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Council for Development and Reconstruction
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FEDERAL REPUBLIC OF GERMANY
Federal Institute for Geosciences and Natural Resources
BGR
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TECHNICAL COOPERATION

PROJECT NO.: 2008.2162.9

Protection of Jeita Spring

SPECIAL REPORT NO. 18

Meteorological Stations installed by the Project

Raifoun
October 2013

Special Report No. 18: Meteorological Stations installed by the Project

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List of Abbreviations

asl	Above mean sea level
BMZ	German Ministry of Economic Cooperation and Development
CDR	Council for Development and Reconstruction
COP	Method for groundwater vulnerability mapping developed by the European Union project COST 620
DEM	Digital elevation model
DST	Dead Sea Transform Fault
EPIK	Method for groundwater vulnerability mapping developed by SAEFL
FC	Financial cooperation
GW	groundwater
KfW	German Bank for Reconstruction and Development
LGM	Last Glacial Maximum
LRA	Litani River Authority
MAPAS	Company operating Jeita Grotto
MoEW	Ministry of Energy and Water
MY	Million years
SAEFL	Swiss Agency for the Environment, Forestry and Landscape
TC	Technical cooperation
UTM	Universal Transverse Mercator
WEBML	Water Establishment Beirut and Mount Lebanon
WP	Waypoint
WS	Weather Station

Acknowledgements

In its effort to protect the water resources in the Nahr el Kalb catchment, the project *Protection of Jeita Spring* experienced great support not only at the political and institutional level but also from many municipalities and people in the catchment area.

We are especially grateful for the backing and support of the Council for Development and Reconstruction (CDR), namely its president, Nabil El Jisr, Dr. Wafaa Charafeddine (Funding Division Director) and Eng. Ismail Makki (Manager Projects Division), the Ministry of Energy and Water (MoEW), namely H.E. Gebran Bassil and his staff, the Water Establishment Beirut and Mount Lebanon (WEBML), namely its president, Joseph Nseir, as well as George el Kadi (Projects Manager), and Maher Chrabieh (Director of the Dbaye treatment plant).

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Many mayors and staff of municipalities in the catchment saw the opportunities which the project hopes to provide in the near future as a chance for development. Among those which very actively assisted the project we would like to highlight the municipalities of Ballouneh (Dr. Pierre Mouzawak, Simon Daou, Tony Daou) and Jeita (Samir Baroud).

The hydrogeological investigations are conducted together with the University of Goettingen, Department of Applied Geology. Joanna Doummar, as a PhD student at University of Goettingen cooperates closely with the project. The project is very much indebted to her for her tireless support and significant input. Prof. Martin Sauter and Dr. Tobias Geyer, her supervisors, provided valuable advice for our work.

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List of Reports prepared by the Technical Cooperation Project Protection of Jeita Spring

Report No.	Title	Date Completed
Technical Reports		
1	Site Selection for Wastewater Facilities in the Nahr el Kalb Catchment – General Recommendations from the Perspective of Groundwater Resources Protection	January 2011
2	Best Management Practice Guideline for Wastewater Facilities in Karstic Areas of Lebanon – with special respect to the protection of ground- and surface waters	March 2011
3	Guideline for Environmental Impact Assessments for Wastewater Facilities in Lebanon – Recommendations from the Perspective of Groundwater Resources Protection	November 2011
4	Geological Map, Tectonics and Karstification in the Groundwater Contribution Zone of Jeita Spring	September 2011
5	Hydrogeology of the Groundwater Contribution Zone of Jeita Spring	July 2013
6	Water Balance for the Groundwater Contribution Zone of Jeita Spring using WEAP including Water Resources Management Options and Scenarios	August 2013
7	Groundwater Vulnerability Mapping in the Jeita Spring Catchment and Delineation of Groundwater Protection Zones using the COP Method	February 2013
7b	Vulnerability Mapping using the COP and EPIK Methods	October 2012
Special Reports		
1	Artificial Tracer Tests 1 - April 2010*	July 2010
2	Artificial Tracer Tests 2 - August 2010*	November 2010
3	Practice Guide for Tracer Tests	Version 1 January 2011
4	Proposed National Standard for Treated Domestic Wastewater Reuse for Irrigation	July 2011
5	Artificial Tracer Tests 4B - May 2011*	September 2011
6	Artificial Tracer Tests 5A - June 2011*	September 2011

Report No.	Title	Date Completed
7	Mapping of Surface Karst Features in the Jeita Spring Catchment	October 2011
8	Monitoring of Spring Discharge and Surface Water Runoff in the Groundwater Contribution Zone of Jeita Spring	May 2013
9	Soil Survey in the Groundwater Contribution Zone of Jeita Spring	First Draft November 2011
10	Mapping of the Irrigation System in the Jeita Catchment	First Draft November 2011
11	Artificial Tracer Tests 5C - September 2011*	February 2012
12	Stable Isotope Investigations in the Groundwater Contribution Zone of Jeita Spring	October 2013
13	Micropollutant Investigations in the Groundwater Contribution Zone of Jeita Spring*	May 2012
14	Environmental Risk Assessment of the Fuel Stations in the Jeita Spring Catchment - Guidelines from the Perspective of Groundwater Resources Protection	June 2012
15	Analysis of Helium/Tritium, CFC and SF6 Tracers in the Jeita Groundwater Catchment*	June 2013
16	Hazards to Groundwater and Assessment of Pollution Risk in the Jeita Spring Catchment	October 2013
17	Artificial Tracer Tests 4C - May 2012*	October 2013
18	Meteorological Stations installed by the Project	October 2013
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1	Quantification of Infiltration into the Lower Aquifer (J4) in the Upper Nahr Ibrahim Valley	May 2012
1 - 1	Addendum No. 1 to Main Report [Quantification of Infiltration into the	June 2012

Report No.	Title	Date Completed
	Lower Aquifer (J4) in the Upper Nahr Ibrahim Valley]	
2	Locating the Source of the Turbidity Peaks Occurring in April - June 2012 in the Dbayeh Drinking Water Treatment Plant	June 2012
3	Locating the Pollution Source of Kashkoush Spring	September 2012
4	Preliminary Assessment of Jeita Cave Stability	April 2013
5	Preliminary Assessment of the Most Critical Groundwater Hazards for Jeita Spring	June 2013
6	Handover of Water Resources Monitoring Equipment and Stations Installed by the BGR Project	November 2013
7	Environmental Impact Assessments for the JSPP Wastewater Treatment Plant and Wastewater Collector (BGR Contributions)	September 2013
Reports with KfW Development Bank (jointly prepared and submitted to CDR)		
1	Jeita Spring Protection Project Phase I - Regional Sewage Plan	October 2011
2	Jeita Spring Protection Project - Feasibility Study - Rehabilitation of Transmission Channel Jeita Spring Intake – Dbaye WTP	May 2012
3	Jeita Spring Protection Project - Environmental Impact Assessment for the Proposed CDR/KfW Wastewater Scheme in the Lower Nahr el Kalb Catchment	October 2013

* prepared in cooperation with University of Goettingen

0 Executive Summary

Meteorological data are important for the establishment of a water balance. One of the aims of the Technical Cooperation (TC) Project Protection of Jeita Spring was to determine the amounts of water available in the Jeita groundwater catchment and proposed management options (Technical Reports No. 5: MARGANE et a., 2013 und No. 6: SCHULER & MARGANE, 2013; MUELLER & MARGANE, 2012). Because the distribution of existing meteorological stations was not adequate for this task, this required the establishment of new meteorological stations. A major shortcoming of the existing meteorological stations is that they are not equipped with heating systems so that measurements of precipitation are incorrect because snow is not measured. This renders all previous rainfall measurements as useless. Altogether 6 meteorological stations were purchased by the BGR project, of which 5 could be installed. All stations are heated. Currently stations are not equipped with telemetric data transfer systems because these do not yet work properly in Lebanon and data transmission would have been unreasonably costly. Meteorological data were collected on a monthly basis using SD cards.

Also 6 rainfall samplers were installed in the Jeita groundwater catchment for stable isotope analyses of rainfall (results explained in Technical Report No. 5: MARGANE et al., 2013, and Special Report No. 12: KOENIGER & MARGANE, 2013).

This report describes what type of stations where installed, where they were installed and how data can be obtained from these stations. The data obtained from the meteorological stations are presented.

1 Introduction

The German-Lebanese Technical Cooperation (TC) Project *Protection of Jeita Spring* is funded by a grant of the German Government (Ministry of Economic Cooperation and development, BMZ). Its aim is to "reduce important risks for the drinking water supply of Beirut through measures implemented in the Jeita catchment". On the German side, the project is implemented by the Federal Institute for Geosciences and Natural Resources (BGR). The project partners on the Lebanese side are the Council for Development and Reconstruction (CDR), the Ministry of Energy and Water (MoEW) and the Water Establishment Beirut Mount Lebanon (WEBML). Important components of the TC project are:

1. Integration of water resources protection aspects into the investment planning and implementation process in the wastewater sector;
2. Integration of water resources protection aspects into landuse planning and improved spring capture and water conveyance;
3. Establishment of a monitoring system;

4. Proposal for an improved Jeita spring capture and conveyance system to Dbayeh.

Jeita spring constitutes around 70 % of the water supply for the Greater Beirut Area has thus an immense importance. Because of the dependency on Jeita water, a major pollution event in the groundwater (GW) catchment of Jeita spring can impact heavily on the health of the population being served by Jeita water. Groundwater protection zones for Jeita spring and all other major springs in the groundwater catchment of Jeita spring were recently proposed by BGR (MARGANE & SCHULER, 2013).

The groundwater system in the Jeita spring catchment was comprehensively investigated (MARGANE, et al., 2013). The establishment of a water balance prepared by the BGR project (SCHULER & MARGANE, 2013) help to manage water resources properly in a catchment and base decisions for investments on sound information. The collection of meteorological data contributes to the establishment of a water balance. For this purpose meteorological stations were installed.

The project was funded through a grant of the German Government (BMZ). It started in July 2010 and ends in December 2013.

2 Scope of work

Among the scope of work of the project was the implementation of a water balance scheme for the Jeita Spring Groundwater catchment area. However, due to the absence of suitable climate data, and a very weak coverage of climate stations in the area, the project decided to install 5 climate stations (collecting temperature and precipitation data) and one full weather station, to cover the study area. The weather stations are distributed all over the area, representing the different altitudes (Table 1; Figure 1).

The previously collected meteorological data are discussed in MARGANE et al. (2013).

To identify the origin of the water sources feeding Jeita spring, stable isotope samples needed to be taken from all relevant springs and from rainfall at different elevations. Under the climatic conditions in the area a typical elevation dependent stable isotope signature can be expected. Based on the stable isotope composition of the springs, the average elevation of the groundwater catchment feeding the springs can then be calculated. This was done for Jeita, Kashkoush, Assal, Labbane, Rouaiss and Afqa springs. In the case of Jeita and Kashkoush springs, the stable isotope samples helped to determine that there is a large contribution to the spring discharges from higher elevations. In order to collect suitable stable isotope samples, not subjected to evaporation effects, the project installed rainfall collectors well distributed over the groundwater catchment at representative elevations (Table 2; Figure 2). The results of the stable isotope sampling are presented in Special Report No. 12 (KOENIGER & MARGANE, 2013) and Technical Report No. 5 (MARGANE et al., 2013).

The previously collected stable isotope data are discussed in MARGANE et al. (2013).

Table 1: Preexisting and New Meteorological Stations in and near the Groundwater Catchment of Jeita Spring

ID	Name	LAT	LONG	Altitude [m asl]	Institution	Year
	Kaslik university	33.982309°	35.618828°	40	NMS	
	Qartaba	34.095215°	35.852850°	1102	NMS	
	Hemlaya	33.938241°	35.706937°	790	NMS	
	Faqra Club	33.987469°	35.811718°	1690	NMS	
	Faraya	34.015412°	35.829295°	1555	USJ	
RS1	Aajaltoun AIS	33.95761°	35.67999°	821	BGR/CDR	2012
RS2	Baqeesh reservoir	33.949771°	35.788706°	1416	BGR/CDR	2012
RS3	Kfar Debbiane municipality	33.98113°	35.77111°	1307	BGR/CDR	2012
RS4	Shaile reservoir	33.955518°	35.653252°	463	BGR/CDR	2012
RS5	Chabrouh dam	34.025799°	35.834505°	1596	BGR/CDR	2012
WS1	Dome du Mzaar	33.965300°	35.840144°	2425	BGR/CDR	-

Table 2: Rainfall Samplers for Stable Isotope Data

ID	Name	LAT	LONG	Altitude [m asl]	Institution	Year
iA	Aajaltoun AIS	33.95761°	35.67999°	821	BGR/CDR	2012
iR	Raifoun BGR office	33.97662°	35.70658°	1036	BGR/CDR	2012
iK	Kfar Debbiane municipality	33.98113°	35.77111°	1307	BGR/CDR	2012
iS	Shaile reservoir	33.95552°	35.65333°	463	BGR/CDR	2012
iC	Chabrouh dam	34.02574°	35.83447°	1591	BGR/CDR	2012
iJ	Jeita restaurant	33.94311°	35.64445°	92	BGR/CDR	2012

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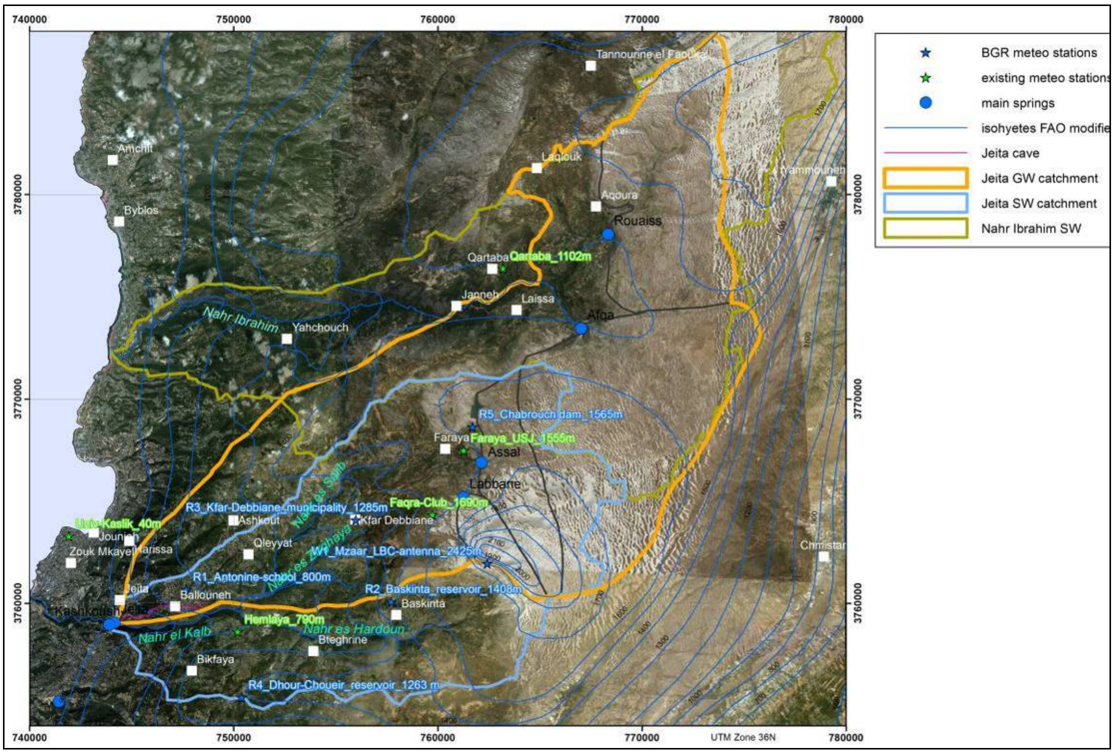


Figure 1: Preexisting and new meteorological stations installed by BGR in the Jeita groundwater catchment

Figure 2: Rainwater Sampling Sites for Stable Isotope Analyses in the Jeita Groundwater Catchment

3 Overview and location of the study area

Jeita spring is located northeast of Beirut, in Nahr el Kalb Valley. Nahr el Kalb River is the dividing line between the Metn district (to the south of the river) and the Kesrwan district (to the north of the river). Jeita spring, located 4 km upstream from the outlet of the river to the Mediterranean Sea is at an elevation of 60 m asl.

The main study area is shown in Figure 3. It is located between (UTM 36N):

N 3,754,000 – 3,778,000

E 742,000 – 777,000

The limits of the groundwater contribution zone of Jeita spring were determined using structural geological and hydrogeological information and tracer tests (Figure 3; MARGANE et al., 2013). The southern part of Nahr el Kalb Valley is not part of the Jeita catchment. Here geological dip is mostly towards south and tracer tests in this area were negative, i.e. no tracer from injections in this part arrived at Jeita. The groundwater catchment covers an area of 406 km² and encompasses the northern part of Nahr el Kalb valley, the mountain plateau between Mount Sannine and Afqa, the upper part of Nahr Ibrahim Valley, and extended areas north and west of the Jeita surface water catchment (Figure 3).

