	0,00	13,62	0,74	1,11	78,91	0,00	0,00	8,64	1,32	780,76	1473,57	10,23	10,48	4,37	485,00

24	Kjellingelva	7,81	0,00	0,32	0,00	0,00	45,04	0,00	6,54	8,02	-0,13	720,61	1314,44	10,25	10,13	3,27	252,32
25	Kjerrslettelva	0,47	0,00	0,00	0,00	0,00	98,93	0,00	-999,	6,26	-3,15	758,99	1327,05	8,62	8,52	0,77	92,50
26	Krutåga	9,76	0,00	12,63	0,00	0,88	60,89	0,00	6,75	5,81	-6,99	294,30	434,77	8,46	8,55	-1,66	436,71
27	Kvernhuselva	4,22	0,00	24,21	0,00	0,80	59,81	0,00	3,90	8,50	1,37	1248,15	2399,13	10,10	10,37	4,34	172,01
28	Laupen	8,82	0,00	0,00	0,00	0,00	91,12	0,00	2,32	6,83	-2,46	649,28	1193,84	9,17	9,04	1,41	202,00
29	Lille Gråttåga	4,49	30,17	0,60	0,00	0,00	64,62	0,00	1,39	4,84	-4,41	495,28	917,91	7,26	7,58	-0,56	626,18
30	Lånivatn	11,59	0,00	3,75	0,00	0,16	74,55	0,00	8,49	6,16	-5,81	274,56	369,67	9,54	8,62	-0,82	306,00
31	Norddalselva	0,45	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,76	3,89	791,30	1362,82	13,31	13,56	7,17	0,00
32	Nordåna	9,54	0,00	5,13	0,00	0,45	57,76	0,00	2,72	8,01	-0,05	712,42	1358,62	9,62	10,15	3,31	321,00
33	Osaelva	7,15	0,00	36,32	0,67	5,72	40,76	0,01	2,44	9,72	0,60	586,27	1126,68	11,46	11,54	4,40	245,00
34	Ovre Forsland	3,77	0,00	0,26	0,00	0,05	92,75	0,00	0,73	6,69	-2,98	731,66	1300,42	9,05	8,93	1,05	427,63
35	Reinåga	6,14	0,00	0,00	0,00	0,45	93,42	0,00	4,89	5,61	-5,13	582,15	1178,07	8,12	8,17	-0,66	154,79
36	Råna øvre	4,74	0,00	19,85	0,00	12,68	57,48	0,00	1,06	7,50	-2,66	414,94	522,63	9,47	9,99	1,57	292,02
37	Råna nedre	4,75	0,00	21,28	0,00	13,09	55,72	0,00	1,00	7,56	-2,62	414,94	521,32	9,53	10,05	1,62	357,02
38	Salhuselva	3,09	0,00	25,82	0,00	1,91	47,03	0,00	1,17	7,27	-2,86	493,68	959,54	10,04	9,51	1,36	460,83
39	Sandslielva	0,15	0,00	43,52	0,00	11,60	43,98	0,00	0,01	8,83	-1,17	422,42	871,59	10,81	10,68	3,00	463,88
40	Savjords-Savåga	0,11	0,00	95,74	0,00	4,29	0,00	0,00	0,00	7,36	-3,65	446,46	852,86	9,90	9,92	0,94	147,51
41	Selforssagåga	4,58	0,00	22,80	0,00	1,86	67,73	0,00	1,14	6,63	-3,60	462,90	890,28	9,15	9,14	0,66	277,60
42	Skorgeelva	2,60	0,00	31,68	0,00	5,24	58,01	0,00	0,36	7,67	0,86	564,15	1074,73	9,12	9,54	3,70	700,99
43	Skorovasselva	3,01	0,00	20,64	0,19	5,89	55,83	0,02	0,49	7,29	-4,67	413,72	646,50	9,73	9,85	0,31	296,23
44	Snøskar	0,00	9,63	0,00	0,00	0,00	90,38	0,00	0,00	5,02	-4,59	502,43	871,55	7,79	7,74	-0,59	137,46
45	Storfjelltjønna	5,56	3,47	0,00	0,00	0,00	90,86	0,00	1,83	6,06	-3,14	863,88	1619,60	8,30	8,46	0,69	159,66
46	Storrapet-Frostisen	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
47	Sørelva	5,57	0,00	0,00	0,00	0,00	94,46	0,00	1,14	5,94	-3,30	751,41	1322,46	8,31	8,22	0,55	334,00
48	Tangvella	2,48	0,00	25,86	0,00	30,36	27,05	0,00	0,28	8,07	-2,52	454,02	591,20	10,03	10,30	1,89	458,68
49	Tindaaga	3,59	2,34	0,94	0,00	0,00	85,67	0,00	3,25	6,13	-1,66	717,01	1214,33	8,44	8,41	1,59	373,34
50	Toven 1	16,13	0,00	0,00	0,00	0,00	83,85	0,00	10,90	6,06	-3,41	747,94	1324,02	8,46	8,34	0,54	13,00

