NATIONAL ACTIVITY FOR LEBANON

Project Proposal to Enhance the LARI Early-Warning System in the Beqaa Valley, Lebanon

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Country	Lebanon
Region	Beqaa Valley
Project Title	Enhance the LARI Early-Warning System in the Beqaa Valley
Duration	36 months
General objective	Enhance the resilience of farmers towards climate change and extremes in the Beqaa
Specific objective	Strengthen LARI EWS so as to support farmers in improving management of the adverse impacts of climate variability on their agricultural activities through agro-meteorological information and advice in the Beqaa Valley
Expected results	1) LARI EWS is strengthened through improved capacity of data collection, management and operating procedures for the production and communication of information. 2) New operational modules for drought risk and irrigation management are available for farmers in the Beqaa Valley.
Beneficiaries	Lebanese Agriculture Research Institute (LARI), farmers of the Beqaa, farmers' associations, agriculture extension service
Activities	Component 1: EWS infrastructure: 1.1 Agrometeorological observations 1.2 Weather forecasts 1.3 Agroecological zoning 1.4 Communication and information tools Component 2: Drought and Water Management Application 2.1 Weather data assessment 2.2 Soil, crop and management database development for irrigation modelling 2.3 Data integration 2.4 Model development 2.5 DWM application calibration and testing 2.6 Training, communication and dissemination
Objectively verifiable indicators of achievement	• The automatic weather station network in the Beqaa is fully operational and transmitting data to LARI. • The climatic database at LARI is operational, and data from AWS is stored and checked. • The agroclimatic zoning of the Beqaa is available at LARI. • The Drought and Water Management application is operational at the district and agroecological zone levels. • The new version of the website is online. • The new version of the LARI EWS app is available for downloading. • Advice is disseminated to target users each day. • Users are trained, and local stakeholders are informed.
Estimated costs	Component 1: 1,309,200 € Component 2: 782,980 € Project management: 747,820 € Overall: 2,840,000 €

Executive summary

Agriculture and Water Sector Strategies in Lebanon recognize the priority to adapt to climate change through the improvement of irrigation efficiency at the farm level and the strengthening of the early-warning system (EWS) considering that Agriculture is the main user of water resources and it is always at risk of water shortages.

The Beqaa Valley accounts approximately 41% of the cropped area with small farms cultivating fruit trees, cereals, olives, vegetables, grapes and other industrial crops. In this region, the Lebanese Agricultural Research Institute (LARI) has already developed a basic EWS to support farmers to better confront the impacts of climate variability. LARI manages an observation network composed by 53 automatic weather stations distributed nationwide. Nevertheless, data management (including quality control) and analysis are not appropriate for an operational EWS. Alerts (weather forecasts, advice on irrigation, bulletins on pest and disease outbreaks) are disseminated through the mobile application LARI-LEB and the LARI website to more than 13,000 registered farmers. A needs assessment, carried out in 2016, recommended to improve the services' quality giving more precise and targeted warnings and advices to farmers.

The project aims to increase the water use efficiency in agricultural sector while reducing the waste of water, nutrients and energy and increasing the farmer's income. The proposal is based on two expected results: i) LARI EWS is strengthened through improved capacity of data collection and management and operating procedures for information production and communication; and ii) New operational modules for drought (water) risk and irrigation management are available for farmers in the Beqaa.

The project strategy builds on the ascertainment that an EWS exists in Lebanon, so that farmers are largely aware of the potential benefit and demand more precise and tailored information and advice to better manage cropping activities. The project will support LARI matching offer of information with demand.

The proposed EWS infrastructure will support the information flow, based on an agrometeorological observation network and database, procedures to acquire weather forecasts from international providers, zoning of the intervention area, and tools and procedures for communication and dissemination.

The approach adopted for Drought and Water Management (DWM) proposes the reinforcement of the existing system through the adoption of a multi-level approach: i) at district/provincial scale, ii) for Agroecological zones and iii) at farm/plot scale. An initial pilot phase will focus on a limited number of farms, focusing on two to four major crops (potatoes, leafy vegetables, grapes, wheat and tomatoes). At the end of the project LARI will be able to provide operationally alerts and advice on the most efficient irrigation options to registered users at the district and agroecological levels and farm dedicated services on contractual basis.

The project direct beneficiary is LARI, whose EWS will be improved. Nevertheless the present proposal is targeted to the 35,000 farms of the Beqaa, involving around 300,000 inhabitants, farmers' associations and agriculture extension service. The sustainability and efficiency of the system are ensured by the inclusion of local stakeholders from the public and private sectors.

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List of Acronyms

AWS	Automatic Weather Station
CC	Climate Change
CNRS	Lebanese National Council for Scientific Research
DB	Database
DBMS	Data Base Management System
DIAM	Department of Irrigation and AgroMeteorology
DSS	Decision Support System
DWM	Drought and Water Management
ENPI	European Neighbourhood and Partnership Instrument
ET	EvapoTranspiration
ET_0	Reference EvapoTranspiration
ETP	Potential EvapoTranspiration
EWS	Early-Warning System
FAO	Food and Agriculture Organisation
GDCA	General Directorate of Civil Aviation
GCM	Global Circulation Model
GDP	Gross Domestic Product
GDPS	Global Data Processing System
GIS	Geographical Information System
GPRS	General Packet Radio Service
GUI	Graphical User Interface
ICT	Information and Communication Technology
IEWCS	Increasing Farmers Resilience through Early Warning and Advisory Climate Service
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel of experts on Climate Change
iOS	IPhone Operating System
IT	Information Technology
Kc	Crop coefficient
Ks	Stress coefficient
Ky	Response factor

LARI	Lebanese Agriculture Research Institute
LMS	Lebanese Meteorological Service
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MOPWT	Ministry of Public Works and Transport
NCRS	National Centre for Remote Sensing
P	Precipitation
QC	Quality Control
QGIS	Quantum Geographical information System
RCM	Regional Circulation Model
RH	Relative Humidity
SC	Steering Committee
SIM	Subscriber Identity Module
SMS	Short Message Service
SNC	Second National Communication
SOP	Standard Operation Procedure
SPI	Standard Precipitation Index
SQL	Structured Query Language
SR	Solar Radiation
SWHC	Soil Water Holding Capacity
T	Temperature
TNA	Training Needs Assessment
UAA	Utilised Agriculture Area
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization
WS	Wind Speed

Introduction

Under the ENPI, Lebanon and eight other Mediterranean countries have, since 2013, been involved in the ClimaSouth project, a regional European Union funded project tackling climate change.