The rainfall distribution used in the Jeita study is presented in Figure 5. It was modified after UNDP & FAO (1973).

This area was studied for its karst features (ABI RIZK & MARGANE, 2011). The high karstification results in high groundwater recharge. According to MARGANE et al. (2013) groundwater recharge in the Upper Aquifer (Sannine Formation; C4) is estimated at 81% of precipitation, while groundwater recharge in the Lower Aquifer (Keserwan Formation; J4) is approx. 58%. A considerable proportion of surface water infiltrates into groundwater (~22-23 %). It is estimated that around 80 MCM (32 %) of Jeita spring discharge originate from riverbed infiltration, mainly from the C4.

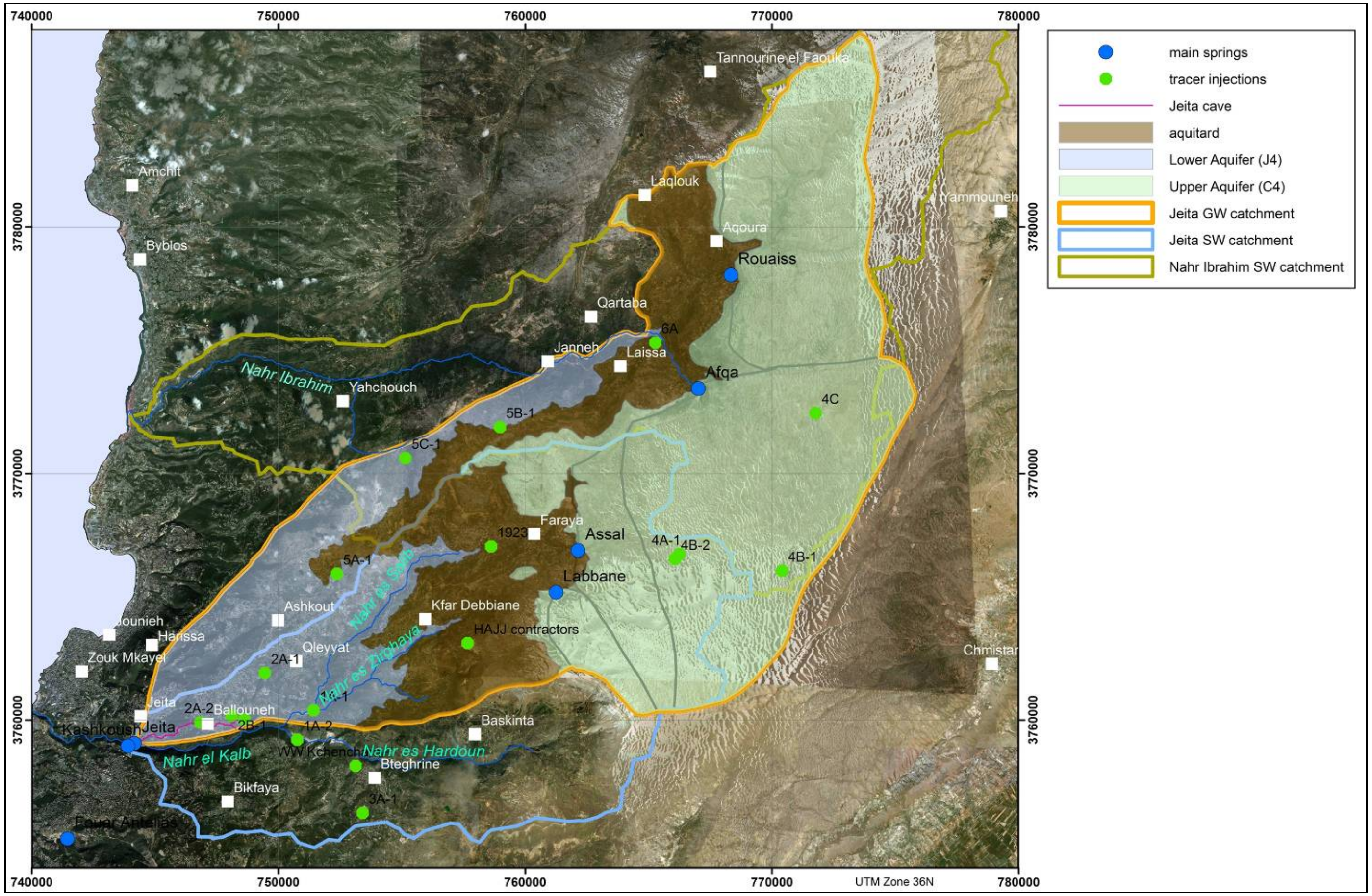


Figure 3: Subdivision of Groundwater System in Aquifer Units and Locations of Tracer Injections

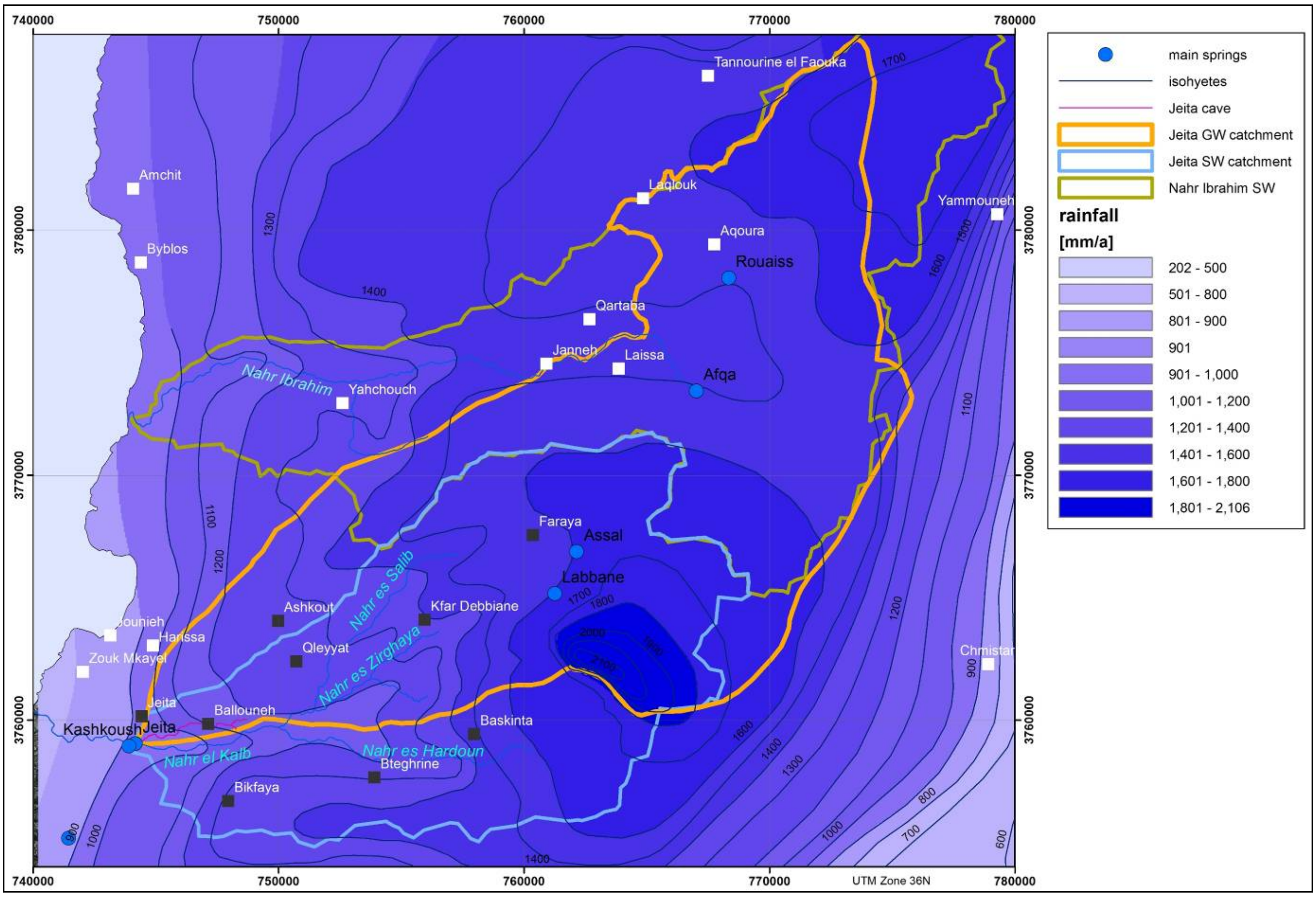


Figure 4: Spatial Distribution of Annual Precipitation
(modified after UNDP & FAO, 1973)

In terms of elevation, the study area ranges between 60 m asl (Jeita) and 2,628 m asl (Mount Sannine).

The topography of the study area can be divided into four main features:

- Narrow and deep valleys formed by extensive erosion over an extended time period in the massive and thick Jurassic limestone, generally following main faults; this feature mainly occurs in at lower to medium elevations (up to 1,000 m asl).
- Less inclined hilltops between those valleys; here villages have developed.
- At the top of J4, the massive Jurassic limestone, there are large areas where bare strongly karstified limestone rocks emerge, between soil filled depressions.

In the area exceeding 1,800 m asl a high plateau was formed with generally light inclinations; no surface drainage pattern has developed here and the plateau is scattered with thousands of depressions (dolines).

4 Methodology

4.1 *Site Selection for Climate Stations*

The selection of a Climate Station location must be based on scientific norms especially those of the World Meteorological Organization Standards (WMO, 2008) concerning the site dimensions and characteristic.

For WMO standards: the following considerations apply to the selection of the site and instrument exposure requirements for a typical synoptic or climatological station in a regional or national network:

(a) Outdoor instruments should be installed on a level piece of ground, preferably no smaller than 25 m x 25 m where there are many installations, but in cases where there are relatively few installations the area may be considerably smaller, for example, 10 m x 7 m (the enclosure). The ground should be covered with short grass or a surface representative of the locality, and surrounded by open fencing or palings to exclude unauthorized persons. In the case of the Jeita catchment barren grey limestones typically occur at outcrop.

(b) There should be no steeply sloping ground in the vicinity, and the site should not be in a topographic depression. If these conditions are not met, the observations may show peculiarities of entirely local significance;

(c) The site should be well away from trees, buildings, walls or other obstructions. The distance of any such obstacle (including fencing) from the raingauge should not be less than twice the height of the object above the rim of the gauge, and preferably four times the height;

(d) The sunshine recorder, raingauge and anemometer must be exposed according to their requirements, preferably on the same site as the other instruments;

For our sites we tried to implement all these conditions and some local conditions like having :

a) installations preferably on governmental land.
b) an electricity power source to insure the continuous operation of station and
c) an even geographical distribution over the study area.

Since most of our stations are collecting data only for rainfall and temperature we have selected from the WMO guide the concerning conditions.

The initial distribution (Figure 5) was based on the estimated groundwater catchment of Jeita Spring, assumed at the time the project started (similar to the surface water catchment of Nahr el Kalb; Figure 4). The below mentioned stations were previewed to be installed:

a) A full weather station including snow height radar close to the highest point of the study area.
   - W1: Dome du Mzaar
b) Five weather stations reading only precipitation and temperature, distributed over the study area
   - R1: in Ajaltoun on the roof of AIS (Antonine International School)
   - R2: in Baskinta Mar Sassin monastery
   - R3: in Kfardebian on the roof of the Municipality
   - R4: in Dhour Choueir on the WEBML reservoir
   - R5: in Chabrouh Dam facilities area

After following many tracer tests and mapping a detailed geological map for the area, the project finally delineated the groundwater catchment area of Jeita Spring in May 2012, proving that the GW catchment is entirely different from the surface catchment area of Nahr el Kalb. Since the weather stations are meant to collect data for the water balance of Jeita spring, some modification of the distribution had to be done (Figure 6) especially for the WS located outside the GW catchment area, like :

- R2 in Baskinta (moved to Bakish on the WEBML reservoir)
- R4 in Dhour Choueir (moved to the WEBML facility station in Shaile)