51	Toven 2	0,47	0,00	0,00	0,00	0,00	98,93	0,00	-999,	6,26	-3,15	758,99	1327,05	8,62	8,52	0,77	92,50
52	Trøkna	1,89	0,00	10,55	0,15	6,92	68,24	0,00	0,13	7,21	-2,63	527,25	955,34	9,06	9,52	1,47	652,50
53	Tungelva	11,79	0,00	0,00	0,00	0,03	88,16	0,00	7,88	6,10	-0,81	859,24	1611,65	7,76	8,01	2,07	323,62
54	Tunselva	1,17	0,00	38,57	0,62	11,07	47,25	0,00	0,17	9,51	-0,58	451,44	891,34	11,48	11,33	3,62	316,61
55	Tverråga	4,21	2,30	7,69	0,00	0,22	63,54	0,00	0,48	6,87	-3,07	851,58	1594,22	9,14	9,25	1,07	629,00
56	Tvinna	1,38	0,00	19,79	0,00	10,06	50,81	0,00	0,30	7,25	-0,52	512,01	979,84	9,11	9,03	2,72	403,07
58	Usma	1,85	0,00	27,50	0,00	15,30	50,93	0,00	0,22	7,13	-3,27	409,65	518,47	9,10	9,71	1,06	469,03
59	Usma Økendal	3,28	0,65	3,71	0,00	0,20	91,98	0,00	0,34	4,89	-2,05	473,63	887,94	6,22	7,25	0,84	901,39
60	Vassdalselva	4,08	0,00	7,47	0,09	4,82	54,01	0,00	1,14	8,00	-0,62	638,28	1208,80	9,82	10,00	2,97	495,34
61	Vesterskarelva Øvre	0,47	29,55	0,00	0,00	0,00	70,05	0,00	0,14	4,53	-4,61	511,70	893,23	7,27	7,18	-0,80	431,00
62	Fagervollvatn	9,58	7,32	0,00	0,00	0,00	83,04	0,00	8,93	6,98	-2,33	935,88	1574,84	9,34	9,15	1,55	338,00
63	Åfjord	12,45	0,00	32,44	0,00	4,17	50,96	0,00	9,98	9,80	0,98	508,43	830,44	11,49	11,69	4,66	150,00
64	Erga	0,00	0,00	97,86	0,00	0,00	2,01	0,00	0,00	7,45	-1,92	273,30	474,86	8,89	10,25	1,98	331,86
65	Storelvi	9,80	1,00	1,21	0,00	0,24	87,19	0,00	3,72	6,09	-1,22	694,14	1330,13	8,02	7,80	1,83	826,00
66	Herand-Fodnasetvatnet	9,79	1,00	1,21	0,00	0,24	87,24	0,00	3,73	6,09	-1,22	694,12	1330,09	8,02	7,80	1,83	826,00
67	Stolaelva	7,14	0,00	2,80	0,00	0,00	89,42	0,00	1,55	6,72	-0,99	950,21	1772,87	8,50	8,50	2,22	1010,00
68	Øyseteelva	5,34	0,00	24,03	0,29	0,87	66,79	0,00	3,08	7,84	-0,66	946,65	1764,65	9,79	9,64	2,88	854,13
69	Malmedalselva	2,21	0,00	44,00	3,37	15,44	20,26	0,00	0,20	9,09	1,58	759,65	1446,05	10,60	10,98	4,71	586,93
70	Roggejavri	4,42	0,00	0,00	0,00	0,00	97,22	0,00	0,00	6,44	-3,94	507,06	995,43	9,28	8,89	0,39	0,00
71	Musken	10,36	0,00	4,96	0,00	0,05	82,98	0,00	3,37	6,92	-3,14	498,19	952,85	9,71	9,21	1,05	430,70
72	Femtevasselva	11,40	0,69	26,39	0,00	2,31	54,91	0,00	5,72	6,94	-3,55	499,95	989,40	9,78	9,32	0,82	919,78
73	Gjerdalen	0,27	0,00	37,20	0,00	0,27	42,85	0,00	0,00	7,52	-3,78	501,71	1009,93	10,41	9,98	0,93	124,80
74	Tennvatnet	9,85	0,00	5,99	0,00	0,08	66,09	0,00	5,54	7,57	-2,65	498,93	965,18	10,32	9,80	1,61	215,14
75	Leirbuktelva	5,45	0,00	4,82	0,00	0,00	67,69	0,00	1,62	6,09	-3,49	319,32	627,94	9,28	8,40	0,50	117,18
76	Rasteelva	0,71	0,00	2,46	0,00	0,00	71,19	0,00	0,33	4,21	-4,70	332,56	662,34	7,38	6,59	-0,99	12,00