The first meeting of the Steering Committee of ClimaSouth, held in September 2013, endorsed the principle of a national activity by countries in the field of mitigation or adaptation to climate change (CC) to meet the needs expressed by partners, and within the Second National Communication (SNC) and Technology Needs Assessment (TNA) reports (MOE, 2010, 2012).

The original proposal, "Increasing Farmers Resilience through Early Warning and Advisory Climate Service (IEWCS)" was the result of an initial field mission (Feb. 18 – Mar. 2, 2013) in addition to the needs expressed by Lebanese stakeholders. This proposal was described in a fact sheet that was approved by the Lebanese focal point, and shared furtherer with national concerned stakeholders as the Lebanese Agriculture Research Institute (LARI) and the Lebanese Meteorological Service (LMS) to collect their advice in to improve and update this proposal.

LARI has already developed a basic early-warning system (EWS) to support farmers to improve their resilience to CC through better management of the impacts of climate variability on their activity. This adaptation measure to CC was meant to provide agro-meteorological information to farmers via SMS. By 2015 this outreach system shifted from SMS to smartphone application and website and the subscribers to this service increased from 2,000 to more than 14,000.

Subsequent to the elaboration of the IEWCS proposal, bilateral meetings and discussions amongst Lebanese key partners (the project focal point, LARI and LMS) and the ClimaSouth project, the process for the formulation of the project proposal was defined.

An assessment report of the existing EWS needs[1] has been developed analysing the EWS under three components-- meteorological, agronomic and information--as well as from the farmer's point of view.

On the assessment a concept design was drafted, presented and approved in a meeting organised at LARI on June 28, 2016 at the presence of main stakeholders (LARI, MoA, MoE, FAO, CNRS, Litani River Authority). The project proposal has been formulated by a multidisciplinary team in collaboration with LARI on the basis of the workshop recommendations. The project proposal will be presented at a workshop in order to attract interest of potential donors in Lebanon to promote a more performing EWS in the Beqaa Valley.

Context

Lebanon still suffers from of development challenges, mainly related to lack of security, political instability and a high level of poverty. During recent years, the Syrian crisis exacerbated the situation because of approximately 1.03 million refugees registered in the country,[2] increasing Lebanon's population by 30%. The population increase, besides social and economic issues has led to an increase in greenhouse gas

[1] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016
[2] UNHCR, 2016, http://data.unhcr.org/syrianrefugees/country.php?id=122

emissions and consumption of natural resources. Moreover, it has led to a 12% increase in domestic water demand.[3]

Because of scarce water resources and high population density, Lebanon is and will be hardly affected by climate change.[4] According to the Second National Communication (SNC) Report, temperatures are expected to increase respectively by 1°C on the coast and 2°C inland by 2040, and rainfall is projected to decrease by 10% to 20% at the same time. Rainfall decrease will have dramatic impact on water availability and accordingly on national water security. Agriculture is the main economic sector, which will suffer due to a water shortage because of the semi-arid climate and where approximately 70% of the available water is used for irrigation. The sector weaknesses are found in the absence of long-term plans for irrigation water management and development, lack of adopting legislations for the establishment and management of water users associations, poor information and lack of information sharing, absence of linkage between research and extension for the dissemination of research results to increase water use efficiency, and weak agricultural extension in particular in rationalisation of water use in irrigation.[5] At the farm level, farms are small and fragmented. This incurs a relatively high cost of setting up irrigation systems, which are often old and inefficient. Moreover, a general lack of awareness about the value of water and its rational use exacerbates the water use inefficiency.

Thus, to reduce the adverse impacts on environmental, economic and social systems, Climate change adaptation is a priority for Lebanon. In fact, Lebanon already took action to mainstream climate change adaptation into the biodiversity,[6] water,[7] forestry[8] and agriculture[9] sectors.

Particularly, the Strategic Roadmap of the National Water Sector Strategy in Chapter 2, "Sector Management Initiatives," item 5.2. "Conservation Initiatives on Irrigation Water" identifies the improvement of water use efficiency in irrigation as a national priority. Moreover, the Ministry of Agriculture Strategy 2015-2019, identifies as priority for the good governance and sustainable use of natural resources the modernisation of irrigation system using new technologies and raising the irrigation efficiency at the farm level and the strengthening of the early-warning system as priority for agricultural research.

According to the INDC (Intended Nationally Determined Contribution), among the overarching objectives for water and agricultural sectors are "improving water efficiency and decreasing water loss in irrigation" and "developing an early-warning system for agricultural pests and climatic conditions."