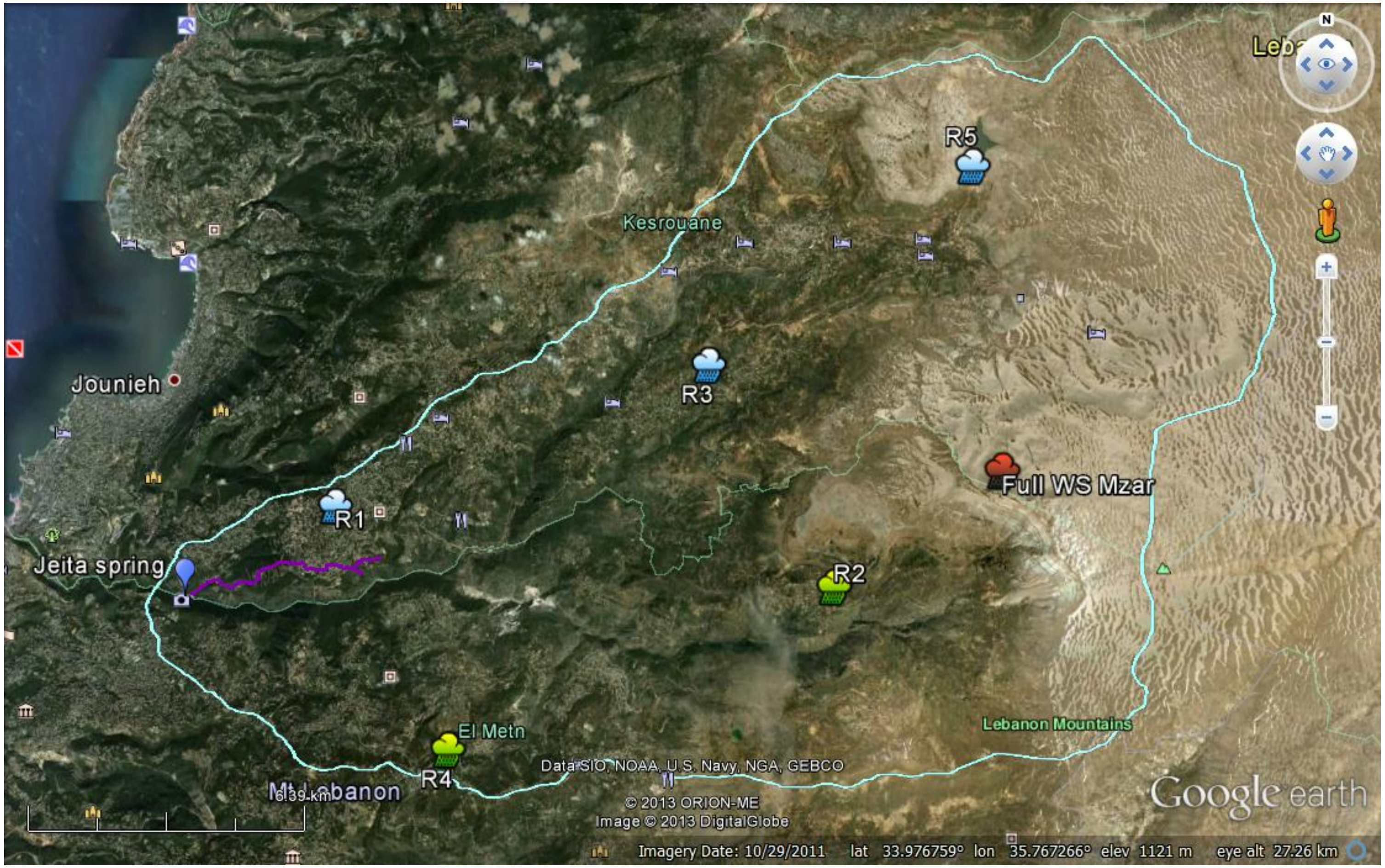


Figure 5: First Distribution of Climate Stations in the Study Area

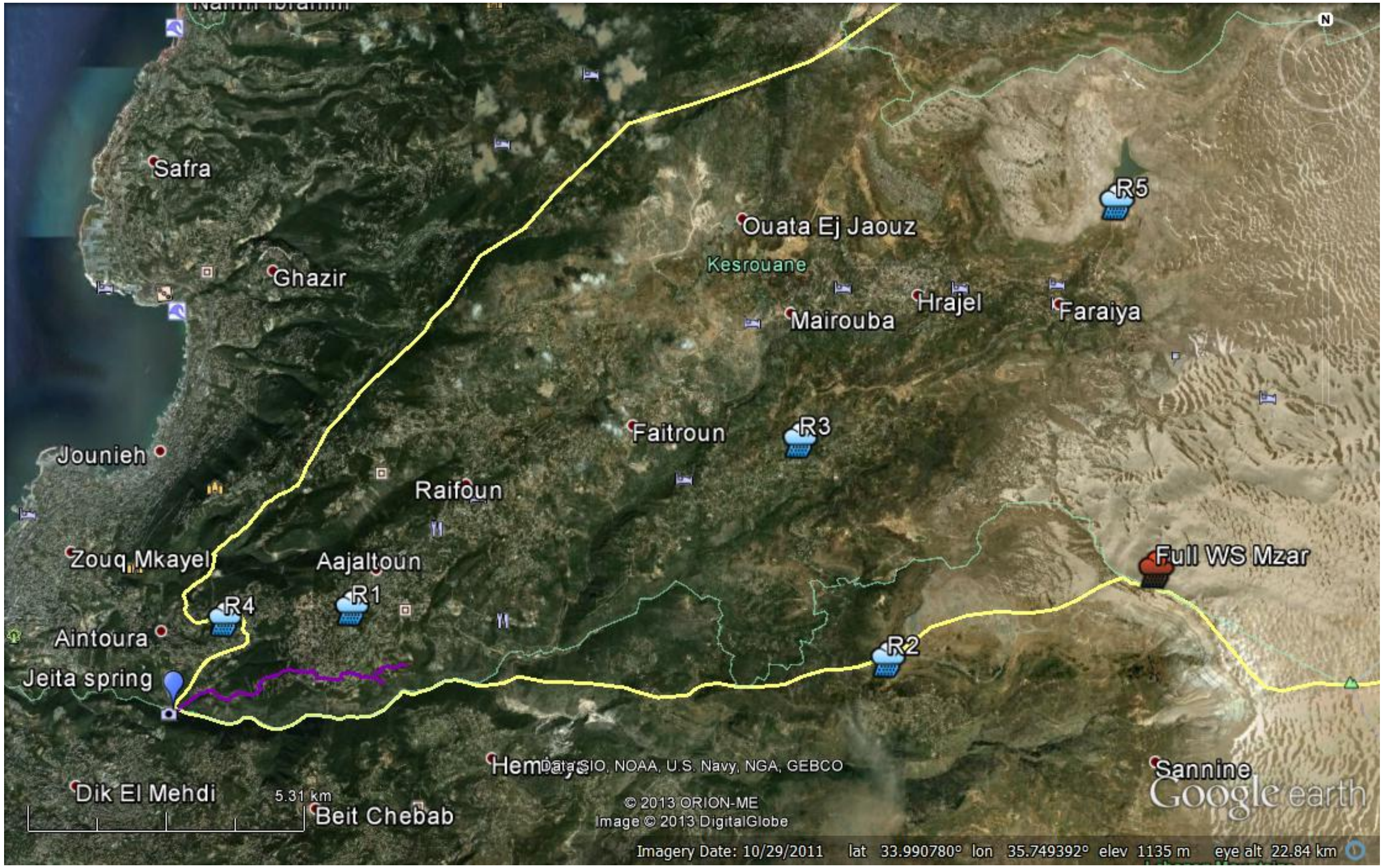


Figure 6: Final Distribution of Climate Stations in the Study Area

W1- The full weather station at Dome du Mzaar, one of the highest summits of Sannine Mountain is located in the high part of Nahr el Kalb surface catchment and of Jeita Spring groundwater catchment.

This location was selected due to the permanent electricity availability at the LBC TV station antenna. The land is in governmental ownership and it represents the highest area of the GW catchment with high snow cover (i.e. the most important sources to recharge groundwater).

It has to be installed in a place further away from the edge of the cliff to avoid wind influence on the reading. It was not so possible to go farther to the north of the station due to the presence of mine fields.

R1- A temperature and precipitation WS, located in Ajaltoun in the middle of the J4 the direct main aquifer of Jeita Spring, on the roof of the Antonine International School (AIS), a private educational establishment.

The station is located in an intensively built up part of the catchment. In order to protect it from vandalism, the WS had to be installed on the roof of the building, where electricity is permanently available.

R2- A temperature and precipitation WS, Located in Baskinta – Bakish area, on a WEBML facility near a reservoir. It is representing the high elevation of the Southern side of the catchment area. Electricity was supposed to be provided 24/24 and 7/7 from the telecommunication antenna close by, but that was not possible due to technical lightning protection problem.

R3- A temperature and precipitation WS, Located in Kfardebian on the roof of the municipality. Kfardebian is a large village of Kesrouan area with lot of inhabitant and housing projects, the roof of a building is representing somehow the land use of the area in addition to the security factor and the electricity availability.

R4- A temperature and precipitation WS, Located in Shaile WEBML pumping and distribution station roof, In the middle of a highly built area, with partly electricity available and a good security condition.

R5- A temperature and precipitation WS, Located in Chabrouh Dam area, on the treatment plant roof, with electricity 24/24 and 7/7 and a nice security conditions.

The installation of the WS in a WEBML station, is providing the availability of the site with easy permission and may be their responsibility after the end of the project, these sites are not easy access for many people.

The locations owners: municipality, governmental establishment and private site are promised to have access to the collected Data related to the WS installed on their propriety.

4.2 *Site Selection for Stable Isotope Rainfall Collectors*

The stable isotope study is concerned to identify the difference of trend in correlation with elevation and distance from the sea. This is why the distribution of the rainfall collectors was related to these too criteria (Table 1). Where possible rainfall collectors were installed at the same site as the meteorological station because both data could then directly be correlated (Figure 7).

The closest point to the sea related to the GW catchment of Jeita spring, is at Jeita spring itself.

- iJ: rainfall collector installed on the roof of Mapas restaurant at the touristic site of Jeita Grotto.
- iS: rainfall collector installed in Shaile WEBML station for the lower elevation of the GW catchment.
- iA: rainfall collector installed in Ajaltoun AIS for the low middle elevation.
- iR: rainfall collector installed in Raifoun at the BGR project office for the middle elevation.
- iK: rainfall collector installed in Kfardebian at the municipality for the middle high elevation. And
- iC: rainfall collector installed in Chabrouh Dam for the high elevation.

Higher part of the catchment was not suitable to install any rainfall collector since most of the precipitation up there are snow, and the collector don't have any facility to melt the snow.

Table 1: Location and Names of Rainfall Collectors for Stable Isotope Samples

	Name	Distance from sea	Elevation asl	Coordinate N	Coordinate E
iJ	Jeita Mapas	4900 m	97 m	33.943236°	35.644309°
iS	Shaile WEBML	5000 m	463 m	33.955502°	35.653340°
iA	Ajaltoun AIS	7300 m	821 m	33.957646°	35.680032°
iR	Raifoun BGR	7000 m	1036 m	33.976586°	35.706579°
iK	Kfardebian municipality	12000 m	1307 m	33.986174°	35.771162°
iC	Chabrouh Dam	19300 m	1591 m	34.025676°	35.834317°

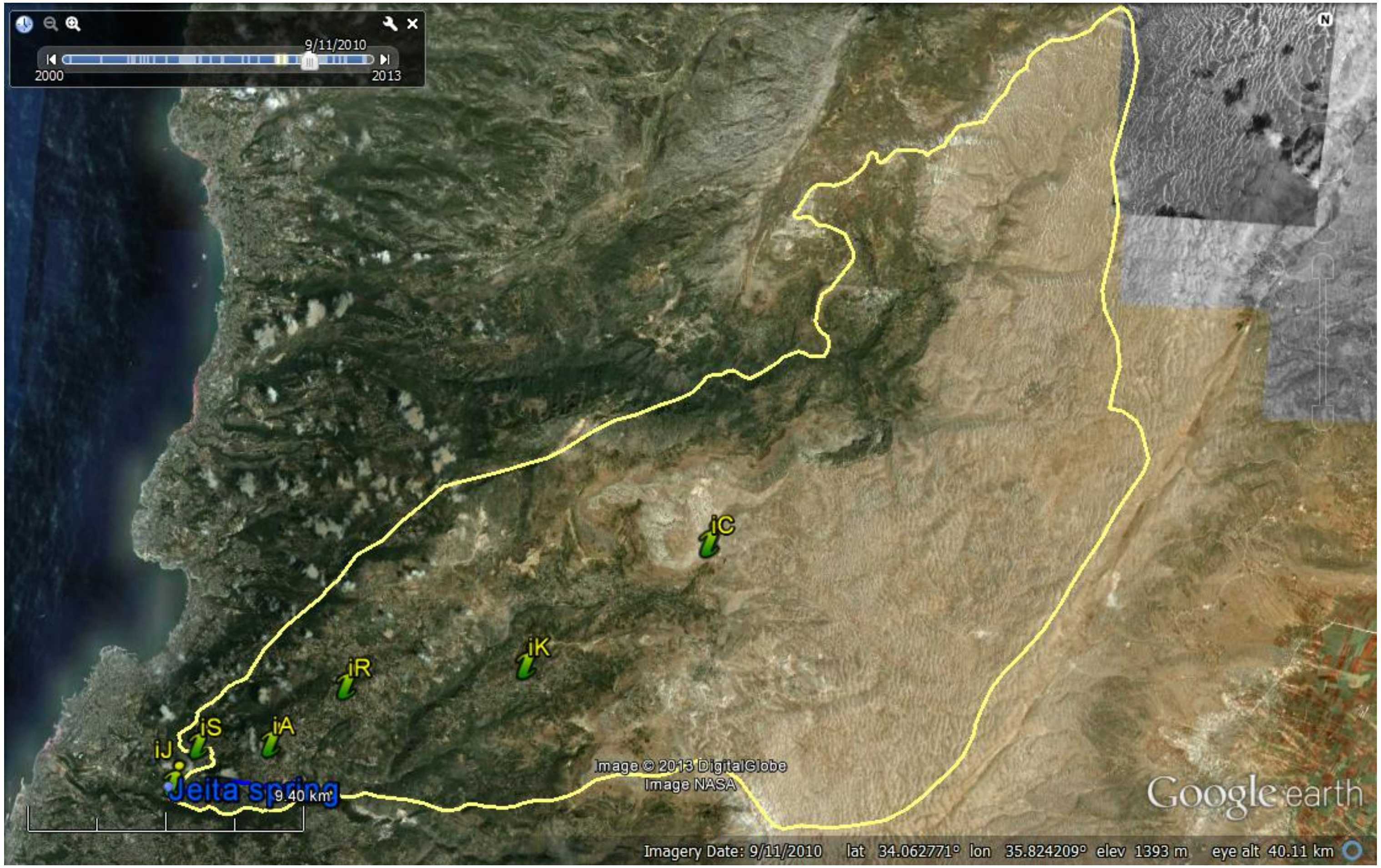


Figure 7: Rainfall Collectors for Stable Isotopes

5 Installation

5.1 *Climate Stations Installation*

5.1.1 Climate Station components

The climate stations were brought from **Thies Clima** ADOLF THIES GmbH & Co. a German company making and selling climate stations all over the world. The WS of the project are divided in two categories:
W1: is a full weather station including the following components:

a) Ultrasonic anemometer 2D
b) Weather and Thermal Radiation Shield compact
c) Temperature Transmitter compact
d) Hygro – Thermo transmitter compact
e) Global Radiation, 2 x Pyranometer CMP 3
f) Backscatter Radiation
g) Snow Level Sensor SHM 30
h) Precipitation transmitter
i) Wind protection and device to refuse birds
j) Integrated Baro – Transmitter
k) Datalogger DLx Met
l) Telescopic Mast 10 m with tilting device for basement
m) Instrument holder 3 m
n) Lightning rod
o) GSM antenna

R1-2-3-4-5: are only including the following component:

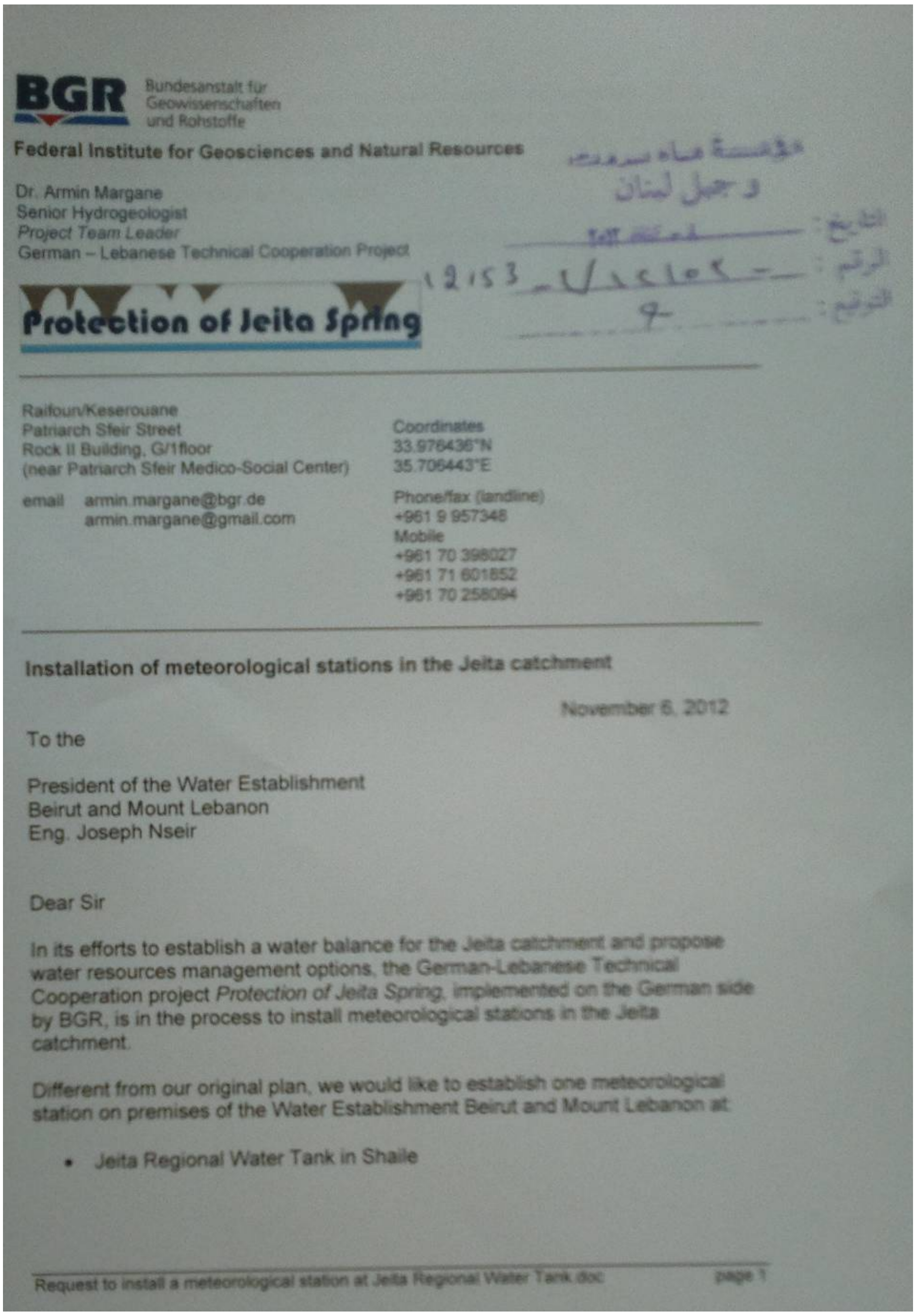
a) Weather and Thermal Radiation Shield compact
b) Temperature Transmitter compact
c) Precipitation transmitter
d) Wind protection and device to refuse birds
e) Datalogger DLx Met
f) Instrument holder 1 m and 2 m

5.1.2 Installation steps and techniques

To implement the installation of the WS there are many administrative and technical steps:

a) Contacting the location owner or user and asking for the permission to install at this location (Figure 8). Discussing the electricity availability and sometimes cost, discussing the accessibility of the team to collect data. For these things WEBML have provided the permissions needed for the stations located on their facilities (Figure 9), Kfardebian municipality was very helpful for the station on their roof top and AIS school manager was very cooperative for having a weather station on the schools roof top as it can be used for educational purposes.

b) Preparing a wooden form for concrete bases where the screws are located to fit exactly with the instrument holder size (Figure 10).
c) Making the concrete bases at the location.
d) Installing the devices on the next day or two days after depending on concrete drying (Figures 11, 12). And
e) Installing the electricity source cable and fuse to keep the battery on charge (Figure 13).



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Installation of meteorological stations in the Jeita catchment

November 6, 2012

To the

President of the Water Establishment
Beirut and Mount Lebanon
Eng. Joseph Nseir

Dear Sir

In its efforts to establish a water balance for the Jeita catchment and propose water resources management options, the German-Lebanese Technical Cooperation project *Protection of Jeita Spring*, implemented on the German side by BGR, is in the process to install meteorological stations in the Jeita catchment.