77	Markenesdalen	0,01	0,01	7,22	0,00	0,03	79,59	0,00	0,00	4,96	-5,75	321,18	541,09	8,28	7,37	-1,29	256,85
78	Moråga	8,61	0,00	3,59	0,00	1,12	86,35	0,00	2,28	6,11	-4,28	474,47	907,38	8,67	8,67	0,05	459,24
79	Savåga	4,22	0,00	28,80	0,00	1,98	62,23	0,00	0,96	6,72	-3,58	461,36	887,07	9,24	9,23	0,71	352,18
80	Eiteråga	2,37	15,55	10,95	0,00	0,28	69,47	0,00	0,33	5,68	-3,77	492,08	917,85	8,10	8,32	0,17	736,72
81	Bordalselv	2,40	0,00	19,75	0,52	0,30	54,25	0,00	0,19	6,99	-1,81	845,19	1626,77	8,76	9,61	1,86	843,00
82	Kverhusbekken	6,27	0,00	6,40	0,00	0,00	80,34	0,00	1,76	6,94	-1,80	918,66	1763,56	8,70	9,48	1,84	648,00
83	Skromme	2,52	0,00	18,38	0,54	0,26	57,15	0,00	0,22	6,92	-1,86	840,45	1618,21	8,70	9,55	1,80	767,00
84	Grøno	5,92	0,57	0,32	0,00	0,43	92,34	0,00	0,67	3,91	-5,83	595,58	1028,21	5,88	7,04	-1,77	670,23
85	Holddøla	3,31	5,28	0,38	0,00	0,01	90,69	0,00	0,26	3,46	-4,27	609,57	1092,99	5,25	6,68	-1,05	707,00
86	Middal	3,79	2,51	1,64	0,00	0,10	91,34	0,00	0,15	3,41	-6,17	555,20	921,22	5,38	6,61	-2,18	672,71
87	Strandåna	3,43	0,00	0,00	0,00	0,00	96,53	0,00	1,05	3,54	-4,68	611,41	1057,98	5,37	6,76	-1,26	291,01

Appendix F: Enlarged topographic and climatic parameters of all SWECO stations (contin. 3)