Agriculture in the Beqaa

Agriculture is the third most important sector in Lebanon, contributes nearly 7% to GDP and employs around 15% of the active population. Agriculture is also one of the most vulnerable sectors to climate change in Lebanon due to the limited availability of water and land resources and the pressure exerted by population growth and urbanisation. In fact, higher temperature, reduced precipitation and high

[3] Republic of Lebanon, Lebanon's Intended Nationally Determined Contribution under the United Nations Framework Convention on Climate Change, 2015

[4] Republic of Lebanon, Lebanon's Second National Communication to the United Nations Framework Convention on Climate Change, 2011

[5] Republic of Lebanon, Ministry of Agriculture Strategy 2015-2019, 2014

[6] Republic of Lebanon, National Biodiversity Strategy and Action Plan, 2015

[7] Republic of Lebanon, National Water Sector Strategy, 2012

[8] Republic of Lebanon, National Forest Plan, 2015

[9] Republic of Lebanon, Ministry of Agriculture Strategy 2015-2019, 2014

evapotranspiration will decrease soil moisture and increase aridity, thereby affecting the productivity of crops.

According to *Agricultural Census 2010,* the total agriculture land area in Lebanon is estimated at 332,000 hectares, of which 231,000 hectares are cultivated (around 113,000 hectares are irrigated).[10]

Approximately 41% of the utilised agriculture area (UAA) is located in the Beqaa Valley, which has two districts: Baalbeck-Hermel and Beqaa. The Beqaa Valley, located roughly 30 kilometres east of Beirut, is approximately 120 kilometres in length and has an average width of about 16 kilometres. It is flanked by two mountain ranges: Mount Lebanon to the west and the Anti-Lebanon mountain range to the east. Two major rivers in the Beqaa Valley are the Orontes, which flows northeast to the Syrian border, and the Litani, which flows southwest before emptying into the Mediterranean in southern Lebanon. The region receives limited rainfall, particularly in the north, because Mount Lebanon blocks precipitation coming from the Mediterranean. The northern section has an average annual rainfall of 230 millimetres compared to 610 millimetres in the central valley.

Agriculture in the Beqaa is characterised by small farm holdings of few hectares, cultivating fruit trees, cereals, olives, vegetables, grapes and other industrial crops.

Approximately half of the UAA in the Beqaa is irrigated (61,700 hectares, according to the agriculture census of 2010). Drip irrigation is predominant, while sprinkler is used for field crops such as cereals, legumes, fodder crops and potato. Two thirds of the irrigated schemes rely on underground water and the remaining is covered by surface water from natural springs and rivers (**Errore. L'origine riferimento non è stata trovata.**). In western Beqaa, part of the water is supplied by the Litany River Authority. However, water use efficiency is less than 50% because of the use of non-appropriated water management practices (open channels, sprinkler system, surface irrigation, irrigation scheduling).

Even if the sector is providing relevant economic benefits to rural areas, inadequate water and plant pest/disease management represent a significant constraint to stabilize and increase agricultural production, particularly in the recent years, due to intensified seasonal and inter-annual climate variability and change.[11]

According to the IPCC and SNC, extremes are expected to increase in frequency and intensity. Drought period is expected to increase by two weeks. Dry spells and heat waves are expected to increase in frequency and intensity having direct impact on rain-fed annual crops, damaging pollination and fruit setting as well as the leaf development. Spring frost risk may augment as well and result in direct damage to all crops. With the expected increase of extremes, floods are likely to increase in frequency and intensity, causing direct damage to winter crops.

Pest outbreaks aren't necessarily climate-driven, and can occur due to a complexity of factors. However, climate plays an important role in increasing the frequency of these outbreaks (wheat brown and yellow rust, apple scab and fire blight on apple, and downy mildew on grapevine are those having major economic impact).

The effects of climate change make more uncertain and complicated the process of water management for irrigation while altering the stage and rate of development of a pathogen reduces the capacity to predict pest outbreaks in addition to the emergence of new pests and diseases. Traditional knowledge has proved to be inadequate to confront this new contest and to adapt the standard prescribed agronomic practices

[10] République du Liban, Résultats globaux du module de base du Recensement de l’Agriculture 2010, Ministry of Agriculture, 2012

[11] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016

considering both water and pest/disease management. Instead, there is a strong need for the continuous, timely monitoring of weather variables and plant phenological phases to provide proactive management recommendations on agricultural practices.[12]

Institutional context

The Lebanese Agricultural Research Institute (LARI) was established in 1964 as an autonomous public institution working under the supervision of the Ministry of Agriculture. The institute conducts applied and basic scientific research for the development and advancement of the agricultural sector in Lebanon. LARI is organised into eight experimental stations (Tel Amara, Tourbol, Kfardan, Kfarchakhna, Abdeh, Sour, Fanar and Lebaa). Among the various activities, LARI provides direct public services related to modern technological needs in the farming society, extension services for farmers. Since 2003, LARI has established an early-warning system (EWS) to support farmers in managing hazards that could damage crops such as drought or pest attacks. The EWS is becoming highly appreciated by farmers since information and advice are communicated daily through SMS and a mobile app.

The Ministry of Agriculture is the body in charge of formulating the strategic framework for the agricultural sector and the development of concrete policies and programs. The Ministry plays an important role in the management of natural resources (agricultural land, irrigation water, forests, fisheries and pastures) and rural dimensions of development programs. The Extension Department provide agricultural extension in Lebanon through field extension centres. In the benchmark area around Baalbek and Hermel, there are three extension centres: in Hermel, Labweh and Dooris. The Extension Department, suffering from the shortage of staff, usually outsources specific extension tasks to universities and non-public actors.[13] FAO partners with the Ministry of Agriculture providing technical supervision for water administrations, NGOs, and extension centres depending on the project and funding source.