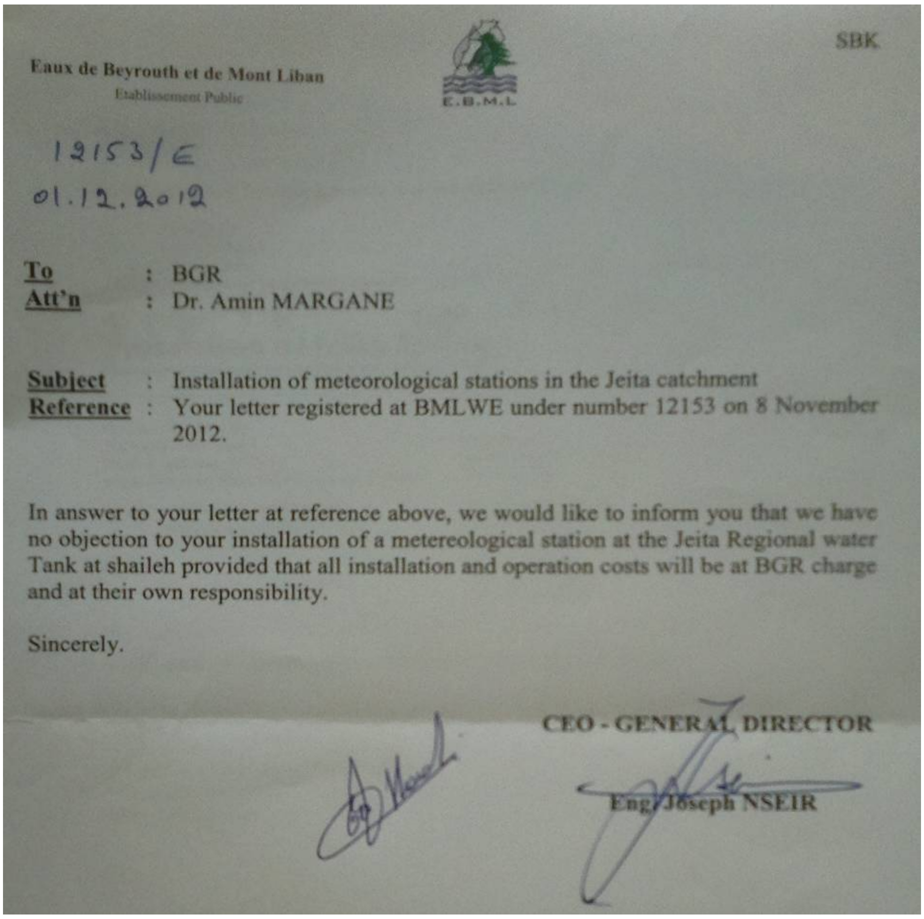
Different from our original plan, we would like to establish one meteorological station on premises of the Water Establishment Beirut and Mount Lebanon at

- Jeita Regional Water Tank in Shaile

Request to install a meteorological station at Jeita Regional Water Tank.doc page 1

Figure 8: Request for Permission to install a Weather Station

Special Report No. 18: Meteorological Stations installed by the Project



Eaux de Beyrouth et de Mont Liban
Etablissement Public

E.B.M.L.

SBK

12153/E
01.12.2012

To : BGR
Att'n : Dr. Amin MARGANE

Subject : Installation of meteorological stations in the Jeita catchment
Reference : Your letter registered at BMLWE under number 12153 on 8 November 2012.

In answer to your letter at reference above, we would like to inform you that we have no objection to your installation of a metereological station at the Jeita Regional water Tank at shaileh provided that all installation and operation costs will be at BGR charge and at their own responsibility.

Sincerely.

CEO - GENERAL DIRECTOR

Eng. Joseph NSEIR

Figure 9: Permission to install Weather Station

Special Report No. 18: Meteorological Stations installed by the Project

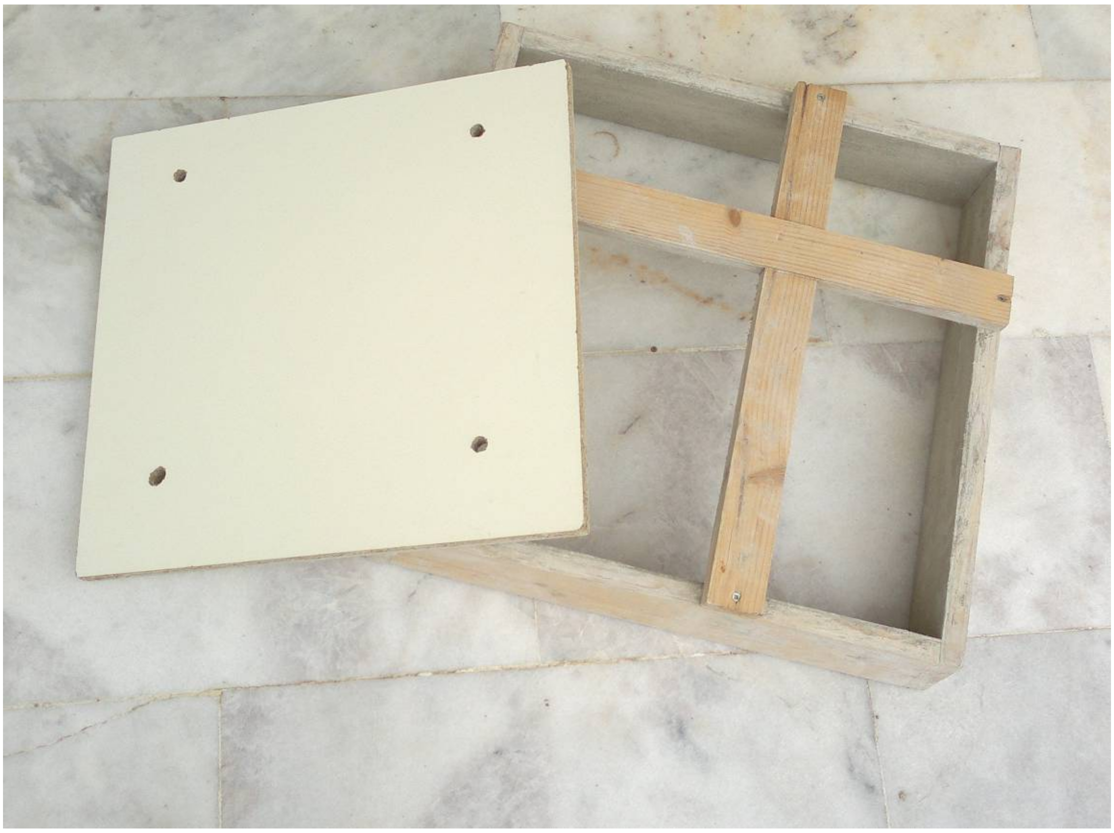


Figure 10: Box for Concrete Base of Instrument Holder

Figure 11: Installing a Weather Station

Figure 12: Installing the individual Components of a Weather Station

Figure 13: Installing the Power Supply to the Station

5.1.3 Settings

Measuring cycle: 1 minute

Memory cycle: 10 minutes

Extreme (value) cycle: 1 hours

5.2 *Rainfall Collectors installation*

5.2.1 Rainfall Collector components

The rainfall collector for stable isotope sampling is a simple instrument. It doesn't have any electronics or sensors. It comes in a carton box including:

a) Plastic body
b) Intake device with spiral plastic tube
c) Over flow tube and
d) Funnel with bird refuse device and filter

This instrument needs a pole of 1 m to hold it.

5.2.2 Installation steps and techniques

Several steps were done for completing the installation of the rainfall collectors:

a) Designing the pole holder for the instrument and a concrete base box (Figures 14, 15)
b) Designing a wooden box to make the concrete base for it
c) Making the concrete and fixing the pole holder in a nice vertical position (Figure 16) and
d) Installing the instrument on the pole (Figure 17)

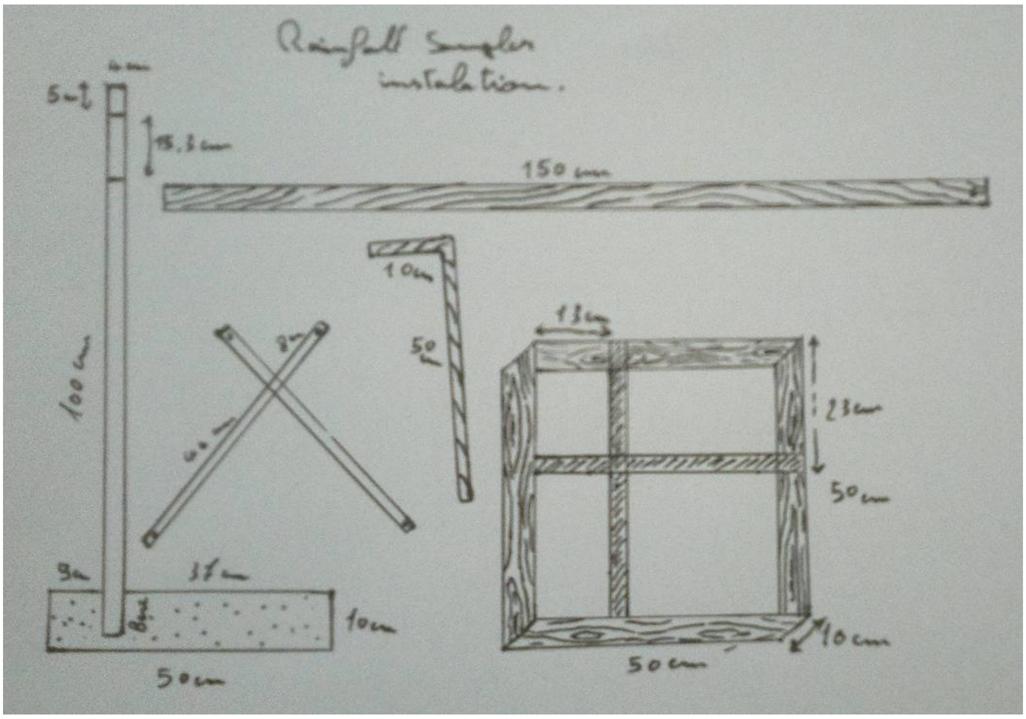


Figure 14: Design of the Instrument Holder and Concrete Base

Figure 15: Instrument Holder

Figure 16: Making the Concrete Base

Figure 17: Rainfall Collector for Isotope Sampling

6 Data Collection and Use

6.1 *Collecting and using Data from Climate Stations*

The Thies climate stations are all equipped with a Datalogger DLx Met, (Figure 18) that can provide many options in collecting data like a USB cable, a modem GSM or an SD card.

The GSM modem was planned to be installed for the climate stations but due to administrative time consuming, the need of checking the instruments and the installation material, and the future operating entity after the end of the project, we preferred to collect Data manually every 15 days.

We were not sure about the battery life time and about the installation resistance to the Lebanese mountain conditions, this is why we was visiting the climate stations twice a month.

To collect Data from the Datalogger DLx Met, you have to do the following steps:

a) Turn On the Datalogger DLx Met by pressing <Enter> and then <▼> together, until you can see the LCD on. Than release immediately. (in case if the station name have a blinking cursor that means you are editing the name, than only you press <Enter> several times to stop any blinking cursor).
b) Push and snap in the SD-Card into the slot of the Datalogger.
c) Push the button <▼> until you reaches the Data Output display blinking. Than press <Enter>
d) Use the <▼> or <▲> button when a cursor is blinking to reach M data (Mean value data) and press <Enter>
e) The data will be saved on the SD-Card and displaying the number of files being copied. When you see <END> the M data transfer is done, you may repeat the procedure to copy the E data (Extreme value data)
f) Remove the Card when Output is ready: push the card until it releases, then pull it out (so called ejector type Push-In/Push-Out).

Remarks: If you find a strange folder name on the SD-Card slightly different than one of your climate stations name, it could be because of or editing the name by mistake, the Datalogger with changed name will create a new Folder on the SD-Card, you can know that when the data output take much longer time to extract data than usual.

Figure 18: Datalogger DLx Met showing buttons <▼> <▲> and <Enter>, the red arrow showing the SD-Card slot.

After collecting the data on an SD card, at the office we create a card copy as backup and we read the data on MEVIS software provided by Thies Clima ADOLF THIES Company (a special dongle is needed).

To proceed in reading the collected Data on MEVIS you must follow the steps

a) After opening the program click on the MKO icon and configure the SD-Card and the stations names and folders. (Figures 19, 20, 21).

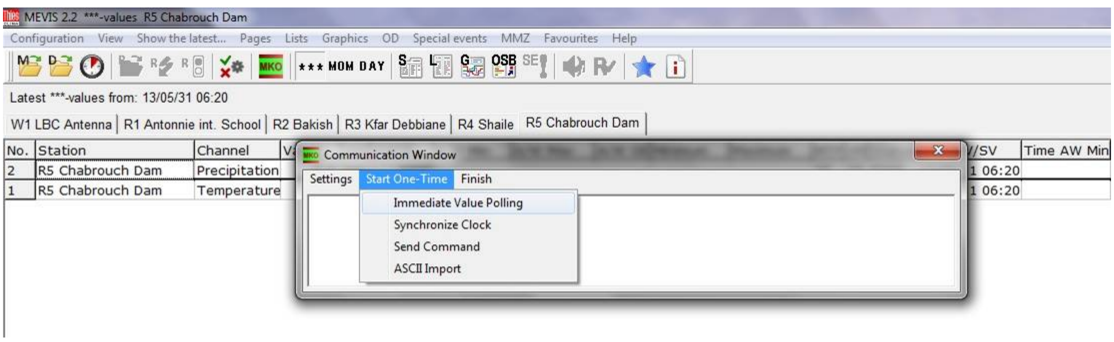


Figure 19: Polling Values into MEVIS Program

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Figure 20: Select Station Name and Datalogger

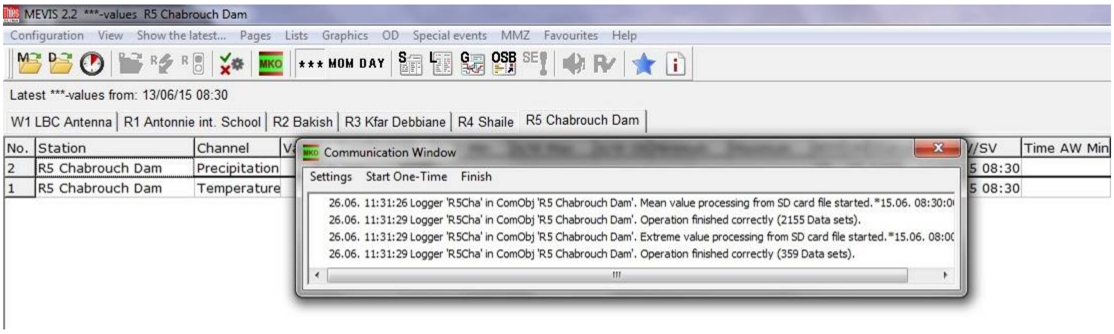

Figure 21: When Operation Finished Correctly poll Data from next Station

b) The next step is to create the suitable list of data that you need by clicking on the list button and configure the stations, sensors, values and time data that you need. (Figure 22)

Special Report No. 18: Meteorological Stations installed by the Project

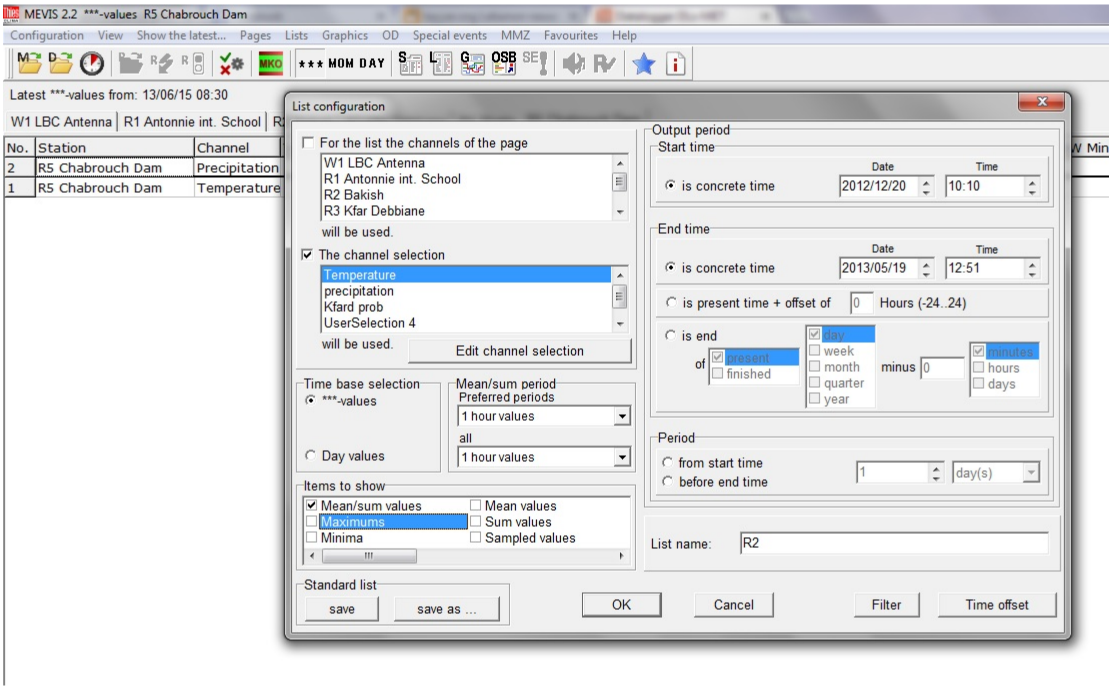

Figure 22: List Configuration window

c) After configuring a list, you press Ok and the list shows you can navigate in to see and compare values. To have a useful list out of the MEVIS program you may export it, by clicking on File > csv file (prior MEVIS list export format), it create a csv format file that can be opened in Microsoft Excel and saved as Excel file, Useful for any report (Figure 23).