No.	Stasjonsnavn	CLF	Q95	Q95WINTER	Q95SUMMER	BFI	ELVENAVN
1	Amunddal	3,02	3,31	2,94	4,74	0,37	ARNVIKELVA
2	Aurstadelva	4,01	3,65	3,62	22,13	0,43	AURSTADELVA
3	Berge	5,58	4,96	5,25	54,49	0,45	BJASTADELVI
4	Bjåstad	0,00	0,00	0,00	0,00	0,00	BJASTADELVI
5	Breidalselva	13,52	11,13	9,60	7,44	0,33	TVERRAGA
6	Breivikelva	0,37	0,36	0,16	13,17	0,44	KYSTFELT
7	Dalaåna	4,03	4,37	4,02	4,96	0,31	DALAANA
8	Eidåa	1,70	1,75	1,46	3,80	0,38	TRIVJA
9	Fjerdingelva	2,59	2,65	2,28	8,23	0,42	FJERDINGELVA
10	Forsland	3,69	4,08	3,21	12,57	0,34	FORSLANDSELVA
11	Geiranger 1	0,00	0,00	0,00	0,00	0,00	GEIRANGELVA
12	Geiranger 2	0,00	0,00	0,00	0,00	0,00	GEIRANGELVA
13	Grytbogelva	3,96	4,00	3,10	5,33	0,34	SØRROKTA
14	Grytneselva	0,00	0,00	0,00	0,00	0,00	KYSTFELT
15	Grøndalselva	2,78	2,84	2,28	6,22	0,36	GRØNDALSELVA
16	Hansfinnsvatn	0,00	0,00	0,00	0,00	0,00	LEIRELVA
17	Hanskijohka	0,00	0,00	0,00	0,00	0,00	KAFJORDVASSDRAGET
18	Hestedalselva	7,79	7,87	16,32	4,52	0,61	KYSTFELT
19	Heståga	8,15	6,84	5,19	11,59	0,51	BEIARELVA
20	Instefjord	0,00	0,00	0,00	0,00	0,00	KYSTFELT
21	Jordalselvi	0,00	0,00	0,00	0,00	0,00	JORDDALSELVI
22	Kanndalen	0,00	0,00	0,00	0,00	0,00	KVANNDALSELVA

23	Kasseelva	0,00	0,00	0,00	0,00	0,00	GUSDALELVA
24	Kjellingelva	0,00	0,00	0,00	0,00	0,00	TVERRAGA
25	Kjerrslettelva	0,00	0,00	0,00	0,00	0,00	KALDAGA
26	Krutåga	0,00	0,00	0,00	0,00	0,00	KRUTAGA
27	Kvernhuselva	0,00	0,00	0,00	0,00	0,00	FJORDSELVA
28	Laupen	12,92	10,49	8,93	5,85	0,17	SAGELVA
29	Lille Gråttåga	0,00	0,00	0,00	0,00	0,00	LILLE GRATAGA
30	Lånivatn	4,87	4,64	3,94	3,26	0,61	REISAVASSDRAGET
31	Norddalselva	7,79	7,87	16,32	4,52	0,61	KYSTFELT
32	Nordåna	6,94	8,12	7,52	7,15	0,33	DALAANA
33	Osaelva	3,73	4,15	3,78	5,56	0,39	
34	Ovre Forsland	0,00	0,00	0,00	0,00	0,00	FORSLANDSELVA
35	Reinåga	2,14	2,29	1,84	4,64	0,35	RØSSAGA
36	Råna øvre	0,00	0,00	0,00	0,00	0,00	RANA
37	Råna nedre	1,74	1,80	1,56	4,24	0,41	RANA
38	Salhuselva	0,00	0,00	0,00	0,00	0,00	ELV FRA HOPVATNET
39	Sandslielva	3,68	3,92	3,21	3,72	0,33	SANDSLIELVA
40	Savjords-Savåga	0,09	0,08	0,07	0,04	0,12	BEIARELVA
41	Selforssagåga	9,01	7,55	6,36	7,11	0,54	BEIARELVA
42	Skorgeelva	0,00	0,00	0,00	0,00	0,00	SKORGEELVA
43	Skorovasselva	1,91	1,94	1,66	5,33	0,38	SKOROVASSELVA
44	Snøskar	0,00	0,00	0,00	0,00	0,00	STORELVA
45	Storfjelltjønna	3,57	4,00	3,18	16,05	0,33	STORELVA
46	Storrapet-Frostisen	0,00	0,00	0,00	0,00	0,00	
47	Sørelva	0,00	0,00	0,00	0,00	0,00	LEIRELVA
48	Tangvella	1,59	1,62	1,40	3,34	0,39	TANGVELLA