The Lebanese Meteorological Service is under the General Directorate of Civil Aviation (GDCA) within the Ministry of Public Works and Transport (MOPWT). Currently, the LMS is subject to a major legal constraint which hinders the recruitment of technicians in order to improve the services of the department. The LMS was dissolved in order to be replaced by a higher committee for meteorology. Nonetheless, for various political reasons the latter was never created or implemented. the LMS is a de-facto entity which keeps providing the minimal possible of the national needs mentioned above. Initially, the LMS has the mandate to send early-warning messages, but due to the limitations in terms of human resources, and limited experience of the existing staff in agriculture, such service is currently suspended. Thus, LMS legislative aspects hinder the enabling environment to collaborate on EWS with LARI.[14]

The Chamber of Commerce Industry and Agriculture of Zahle and Beqaa generally represents the interests of the commercial, industrial and agricultural sectors of the Beqaa region and offers a wide range of services to members, private and public institutions and focus on the development of the local and economy through lobbying, networking and projects. The Agricultural Extension Office of the Chamber of Zahle and the Beqaa assists farmers, agricultural cooperatives and agricultural companies through training, field visits, publication of extension manuals on specific agricultural topics, agriculture trade shows and exhibitions, and market information systems.

[12] Ibid

[13] Burton E. Swanson and Kristin Davis. Status of Agricultural Extension and Rural Advisory Services Worldwide, GFRAS, 2014

[14] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016

The Litani River Authority was established in 1954 as a public institution with an administrative and financial personality and autonomy. Amongst its various functions, it implements the Litani irrigation, drying, drinking water and electricity projects, ensures water monitoring, and manages and exploits irrigation water in central northern Beqaa.

Current situation of EWS in Lebanon

The EWS at LARI is managed by the Department of Irrigation and AgroMeteorology (DIAM). Data collection and processing are conducted by the concerned departments (DIAM, Phytopathology, etc.), but the early-warning messages are released only by DIAM after approval from the Administrative Council.

As of June 2016, LARI had 53 automatic weather stations (PESSL model iMETOS 2 and 3) distributed nationwide but only 35 stations provide continuous data. Observed data is transmitted by GPRS to the database provided by PESSL. Data can be accessed through registration station by station, browsed and downloaded in different formats. Quality control and data management are performed with rudimentary tools at central level. LARI has local technicians responsible for the management of the stations and a bench for AWS reparation. Human resources for network maintenance and management are limited in terms both of number and qualification. Based on station data, weather forecasts are provided using METOS or DACOM services.

Data pertaining to pests and diseases is collected in the field by the Fruit Tree and Phytopathology departments, respectively. Actually, disease infestations for treatments and crop water demand for irrigation management are forecast using expert analysis rather than models. Sectoral experts develop the respective messages for dissemination. The messages are either of a warning/alert nature when climate extremes are expected, with preventive measures for action addressed to farmers. Once the EW message is approved by the head of the administrative council of LARI, it is disseminated by DIAM through the mobile application LARI-LEB application (mobile text messages before 2015) and the LARI website.

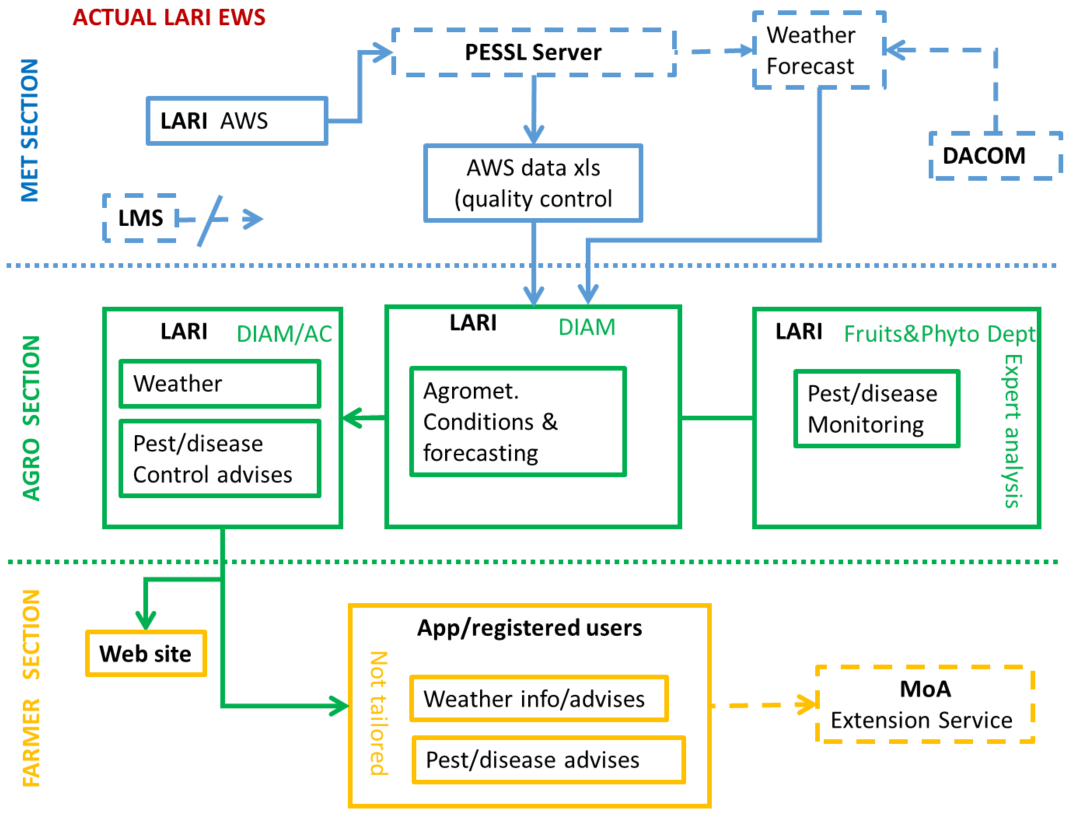

Figure 1, Information flow of the LARI EWS

LARI has, since March 2015, worked to develop a mobile application which provides daily information to registered users. This information includes weather forecasts, advice about irrigation periods and methods, and alerts about pest and disease outbreaks as well as the corresponding control measures. Actually, as of June 2016, more than 13,000 adherents were registered.