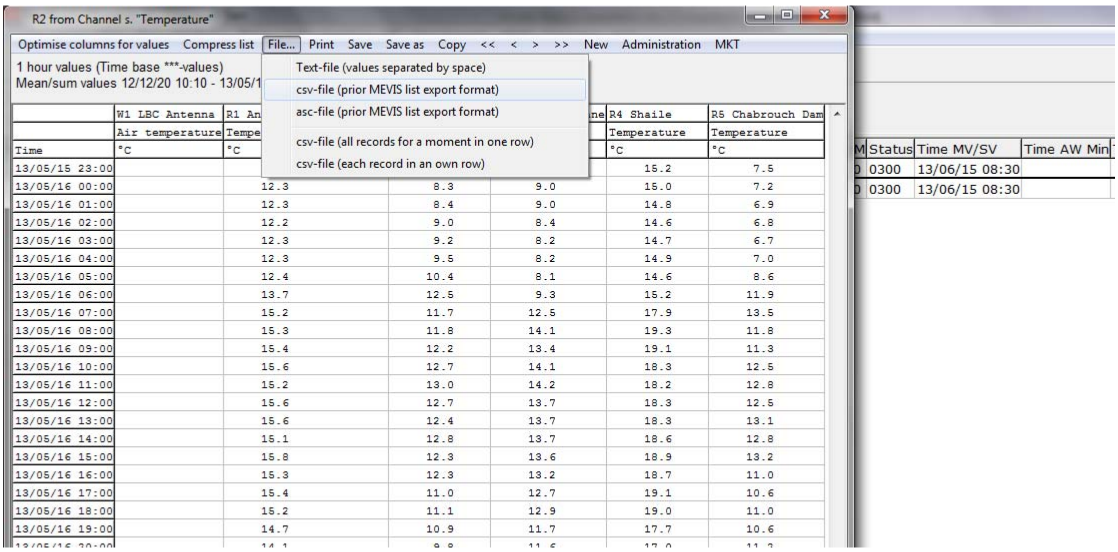

Figure 23: List Window with Export Tips

Special Report No. 18: Meteorological Stations installed by the Project

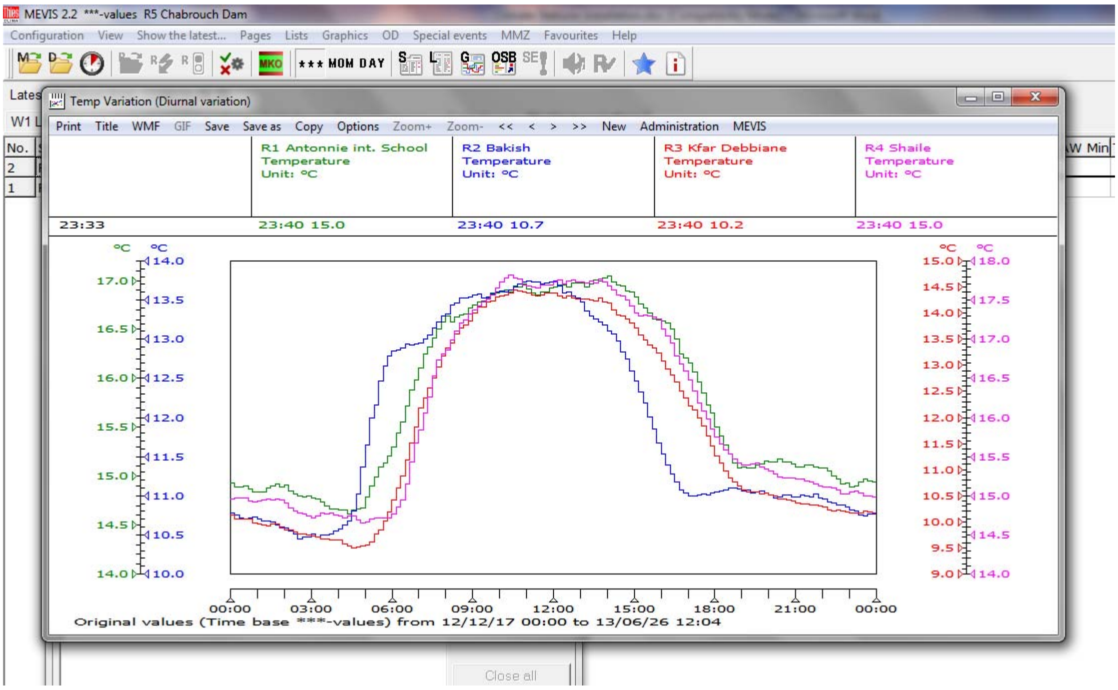

Figure 24: Graphic Presentation of Data in MEVIS

6.2 *Collecting and Managing Samples from Rainfall Collectors*

The rainfall collectors bucket can collect maximum a 250 mm of precipitation, the additional precipitation quantity will go inside the system and will be mixed with the accumulated water than the mixed over flow will go out of the bucket. In some storms in Lebanon we have intensive rainfall events (more than 100 mm in 24 h). It is preferably to collect the samples before having any overflow, that's why the timing of collecting the samples is changing during the rainy season. It started in October, November and December to be twice a month, every 1st and 16th of the month, than in January, February and March three times a month, every 1st, 11th and 21st of the month, and in April and Mai back to twice a month every 1st and 16th, than June to September to be checked once a month to collect if exist very few rainwater.

Every rainfall collector instrument is provided with 2 buckets that we labeled them by the name of the station, a number and the weight of the empty bucket without the cap (e.g. iJ-1 ---165.9 g, or iJ-2 ---174.53 g), to collect the rainfall we take the empty bucket to the station, replace it with the one installed in the instrument and bring back the rainwater in the closed tight bucket.

At the office Laboratory we shake every bucket, we open it, measure the E.C than weigh it deducting the bucket weight to have the net rainwater weight, and fill a plastic bottle of 125 ml as a sample and label it (name of the station, date and sample ID number)

We have created an excel sheet to convert the rainwater weight to rain quantity in (mm) and to calculate and compare the cumulative rainfall quantity and E.C in all our stations (Figure 25). And we created another sheet comparing the E.C with the coordinates and the distance from the coast of every station (Figure 26).

G83 fx 2013/06/01

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Station_Name	Station_ID	LAT	LONG	Elevation	Dist_coast	Date	Bottle_No	Amount_ml	Amount_mm	cumulative_mm	Sample_ID	dO-18	dD	EC_µS/cm	Total P
41	Aajaltoun_AIS	iA					13/06/01			0.0	1318.1					
42	Aajaltoun_AIS	iA					13/06/16			0.0	1318.1					
43	Aajaltoun_AIS	iA					13/07/01			0.0	1318.1					1318.1
44	Chabrouh_dam	iC					12/10/16	iC-1	535.071	37.9	37.9	1002				
45	Chabrouh_dam	iC					12/11/01		458.11	32.5	70.4	1007				
46	Chabrouh_dam	iC					12/11/16		3097.8	219.7	290.1	1012				
47	Chabrouh_dam	iC					12/12/04		201.7	14.3	304.4	1017				
48	Chabrouh_dam	iC					12/12/16		3448.18	244.6	549.0	1021				
49	Chabrouh_dam	iC					13/01/01		2344.96	166.3	715.3	1028				
50	Chabrouh_dam	iC					13/01/17		1890.06	134.0	849.4	1034				
51	Chabrouh_dam	iC					13/01/21		128.83	9.1	858.5	1040				
52	Chabrouh_dam	iC					13/02/04		1231.31	87.3	945.8	1046				
53	Chabrouh_dam	iC	34.02574	35.83447	1591	19300	13/02/11		1107.33	78.5	1024.4	1052			29.7	
54	Chabrouh_dam	iC					13/02/21		2320.18	164.6	1188.9	1058			22.4	
55	Chabrouh_dam	iC					13/03/01		1037.97	73.6	1262.5	1064			41.1	
56	Chabrouh_dam	iC					13/03/11		180.501	12.8	1275.3	1070			71.2	
57	Chabrouh_dam	iC					13/03/21		621.82	44.1	1319.4	1076			41.9	
58	Chabrouh_dam	iC					13/04/02		424.38	30.1	1349.5	1082			69.8	
59	Chabrouh_dam	iC					13/04/16		2267.881	160.8	1510.4	1088			32.4	
60	Chabrouh_dam	iC					13/05/01		2366.45	167.8	1678.2	1094			18.1	
61	Chabrouh_dam	iC					13/05/16		739.45	52.4	1730.6	1100			27.4	
62	Chabrouh_dam	iC					13/06/01			0.0	1730.6					
63	Chabrouh_dam	iC					13/06/16			0.0	1730.6					
64	Chabrouh_dam	iC					13/07/01			0.0	1730.6					1730.6
65	Jeita_Mapas	iJ					12/10/16	iJ-1	866.78	61.5	61.5	1003				
66	Jeita_Mapas	iJ					12/11/01		129.6	9.2	70.7	1008				
67	Jeita_Mapas	iJ					12/11/16		1770.44	125.6	196.2	1013				
68	Jeita_Mapas	iJ					12/12/04		563.75	40.0	236.2	1018				

Figure 25: Data Collection Sheet

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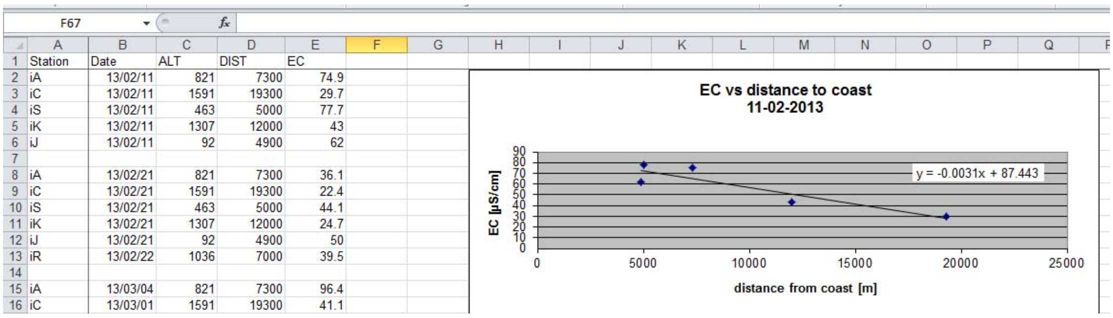

Station	Date	ALT	DIST	EC
iA	13/02/11	821	7300	74.9
iC	13/02/11	1591	19300	29.7
iS	13/02/11	463	5000	77.7
iK	13/02/11	1307	12000	43
iJ	13/02/11	92	4900	62
iA	13/02/21	821	7300	36.1
iC	13/02/21	1591	19300	22.4
iS	13/02/21	463	5000	44.1
iK	13/02/21	1307	12000	24.7
iJ	13/02/21	92	4900	50
iR	13/02/22	1036	7000	39.5
iA	13/03/04	821	7300	96.4
iC	13/03/01	1591	19300	41.1

Figure 26: Electric Conductivity versus Distance for Stable Isotope Rainfall Samples during a Specific Period of Time

7 Meteorological Data Collected from the Project Stations

The stations installed by the project started functioning and collecting data as mentioned in the table below. Data are presented in Figure 27-47.

Symbol	Location	Date	Time
R1	AIS - Ajaltoun	29-01-2013	11:00 h
R2	WEBML tank Bakish-Baskinta	06-02-2013	10:00 h
R3	Municipality - Kfardebian	31-12-2012	08:00 h
R4	WEBML station - Shaile	18-12-2012	12:00 h
R5	Chabrouh Dam - Faraya	05-02-2013	10:00 h

7.1 *Rainfall*

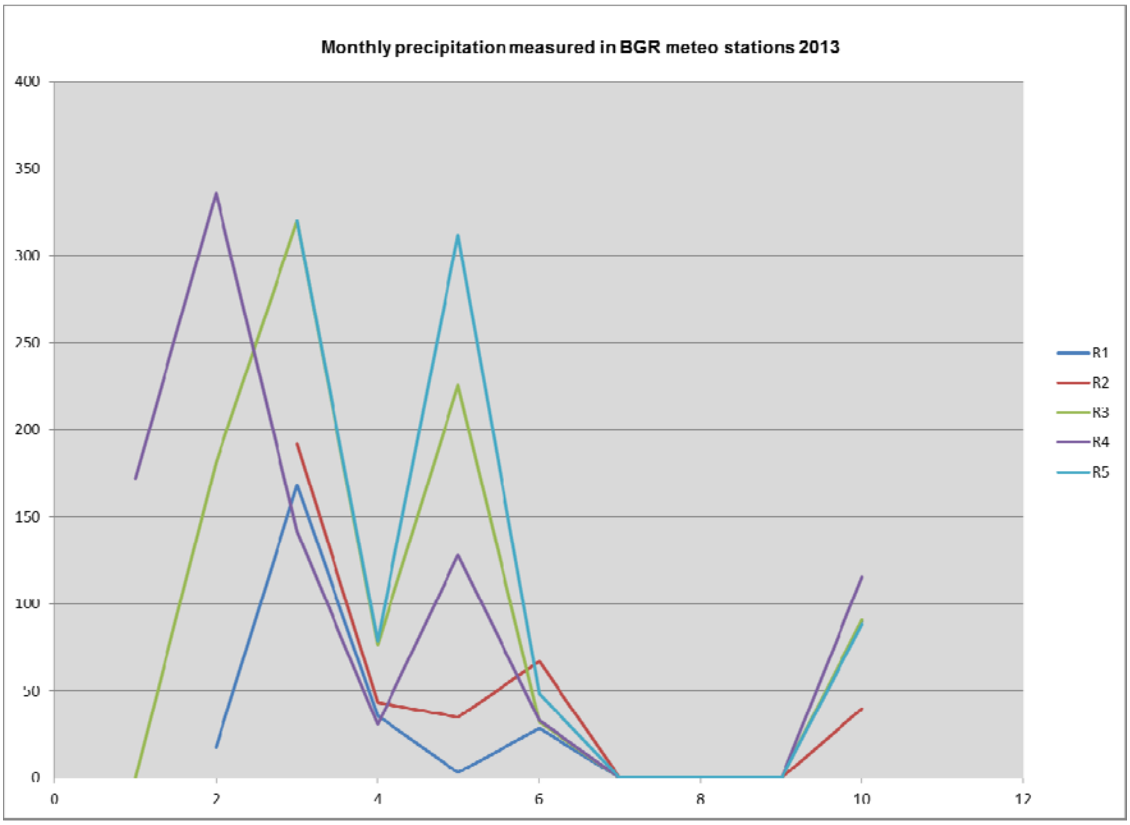

Figure 27: Rainfall Measured at BGR Meteo Stations

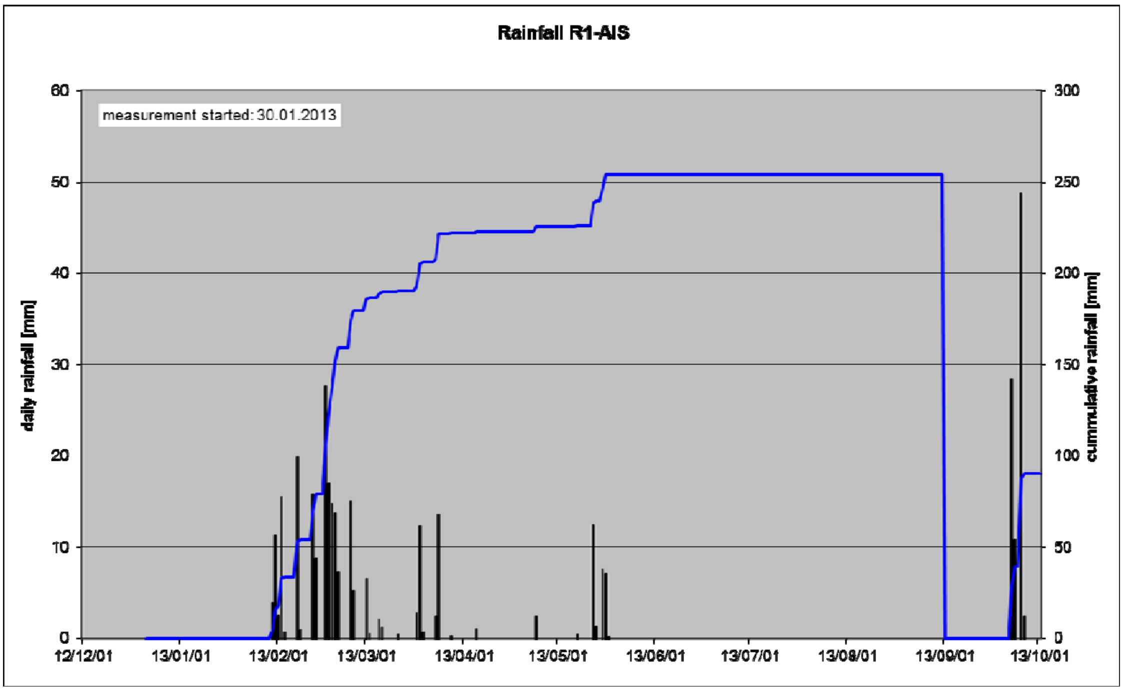

Figure 28: Rainfall measured at BGR Meteo Station R1-AIS
(Antonine International School)