49	Tindaaga	0,00	0,00	0,00	0,00	0,00	KYSTFELT
50	Toven 1	0,00	0,00	0,00	0,00	0,00	KALDAGA
51	Toven 2	0,00	0,00	0,00	0,00	0,00	KALDAGA
52	Trøkna	3,20	3,42	2,62	6,38	0,35	TRØKNA
53	Tungelva	0,00	0,00	0,00	0,00	0,00	TUNGEELVA
54	Tunselva	2,43	2,60	2,29	3,24	0,35	TUNSELVA
55	Tverråga	7,52	8,11	5,73	19,07	0,38	ELV FRA GODVASSDALEN
56	Tvinna	2,89	3,13	2,26	6,65	0,35	TVINNA
58	Usma	0,00	0,00	0,00	0,00	0,00	USKA
59	Usma Økendal	7,55	8,25	5,63	17,69	0,43	USMA
60	Vassdalselva	3,23	3,59	2,83	6,36	0,36	BØVRA
61	Vesterskarelva	0,00	0,00	0,00	0,00	0,00	STORELVA
62	Øvre Fagervollvatn	0,00	0,00	0,00	0,00	0,00	HOLMELVA
63	Åfjord	0,00	0,00	0,00	0,00	0,00	KROKELVA
64	Erga	0,00	0,00	0,00	0,00	0,00	DRIVA
65	Storelvi	0,00	0,00	0,00	0,00	0,00	STORELVI
66	Herand-Fodnasetvatnet	0,00	0,00	0,00	0,00	0,00	STORELVI
67	Stolaelva	0,00	0,00	0,00	0,00	0,00	EIDESELVA
68	Øyseteelva	0,00	0,00	0,00	0,00	0,00	ØYSTESEELVI
69	Malmedalselva	0,00	0,00	0,00	0,00	0,00	MALMEELVA
70	Roggejavri	0,00	0,00	0,00	0,00	0,00	HEIDDEJÅKKA
71	Musken	0,00	0,00	0,00	0,00	0,00	RUOSSAJOHKA
72	Femtevasselva	0,00	0,00	0,00	0,00	0,00	SAGELVVASSDRAGET
73	Gjerdalen	0,00	0,00	0,00	0,00	0,00	KOBBELVVASSDRAGET
74	Tennvatnet	0,00	0,00	0,00	0,00	0,00	KYSTFELT

75	Leirbuktelva	0,00	0,00	0,00	0,00	0,00	KYSTFELT
76	Rasteelva	0,00	0,00	0,00	0,00	0,00	KYSTFELT
77	Markenesdalen	0,00	0,00	0,00	0,00	0,00	TØMMERELVA
78	Moråga	0,00	0,00	0,00	0,00	0,00	BEIARELVA
79	Savåga	0,00	0,00	0,00	0,00	0,00	BEIARELVA
80	Eiteråga	0,00	0,00	0,00	0,00	0,00	EITERÅGA
81	Bordalselv	0,00	0,00	0,00	0,00	0,00	DALELVA
82	Kverhusbekken	0,00	0,00	0,00	0,00	0,00	DALELVA
83	Skromme	0,00	0,00	0,00	0,00	0,00	DALELVA
84	Grøno	0,00	0,00	0,00	0,00	0,00	SULDALSVASSDRAGET
85	Holddøla	0,00	0,00	0,00	0,00	0,00	SULDALSVASSDRAGET
86	Middal	0,00	0,00	0,00	0,00	0,00	MIDDALSELVA
87	Strandåna	0,00	0,00	0,00	0,00	0,00	SULDALSVASSDRAGET