LARI APP
The LARI application is a smartphone app that transmits on a daily basis for farmers, fishermen, citizens, etc.: 1. Weather forecast for up to four days or a maximum of 10 days 2. Update of cumulated rainfall amount (after every rainy day) with comparison on mean and previous rainy season 3. Recorded maximal and minimal temperature 4. Alert regarding heat waves for farmers, suggesting them to irrigate 5. Alert farmers before expected frost, and suggesting to farmers to do practices to reduce the risk 6. Wind storms alerts for farmers, fishermen, etc. 6. Alert farmers of any pest outbreak based on field observation, mentioning the area of the outbreak, on what crop, and what are the chemical measures to achieve pest control 7. Based on climate forecast, suggest to farmers when it is appropriate to conduct procedures (sowing, harvesting, pruning, etc.) 8. News and events and general information for all subscribers

Table 1: Type of messages delivered by LARI-LEB application (source: Stephan, 2016)

A 2016 field survey conducted by ClimaSouth with 100 farmers distributed along the Beqaa Valley[15] concluded that:

- 43.75% of the surveyed farmers have heard of the LARI application and are using it.
- 6.25% of the surveyed farmers have heard of the LARI application but don't use it.
- 10% of the surveyed farmers hadn't heard of the application but used the website.
- 10% of the surveyed farmers hadn't heard of the application but, after the survey, they would upload it.
- 30% of the surveyed farmers hadn't heard of the LARI application and didn't show any intention of uploading it.

In conclusion, the recommendation of the survey that might help improving the LARI EWS were mainly focused on: i) improving the accuracy of the weather forecast taking into consideration the various microclimates in the Beqaa; ii) giving more precise and targeted advices and instructions along with their warnings for irrigation and pest outbreaks; and iii) publishing technical and scientific information for the public.

[15] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016

Objectives and results

Objectives

The **general objective** of the project is to "enhance the resilience of farmers towards climate change and extremes in the Beqaa."

According to the Ministry of Agriculture Strategy 2015-2019, and particularly the area of intervention "Enhancing agricultural scientific research" under the Course of Action V, "Strengthening agricultural research," the **specific objective** of the project is to:

Strengthen LARI EWS to support farmers improving management of adverse impacts of climate variability on their agricultural activities through agro-meteorological information and advice in the Beqaa Valley.

Expected results

The proposal is based on two expected results:

1) LARI EWS is strengthened through improved capacity of data collection and management and operating procedures for information production and communication
2) New operational modules for drought (water) risk and irrigation management are available for farmers in the Beqaa.

Beneficiaries

The project first beneficiary will be LARI, whose EWS will be improved. LARI will profit of training, technical assistance, tools and equipment. LARI will get through the project more visibility, an increased role in agriculture extension and of course in agricultural research.

EWS of LARI targets farmers throughout Lebanon. Actually, more than 13000 users are registered. The present proposal is targeted to farmers of the Beqaa. Nevertheless, the improvement of the EWS will benefit farmers also from other regions. In fact, the EWS infrastructure is common for the entire country. Farmers of the Beqaa will receive targeted information and advice for their specific needs, while farmers from other regions will continue to have information and advice as usual, but supported by an improved EWS infrastructure.

In the Beqaa 35,000 farms are potential beneficiary of the project involving around 300,000 inhabitants.

In addition to single farmers, farmers' associations and organisations will benefit from the improved EWS. Specific information activities are designed in order to sensitize farmers' organisations and help them to bridge the technology gap for farmers who are less skilled in IT.

The agriculture extension service of Ministry of Agriculture will take advantage of EWS products and will be involved in training activities. In addition to farmers' organisations, the extension service will support the EWS to reach farmers who are less skilled in IT through specific analogue products (e.g., bulletins).

Finally, LARI EWS provides warnings also to the general public to inform for possible weather hazards. Schools, universities of mountain areas are amongst the beneficiaries of the daily warning messages.

Littoral educational institutes receive warnings of flash floods that might hinder traffic circulations. Flash floods also occur in the northern inlands of the country where people will be prepared for possible risks. LARI's EWS reaches also journalists, decision-makers, TVs, newsletters and public in general.

Methodological Approach

EWS infrastructure

The project strategy builds on the ascertainment that a EWS for farmers exists in Lebanon, so that farmers are largely aware of the potential benefit and demand more precise and tailored information and advice to better manage cropping activities.

Observed and forecasted climatic trends as well as the necessity to improve the cropping efficiency in terms of inputs use make urgent the demand of agrometeorological services for farmers. Services actually offered by LARI EWS can be improved in terms of quality and quantity with a relatively limited support compared to the enormous benefits to be gained by the agricultural sector.

In fact, LARI already proved to have extended scientific and technical knowledge to manage and develop an improved EWS, but, LARI has limited human resources.

The purpose of the project is indeed to support LARI matching offer of information with demand. That will be possible by evolving LARI EWS to respond to farmers specific needs, as highlighted by the survey done in 2016 by ClimaSouth,[16] specifically to progress from general to precise information targeted towards specific users.

Furthermore, global changes oblige to project the EWS into the future taking into consideration the expected impact of Climate Change, the development of Beqaa Valley agriculture in relation to market regional trends and agricultural innovative techniques and the advancements in information and computing technologies, meteorological models and communication. On that basis, the future EWS will be designed to be appropriate for the farmer demand, sustainable for LARI management and apt to support the agricultural development of Beqaa Valley.