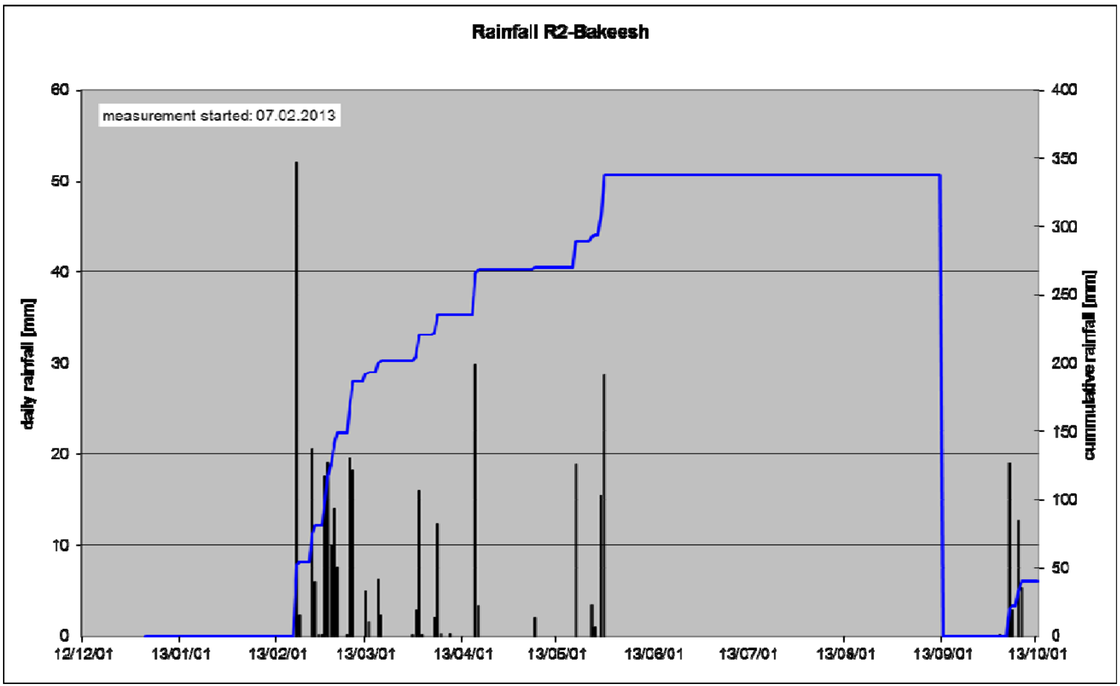

Figure 29: Rainfall measured at BGR Meteo Station R2-Bakeesh (Reservoir)

Special Report No. 18: Meteorological Stations installed by the Project

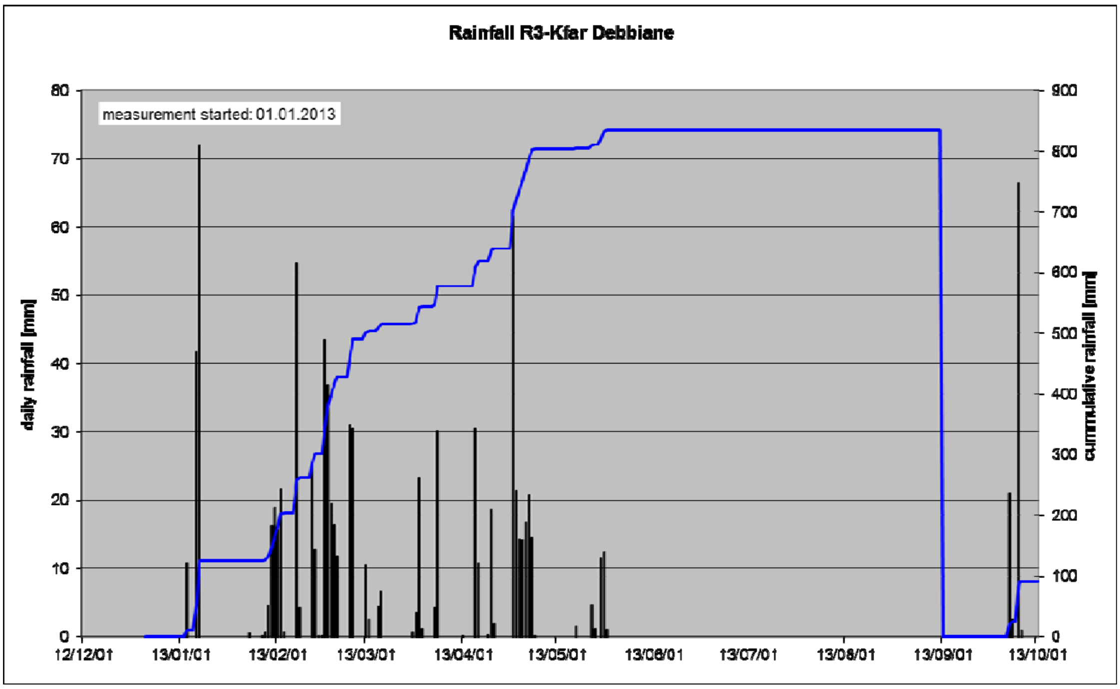

Figure 30: Rainfall measured at BGR Meteo Station R3-Kfardebbiane (Municipality)

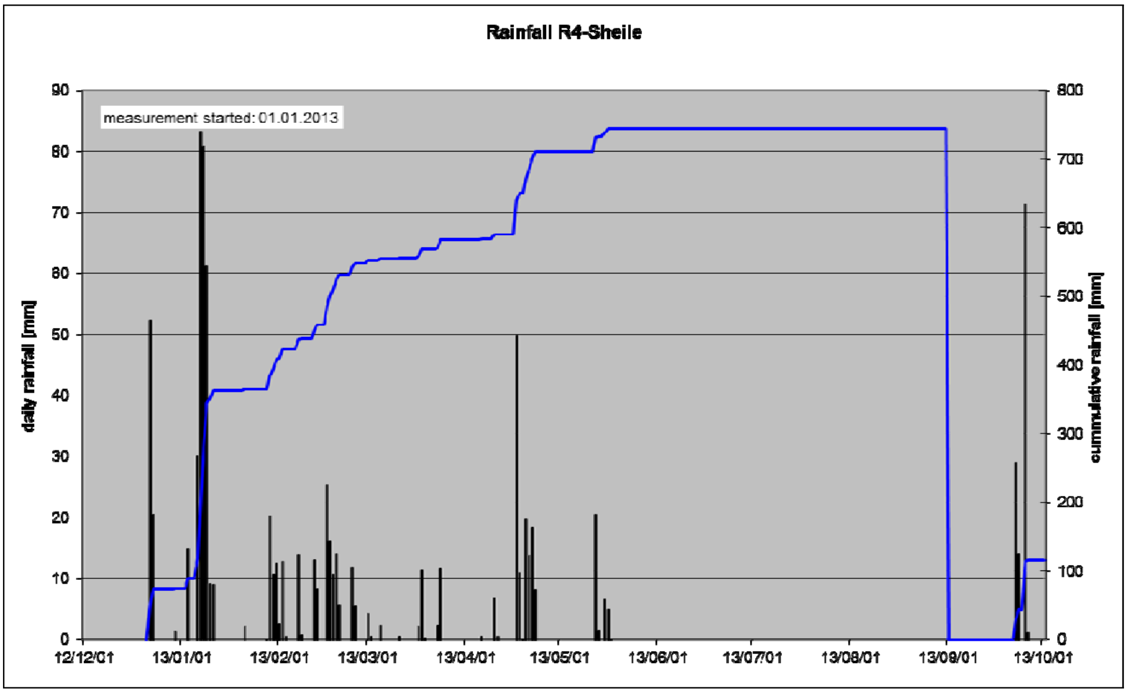

Figure 31: Rainfall measured at BGR Meteo Station R4-Sheile (Reservoir)

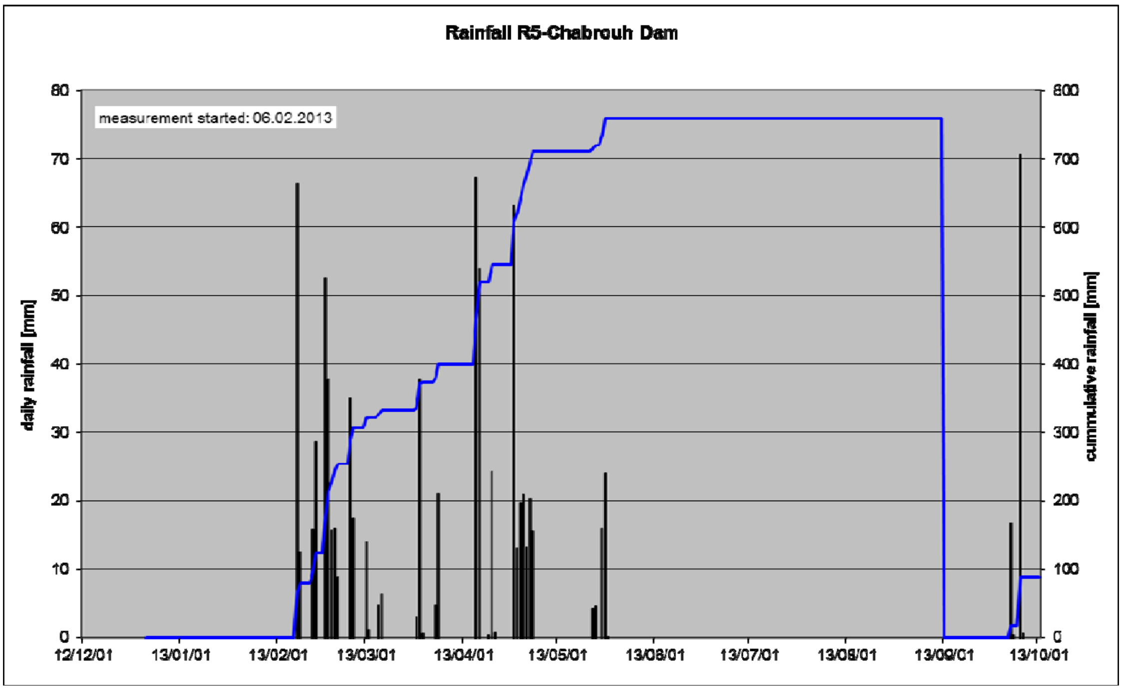

Figure 32: Rainfall measured at BGR Meteo Station R5-Chabrouh Dam (Treatment Plant)

7.2 *Temperature*

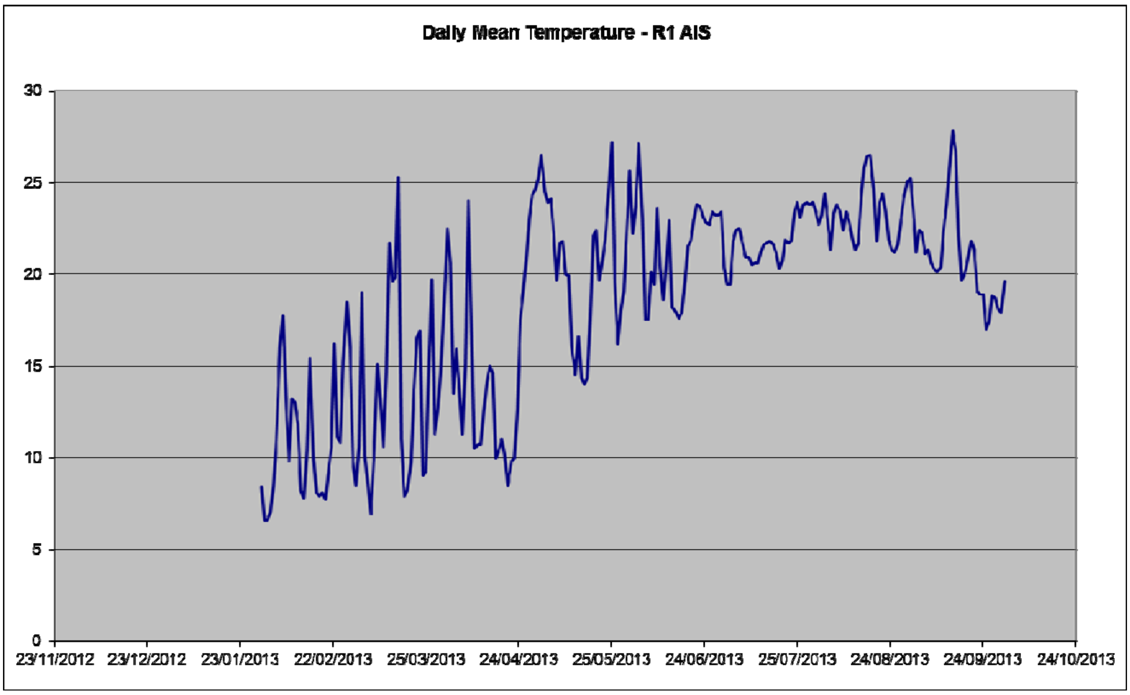

Figure 33: Daily Mean Temperatures measured at BGR Meteo Station R1-AIS (Antonine International School)

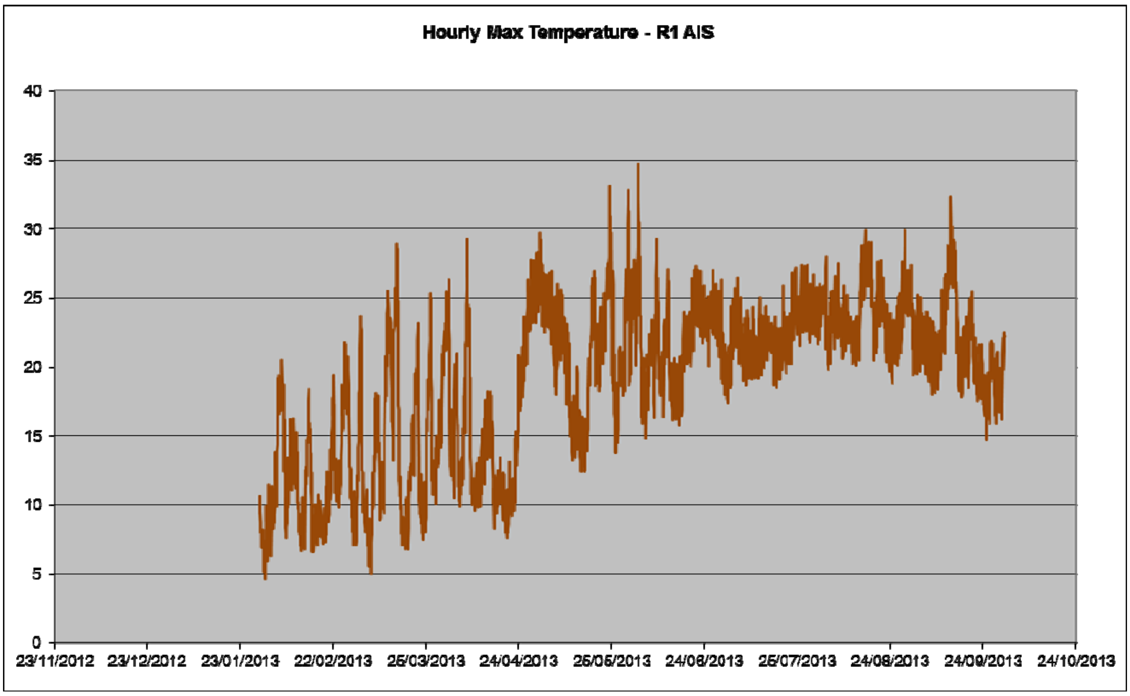

Figure 34: Hourly Maximum Temperatures measured at BGR Meteo Station R1-AIS (Antonine International School)