Appendix F: Enlarged topographic and climatic parameters of all SWECO stations (contin. 4)

No.	Stasjonsnavn	KOMMNR	KOMMNAVN	FYLKENAVN	SHAPE_AREA (m2)	SHAPE_LEN (m2)
1	Amunddal	1630	Åfjord	Sør-Trøndelag	81253648,6	51212,5
2	Aurstadelva	1519	Volda	Møre og Romsdal	5258806,7	11037,9
3	Berge	1420	Sogndal	Sogn og Fjordane	12055998,6	15164,6
4	Bjåstad	1420	Sogndal	Sogn og Fjordane	8740879,0	14490,6
5	Breidalselva	1838	Gildeskål	Nordland	4796368,7	15064,6
6	Breivikelva	1838	Gildeskål	Nordland	5631389,8	11746,3
7	Dalaåna	1129	Forsand	Rogaland	16920662,1	23787,1
8	Eidåa	1636	Meldal	Sør-Trøndelag	17309290,1	20570,5
9	Fjerdingelva	1742	Grong	Nord-Trøndelag	53367852,5	33348,7
10	Forsland	1822	Leirfjord	Nordland	36259143,4	35228,9
11	Geiranger 1	1525	Stranda	Møre og Romsdal	84107488,0	47249,9
12	Geiranger 2	1525	Stranda	Møre og Romsdal	84121359,5	47246,1
13	Grytbogelva	1702	Steinkjer	Nord-Trøndelag	653959,3	3396,5
14	Grytneselva	1543	Nesset	Møre og Romsdal	5403044,5	10272,8
15	Grøndalselva	1740	Namsskogan	Nord-Trøndelag	46811217,4	37726,2
16	Hansfinnsvatn	1822	Leirfjord	Nordland	5607538,4	14204,7
17	Hanskijohka	1940	Kåfjord	Troms	10081930,8	15640,5
18	Hestedalselva	1411	Gulen	Sogn og Fjordane	137689,6	1770,7
19	Heståga	1839	Beiarn	Nordland	5281608,5	14158,2
20	Instefjord	1613	Snillfjord	Sør-Trøndelag	8119090,0	14080,1
21	Jordalselvi	1420	Sogndal	Sogn og Fjordane	21108519,6	24763,8
22	Kanndalen	1543	Nesset	Møre og Romsdal	23168330,0	20662,7

23	Kasseelva	1511	Vanylven	Møre og Romsdal	6584427,8	14762,7
24	Kjellingelva	1838	Gildeskål	Nordland	2553036,5	13438,2
25	Kjerrslettelva	1824	Vefsn	Nordland	267243,7	2050,4
26	Krutåga	1826	Hattfjelldal	Nordland	173632232,5	77411,7
27	Kvernhuselva	1411	Gulen	Sogn og Fjordane	4388172,0	9894,5
28	Laupen	1833	Rana	Nordland	9803168,1	15522,3
29	Lille Gråttåga	1839	Beiarn	Nordland	6197025,5	13073,7
30	Lånivatn	1942	Nordreisa	Troms	8500689,3	12959,8
31	Norddalselva	1411	Gulen	Sogn og Fjordane	137689,6	1770,7
32	Nordåna	1129	Forsand	Rogaland	10017177,8	15831,7
33	Osaelva					
34	Ovre Forsland	1822	Leirfjord	Nordland	36260227,1	35281,8
35	Reinåga	1832	Hemnes	Nordland	4283889,1	9616,1
36	Råna øvre	1664	Selbu	Sør-Trøndelag	18634712,5	24953,8
37	Råna nedre	1664	Selbu	Sør-Trøndelag	19224958,0	26228,6
38	Salhuselva	1848	Steigen	Nordland	16483450,8	18623,7
39	Sandslielva	1724	Verran	Nord-Trøndelag	8286336,2	14004,6
40	Savjords-Savåga	1839	Beiarn	Nordland	553590,4	3512,2
41	Selforssagåga	1839	Beiarn	Nordland	24048064,6	24949,4
42	Skorgeelva	1539	Rauma	Møre og Romsdal	42275657,1	35782,7
43	Skorovasselva	1740	Namsskogan	Nord-Trøndelag	45951097,6	35220,3
44	Snøskar	1805	Narvik	Nordland	4428050,8	8750,6
45	Storfjelltjønna	1813	Brønnøy	Nordland	9670534,8	20832,7
46	Storrapet-Frostisen				68702,6	1274,7
47	Sørelva	1822	Leirfjord	Nordland	4432241,3	10157,9
48	Tangvella	1664	Selbu	Sør-Trøndelag	33903868,3	36518,7