The improvement of the LARI EWS demand to attentively analyse the actual system and identify its strengths and weaknesses, as well as opportunities and threats.

The sustainability of the system will largely rely on LARI human resources which actual availability needs to be taken into consideration for any further development. The project will support LARI to develop better performing analysis tools and to automate the procedures for data analysis and modelling. Moreover, Standard Operating Procedures for warning and advice issuance will help optimise the flow of information.

The EWS information flow relies on a robust infrastructure based on an agrometeorological observation network and database, procedures to acquire weather forecasts from international providers, zoning of the intervention area, and the tools and procedures for communication and information conveyance.

The EWS infrastructure will rely on tools and databases developed using freeware and open source software, in order to ensure the maximum of ownership and possibility to further improve and adapt to the evolving needs of EWS.

[16] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016

Table 2. SWOT analysis for LARI EWS

(adapted from J. Stephan, NEEDS ASSESSMENT FOR EARY WARNING SYSTEM IN THE BEQAA, ClimaSouth 2016)

Strengths	**Opportunities**
Functional AWS (53, incl. 17 in the Beqaa) Bench for AWS maintenance at LARI Existing network infrastructure Weather forecasts available per each station Functional mobile APP 13,000 APP subscribers Existing website General satisfaction of farmers Existing trained researchers	ClimaSouth assistance Existing potential donors Possibility for recruitment for technical staff Possibility to interface AWS Possibility for querying PESSL database Access to GCM/RCM outputs Availability of Seasonal forecasts ICT Availability of models for water balance and pests/diseases Presence of multiple stakeholders (private and public)
Threats	**Weaknesses**
Absence of governmental decision for recruitment Difficulties of database management Difficulties of calibration of models (pest, water EWS) Theft of AWS (very rare) Difficulties in finding locations for AWS representing all the agro-bioclimatic zones Poor collaboration with MoA Extension system Limited collaboration with LMS Limited ICT literacy of farmers Data availability for agroecological zoning	Limited human resources AWS may be not representative of all agroclimatic zone in Beqaa Dependency on PESSL server Absence of climatic DB Lack of software for data processing, and data control Weather forecasts relying on DACOM or METOS Absence of tailored advice APP not user friendly for substantial number of farmers Absence of calibrated models (water and pests) for the Beqaa Inappropriate mitigation message, divergent from FAO and MoA extension approach Diversity and complexity of agriculture systems and of farmers

The EWS infrastructure will allow analysis and modelling of water and pests adopting an approach per small homogenous zones (or agro-bioclimatic /agroecological zones) where focusing on specific crops/pests.

Agroecological zoning, with related database, will be developed as a reference for water and pest modelling at territorial scale. Main information layers will include soil, land cover, morphology, crops, and agronomic practices.

Moreover, the sustainability and efficiency of the system are related to the inclusion of local stakeholders from the public and private sectors. Main public ones are MoA extension service, Litani River Authority, water establishments of specific areas, the Chamber of Commerce, Industry and Agriculture of Zahle and Beqaa.

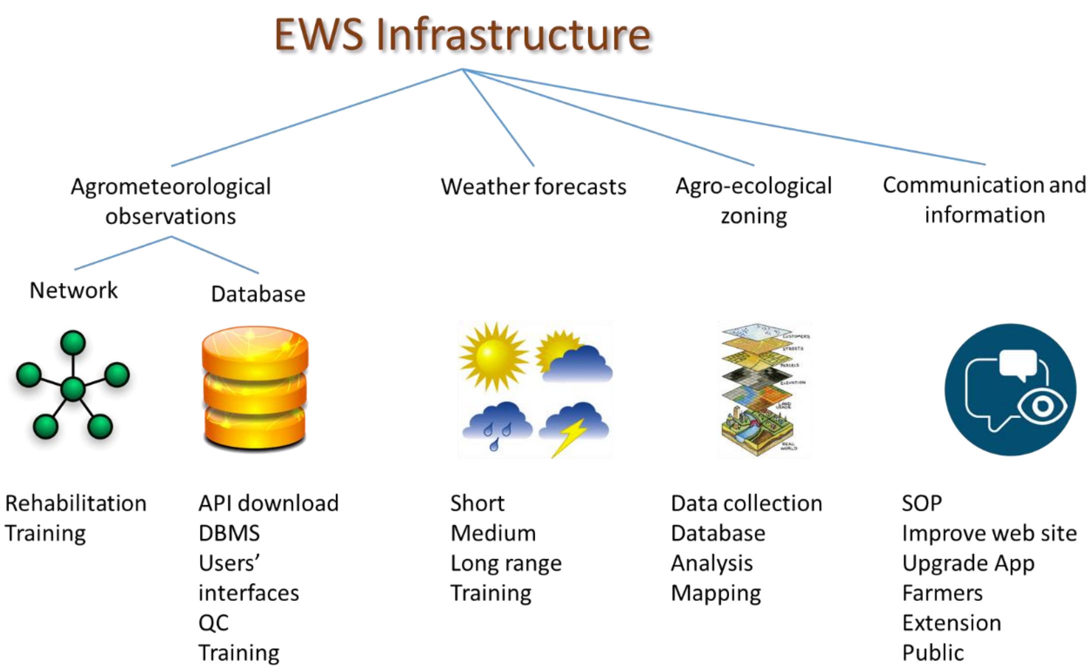

Figure 2. EWS infrastructure components

Private no profit stakeholders include cooperatives and farmers' associations, while private sector for-profit include companies such as agricultural materials suppliers which support customers and follow-on in terms of their product's applications. These companies provide extension for clients but don't engage in broad-based public sector style extension. These stakeholders will be part of the information flow, receiving the alerts and advice to circulate them amongst farmers who are less skilled in IT but will also facilitate the feedback from the field to LARI. Feedback information will not be only targeting the quality and the efficiency of the system but also a valuable source of information on the agricultural campaign.