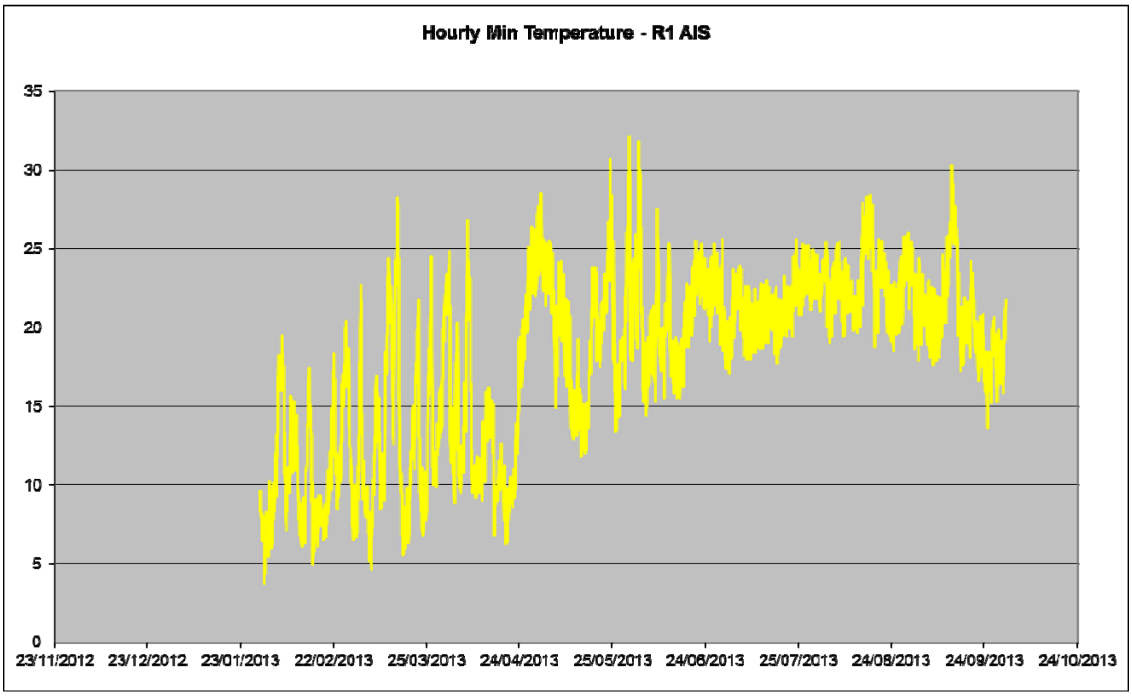

Figure 35: Hourly Minimum Temperatures measured at BGR Meteo Station R1-AIS (Antonine International School)

Special Report No. 18: Meteorological Stations installed by the Project

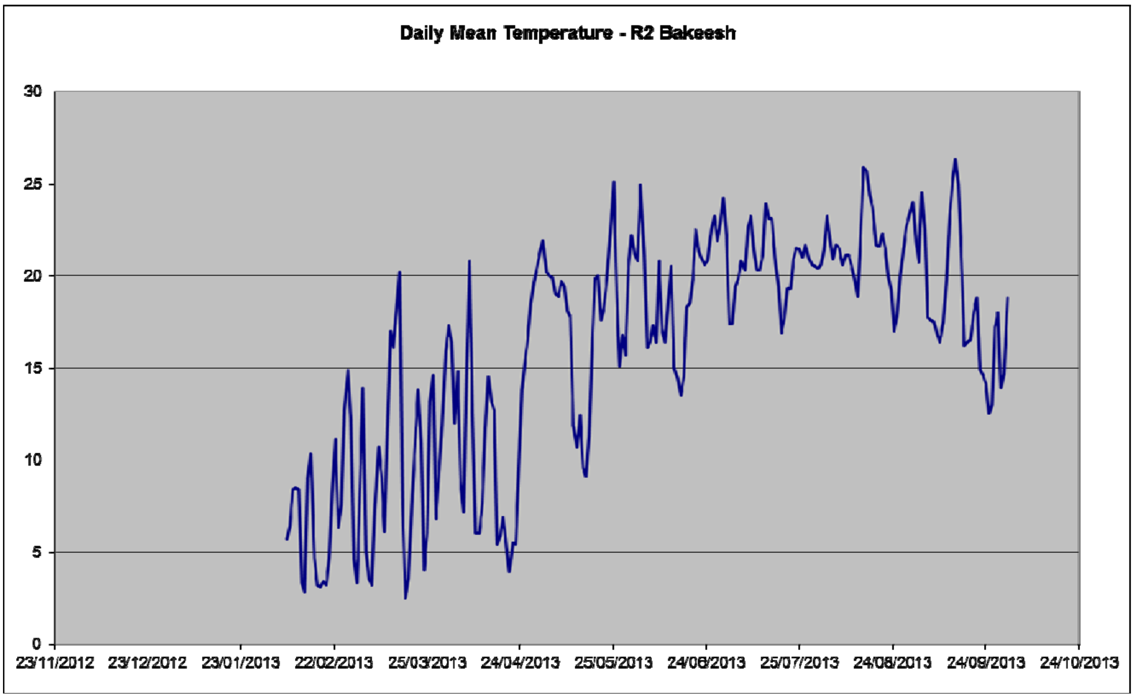

Figure 36: Daily Mean Temperatures measured at BGR Meteo Station R2-Bakeesh (Reservoir)

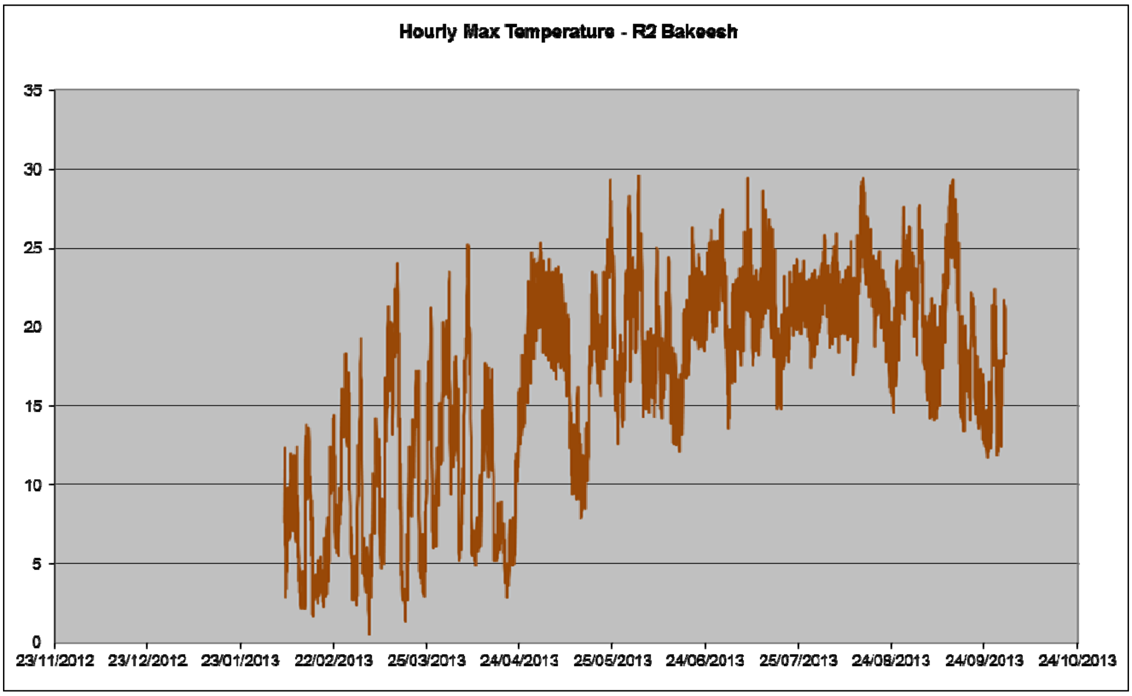

Figure 37: Hourly Maximum Temperatures measured at BGR Meteo Station R2-Bakeesh (Reservoir)

Special Report No. 18: Meteorological Stations installed by the Project

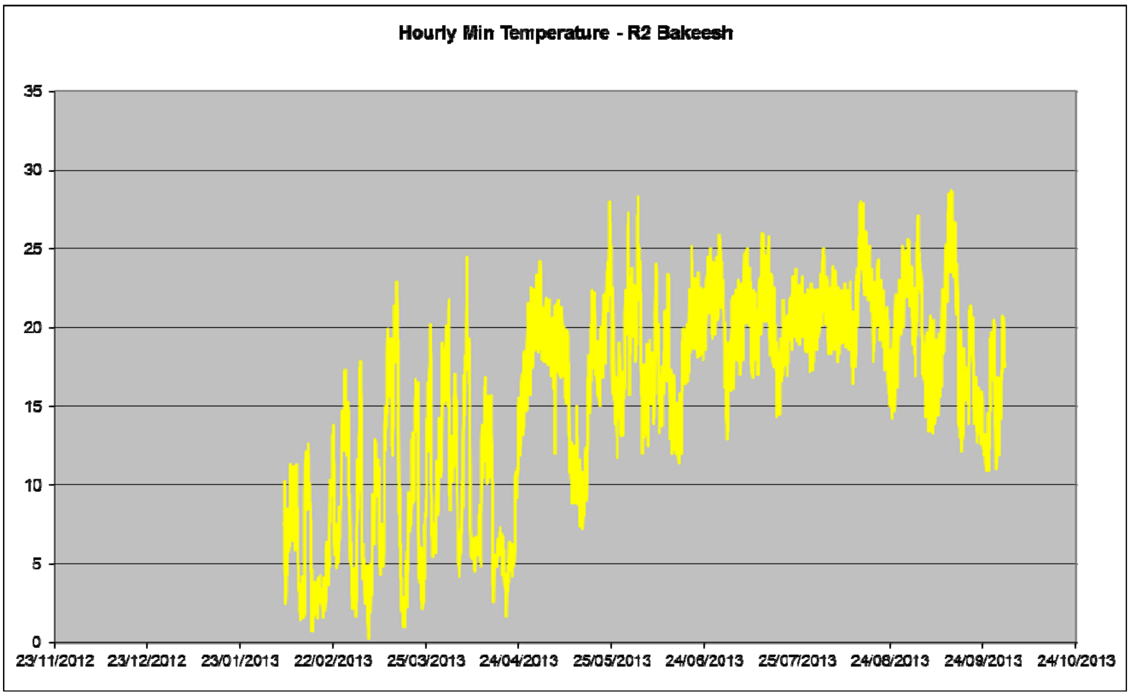

Figure 38: Hourly Minimum Temperatures measured at BGR Meteo Station R2-Bakeesh (Reservoir)

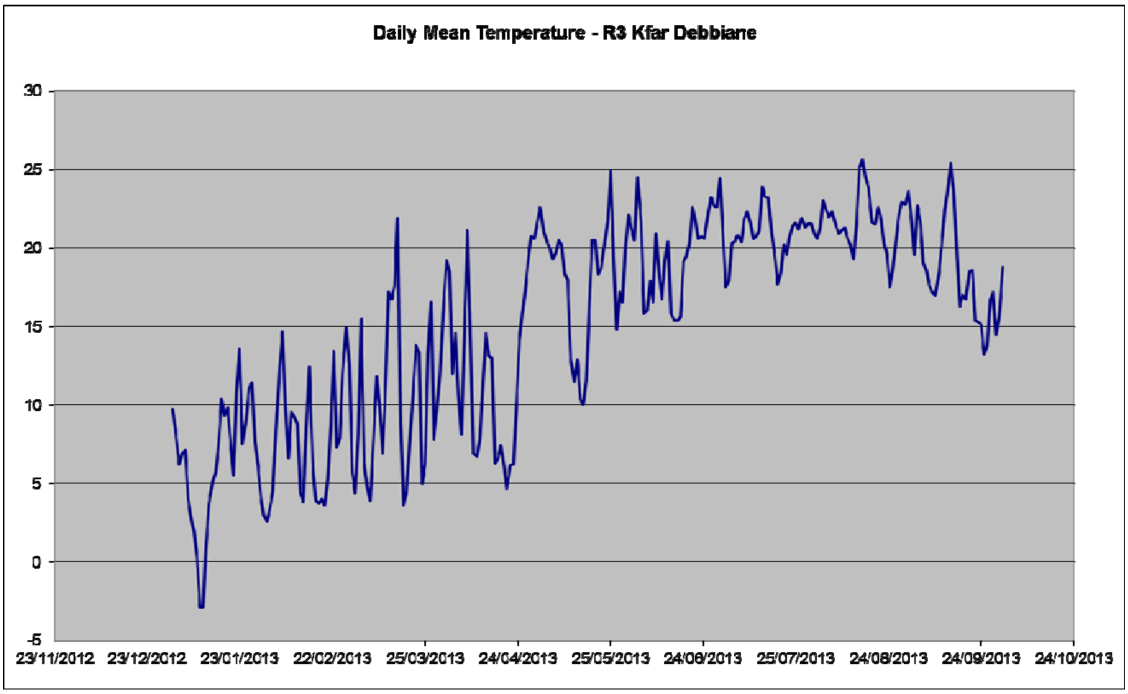

Figure 39: Daily Mean Temperatures measured at BGR Meteo Station R3-Kfardebbiane (Municipality)

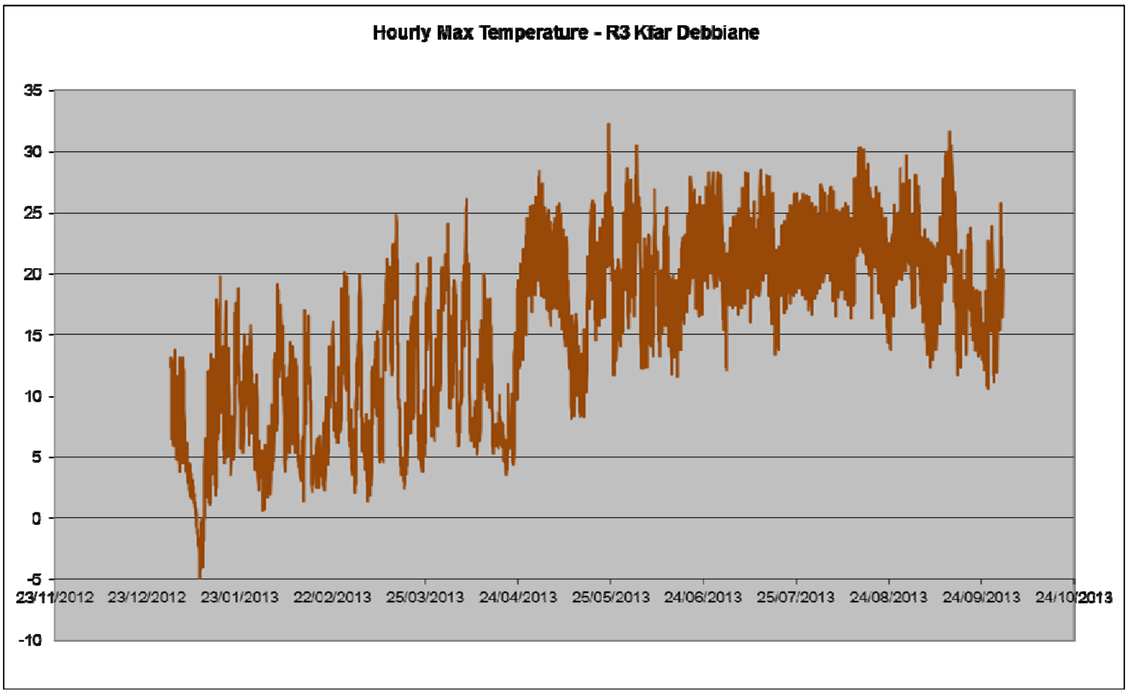

Figure 40: Hourly Maximum Temperatures measured at BGR Meteo Station R3-Kfardebbiane (Municipality)

Special Report No. 18: Meteorological Stations installed by the Project

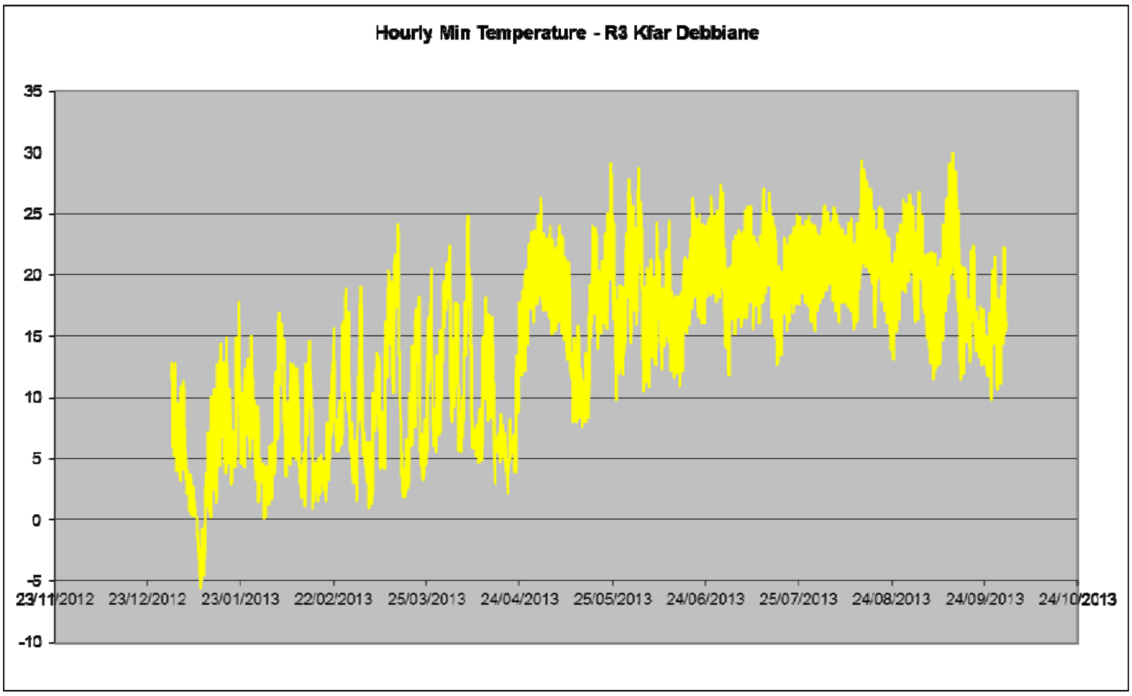

Figure 41: Hourly Minimum Temperatures measured at BGR Meteo Station R3-Kfardebbiane (Municipality)