49	Tindaaga	1838	Gildeskål	Nordland	3341959,8	8271,1
50	Toven 1	1824	Vefsn	Nordland	1472103,2	5708,2
51	Toven 2	1824	Vefsn	Nordland	267243,7	2050,4
52	Trøkna	1567	Rindal	Møre og Romsdal	8586481,1	17514,2
53	Tungelva	1519	Volda	Møre og Romsdal	5817303,1	10474,1
54	Tunselva	1724	Verran	Nord-Trøndelag	16024405,2	21208,4
55	Tverråga	1813	Brønnøy	Nordland	28393861,0	26303,8
56	Tvinna	1449	Stryn	Sogn og Fjordane	15493087,0	18688,0
58	Usma	1664	Selbu	Sør-Trøndelag	69650685,1	40881,5
59	Usma Økendal	1563	Sunndal	Møre og Romsdal	40776717,4	34270,0
60	Vassdalselva	1566	Surnadal	Møre og Romsdal	15897745,2	17612,2
61	Vesterskarelva	1805	Narvik	Nordland	6004630,7	14084,0
62	Øvre Fagervollvatn	1833	Rana	Nordland	9872400,6	16793,4
63	Åfjord	1630	Afjord	Sør-Trøndelag	10476018,9	14352,9
64	Erga	1563	Sunndal	Møre og Romsdal	93249,8	1865,4
65	Storelvi	1227	Jondal	Hordaland	43553044,3	35204,9
66	Herand-Fodnasetvatnet	1227	Jondal	Hordaland	43529967,8	35182,9
67	Stolaelva	1241	Fusa	Hordaland	7435447,8	14016,3
68	Øyseteelva	1238	Kvam	Hordaland	39290878,2	32097,0
69	Malmedalselva	1548	Frµna	Møre og Romsdal	29693600,0	32718,4
70	Roggejavri	1850	Tysfjord	Nordland	14143,9	556,1
71	Musken	1850	Tysfjord	Nordland	15514771,9	16919,5
72	Femtevasselva	1849	Hamarøy	Nordland	83461057,0	61074,4
73	Gjerdalen	1845	Sørfold	Nordland	1149299,1	4657,3
74	Tennvatnet	1849	Hamarøy	Nordland	6553426,2	13310,4

75	Leirbuktelva	1902	Tromsø	Troms	6611681,1	14575,7
76	Rasteelva	1902	Tromsø	Troms	5074183,1	9171,1
77	Markenesdalen	1933	Balsfjord	Troms	9539812,5	12807,0
78	Moråga	1839	Beiarn	Nordland	10476697,6	22758,2
79	Savåga	1839	Beiarn	Nordland	26165342,5	25909,7
80	Eiteråga	1839	Beiarn	Nordland	39294287,6	27898,3
81	Bordalselv	1211	Etne	Hordaland	45170144,5	37490,9
82	Kverhusbekken	1211	Etne	Hordaland	5320425,9	11945,7
83	Skromme	1211	Etne	Hordaland	42522533,9	35728,2
84	Grøno	1228	Odda	Hordaland	66323778,1	54465,9
85	Holddøla	1228	Odda	Hordaland	19912673,8	23261,4
86	Middal	1228	Odda	Hordaland	46104475,8	41047,8
87	Strandåna	1228	Odda	Hordaland	4096522,6	8458,9