Moreover, a framework for collaboration with MOA and FAO should be established about the advice to be delivered within the early warning in order to avoid inappropriate messages.

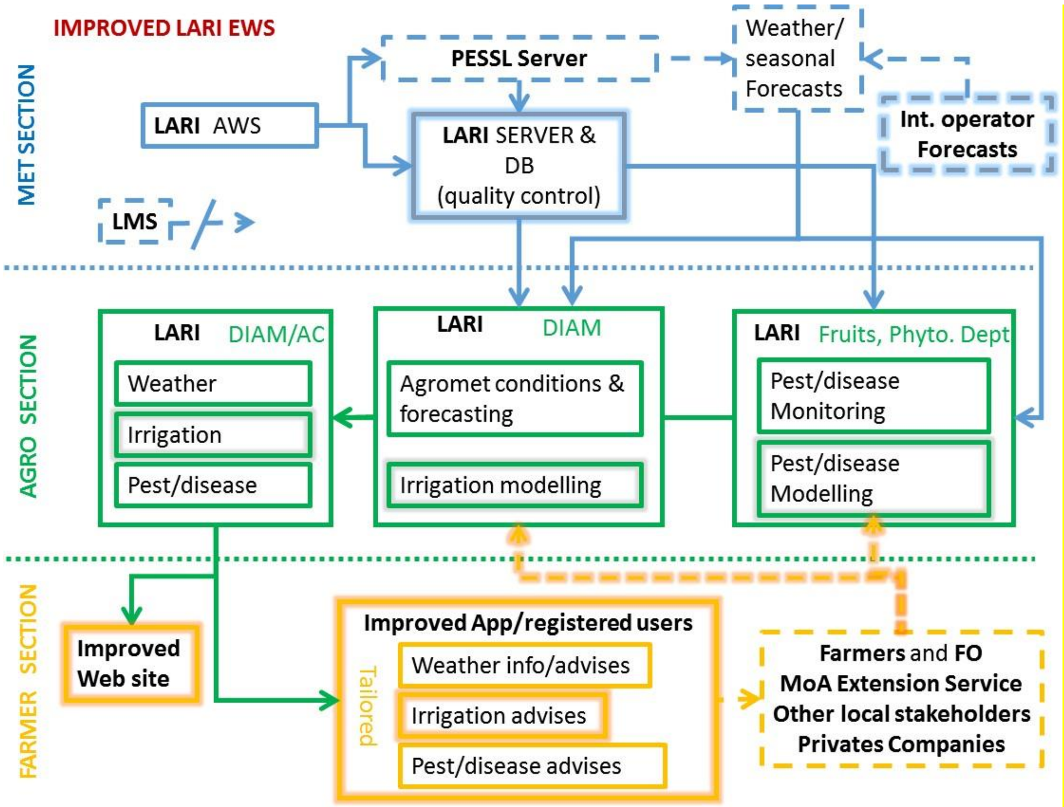

Figure 3. Information flow of the improved LARI EWS

Agricultural Water Management

Although EWS for irrigation is a crucial issue, the development of a system providing suitable information for irrigation scheduling is a great challenge for LARI due to the complexity and diversity of crops, soils, microclimates, and planting calendars in the Beqaa. Moreover, technical limitation in water supply (water isn't always pressurised, and water meters are lacking) reduce the effectiveness of the information for a significant part of users. Furthermore, detailed data needed for the calculation of crops' water demand is often unavailable, due to the lack of essential information at local scale; data regarding ET_O, soil temperature, soil moisture, soil texture, are needed, in addition to the type of cropping system (crops, cultivars, density of plantation, plantation calendar, etc.). LARI already conducted field trials using freeware water-balance crop models. However the results were applicable only to the trial plots. Alternatively, LARI calculates a simple water balance using the crop stages and ET_o computed through data from AWS or Class A weather stations.

Therefore, considering all these constraints, the strategy adopted for drought and water management (DWM) proposes the reinforcement of the existing system through the adoption of a multi-level approach based on the availability and quality of data (Table 3):

1) Climatic: Suitable for administrative regions/districts, with risks determined using only weather variables
2) Pedo-climatic: Suitable homogeneous zones, with risk and irrigation advice are determined using weather and soil data on small, homogeneous pedo-climatic zones
3) Agroecological: Suitable for homogeneous zones; risks are determined using weather, soil and generalised crop data, with water demand calculated on small homogeneous agro-ecological zones per specific crops with generalised phenological information and soil characteristics

4) Irrigation: Suitable for farm/plot scale, with risks determined using weather data and detailed in-field observed data on crops, soil and water management

Table 3. DWM complexity level versus data availability and scale of application

DWM complexity level versus data availability	Weather	Soil	Crop	Management
1. Climatic, regional, large-scale	+	-	-	-
2. Pedo-climatic	+	+	-	-
3. Agro-ecological	+	+	+	-
4. Irrigation (plot-specific)	+	+	+	+

The system should therefore be designed according to the following principles:

1. Modular, with the ability to consider different geographical scales with their specific stakeholders
2. Flexible, with the ability to provide information using input data (weather, soil, crop, management) with different levels of accuracy
3. Based on different level of complexity and addressed to different type of users (farmers, water managers, extension service staff, policy/decision-makers, etc.)
4. Dynamic, based on daily water balance generated in its simplest form from weather data and also in a complex form from soil and crop/management data at the level where they are available
5. Inclusive of site/zone/region-specific risk alert and irrigation advice support
6. Prone to consider different phases of drought stress (meteorological, agricultural, hydrological)

The DWM system will be modular and developed for three main application scales and four data-availability scenarios and complexity levels:

a) Simple DWM for district/provincial scale where data availability is limited only to weather data (first level)
b) DWM for Agroecological zones where large scale and generalised soil data and eventually crops phenological data (second and third levels, respectively) are available; it will permit to provide drought (water stress) risk and a rough irrigation advice over a large area;
c) Complex DWM for farm/plot scale (fourth level) where all data (weather, soil, crop, management) of good quality will be available on a small scale while also making it possible to provide, in addition to drought (water stress) risk, adequate crop/site specific irrigation advice.