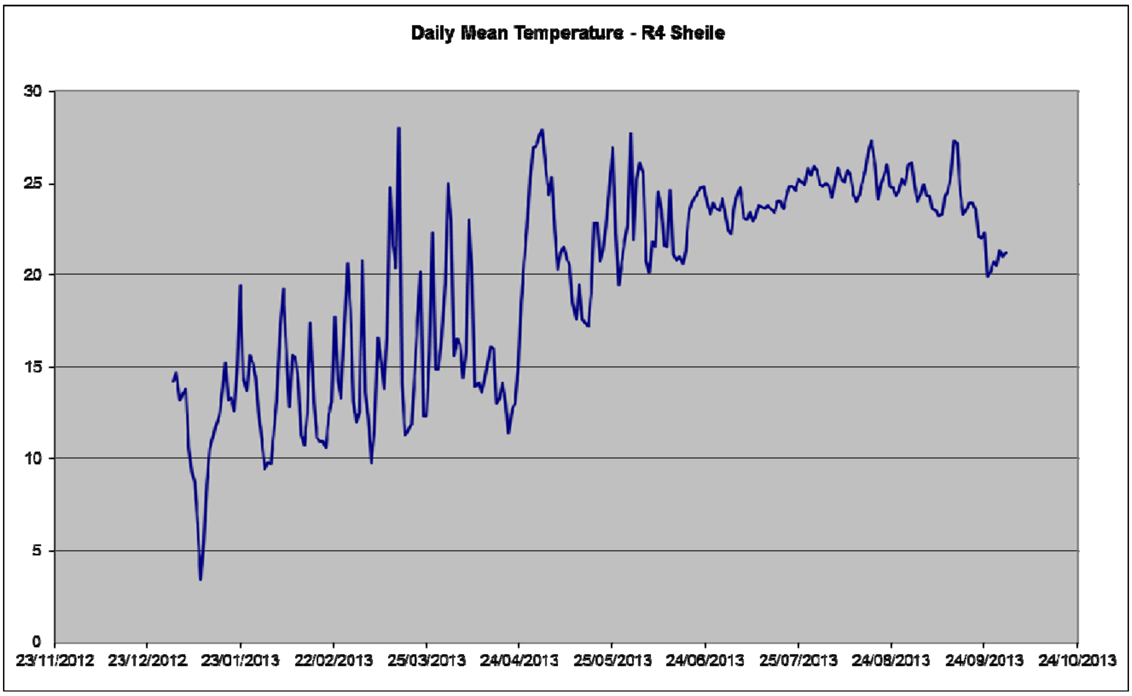

Figure 42: Daily Mean Temperatures measured at BGR Meteo Station R4-Sheile (Reservoir)

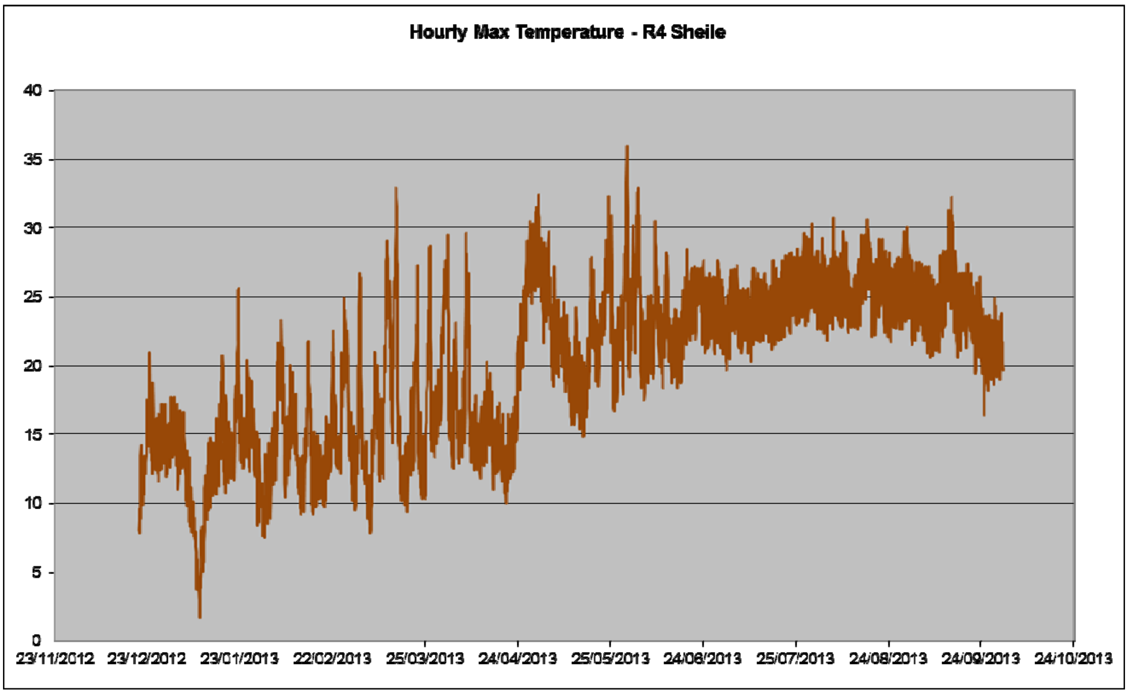

Figure 43: Hourly Maximum Temperatures measured at BGR Meteo Station R4-Sheile (Reservoir)

Special Report No. 18: Meteorological Stations installed by the Project

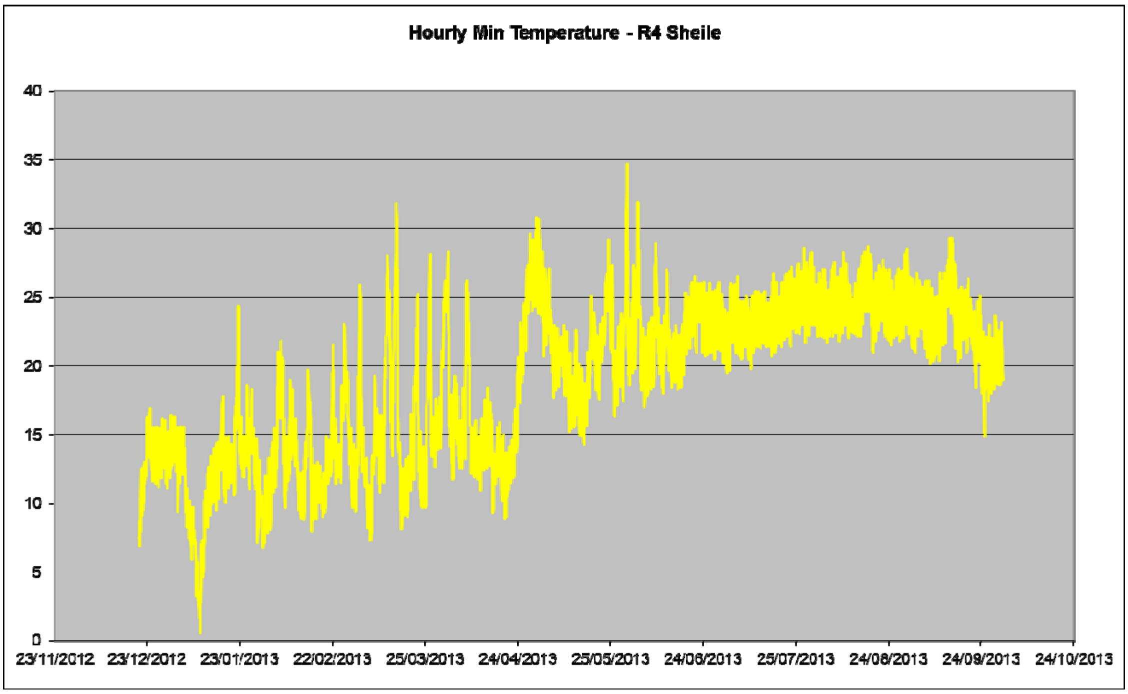

Figure 44: Hourly Minimum Temperatures measured at BGR Meteo Station R4-Sheile (Reservoir)

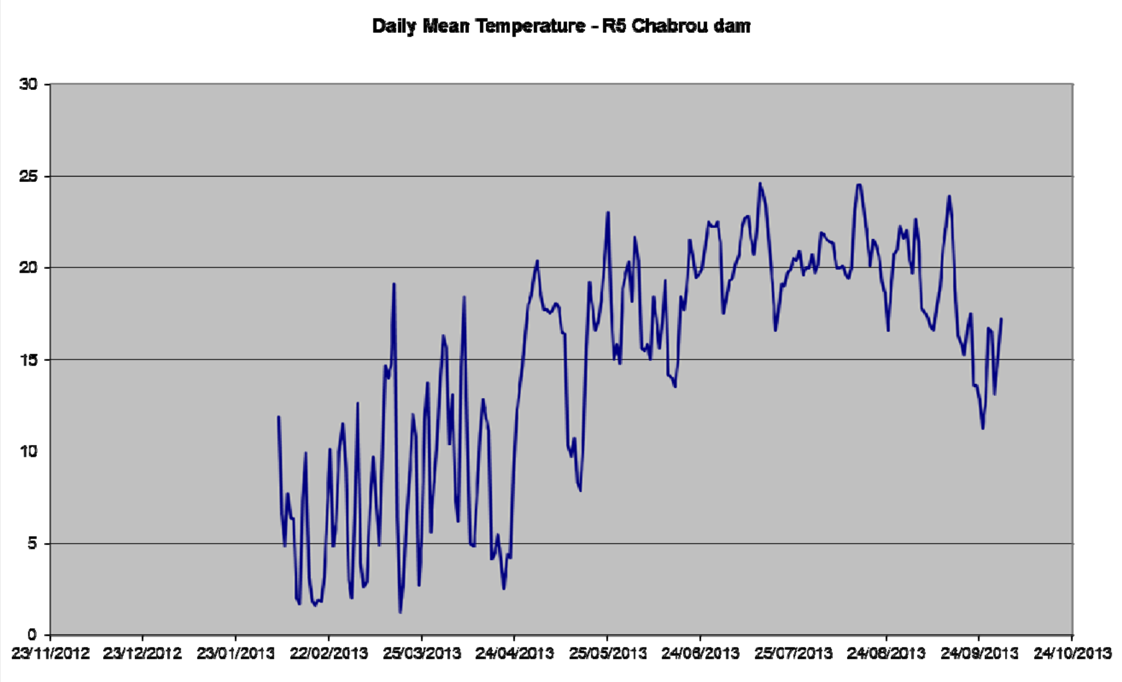

Figure 45: Daily Mean Temperatures measured at BGR Meteo Station R5-Chabrouh Dam (Treatment Plant)

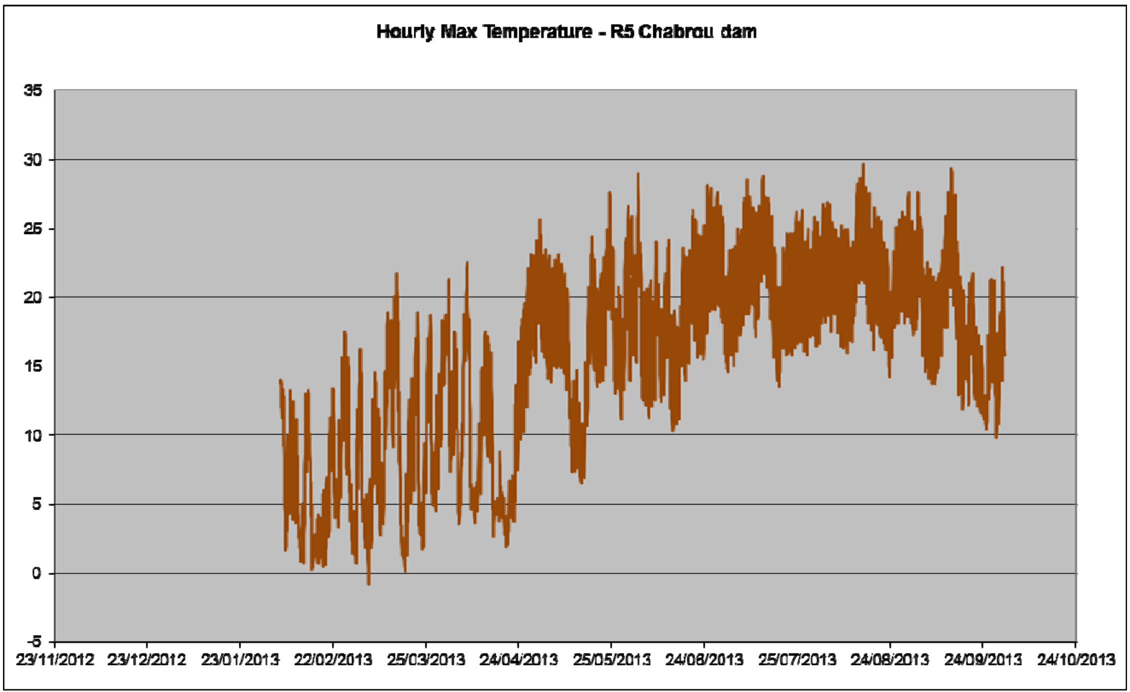

Figure 46: Hourly Maximum Temperatures measured at BGR Meteo Station R5-Chabrouh Dam (Treatment Plant)

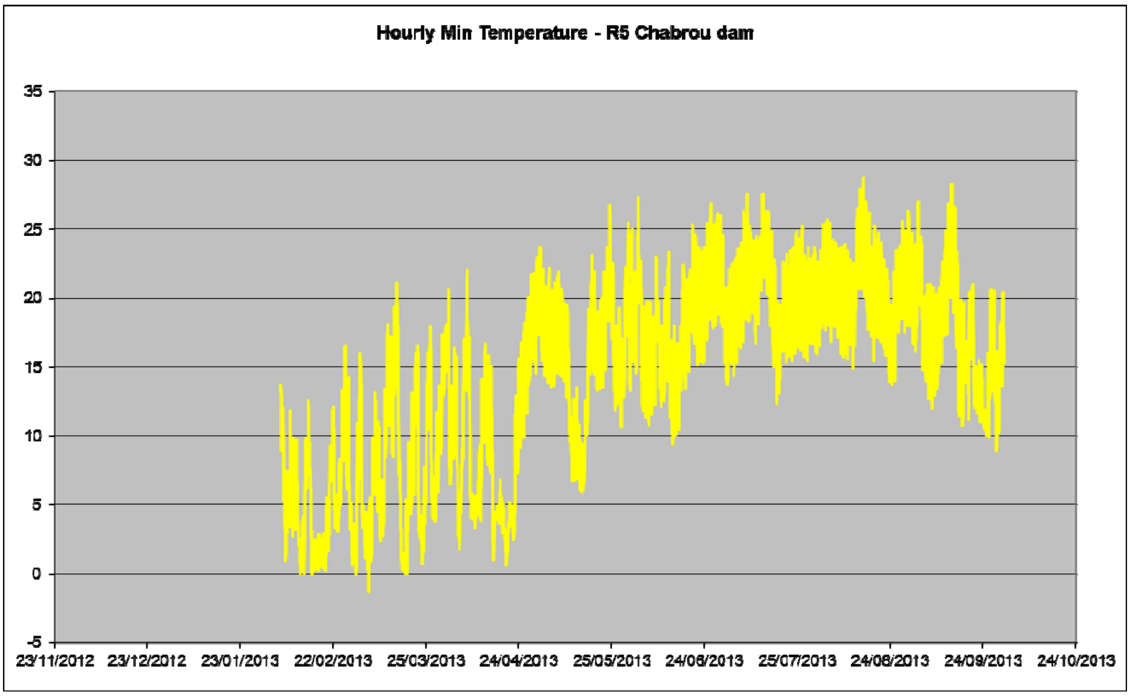

Figure 47: Hourly Minimum Temperatures measured at BGR Meteo Station R5-Chabrouh Dam (Treatment Plant)

Difficulties and Recommendations

In the study area, there is a danger of heavy rainfalls and high speed wind storms that must be taken in consideration for any climate installation to be robust and heavy duty, very well fixed to the base and very well tighten screws and components.

Avoid having any cable passing above the instruments even if it is higher than 10 m or away more than 10 m, due to a snow event the snow might be sticking on it, than with some wind it could fall down and reach any instrument, that might cause damages and or bad readings (Figure 48).

During snowy season, the rainfall collector can be kept in the snowy area. The naturally falling snow will not cause any damage to the instrument but might cause less collecting of precipitation due to possible snow melting outside the funnel (Figure 49).

Figure 48: Damaged Funnel and Device to refuse Birds due to a Piece of Ice falling on the Instrument

Figure 49: Rainfall Collector in Snow Covered Area

8 References

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