The DWM application will access all data needed through specific protocols for the various databases. The main components of irrigation EWS and data flow are shown in Fig. 4.

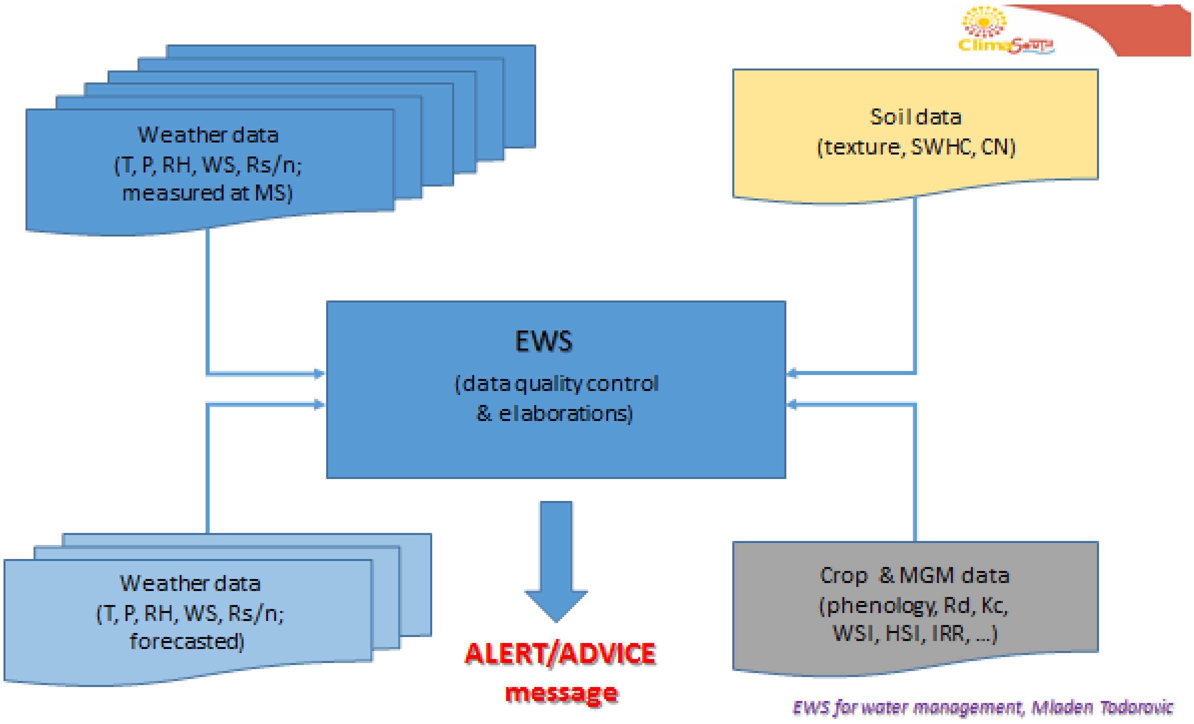

Figure 4. Data flow and the components of the DWM system for agricultural water management

<u>DWM for district/provincial scale</u>

The first level of complexity: The system will run using only the weather data from the AWS. Water balance model will be based on daily precipitation and reference evapotranspiration estimate. Evapotranspiration will be calculated suing the FAO Penman-Monteith approach. The system will consider: a) cumulative water deficit after the last precipitation; b) overall water deficit starting from a preselected date (defined by users, as in the past 10, 20, 30 days); c) difference in water deficit in respect to the historical water balance for the same period (when the historical DB will be available); d) Standard Precipitation Index (SPI); e) heat stress, i.e., air temperature above the historical average threshold. Weather forecasting data will be used in order to present the foreseen trend for at least three days.

DWM for agroecological zones

The second and third levels of complexity: At this scale the system will run using weather, soil and crop (where available) data. In the case of availability of only soil data, the soil/water balance will be developed and the irrigation advice will be designed to consider: a) shallow-rooted crops (for the top 50 cm of the soil profile); b) moderately deep-rooted crops (for top 100 cm); and c) very deeply rooted crops (for the top 150 cm).

Where crop data is available, soil/water balance will run for some generalised as to the expected crop parameters and growing season.

At this scale, the system will run on the AWS spot (for the estimate of reference evapotranspiration). The data will be interpolated over the area of interest using a GIS-based spline interpolation technique frequently applied for climatological and hydrological variables. Thus, the soil/water balance will be estimated and drought (water stress) risk maps will be developed and updated on a daily basis for agroecological zone. Irrigation advices will be available where crop data is available for specific locations when the user inserts the soil characteristics (texture and depth), crop type and planting date. Otherwise, the irrigation advice will be based only on the climatic water deficit and rough/generalised soil and crop data, i.e., considering the specific agro-ecological zones.

DWM for farm/plot scale

Complex DWM will be an extended version of the simple system and it will be useful for the specific locations where soil, crop and water management data is fully available (Fig. 1). This data will be supplied either by the LARI staff or farmers interested for a site specific drought risk assessment and irrigation management. The system will run a daily-basis soil/water balance model as described in *FAO 56 Irrigation and Drainage Technical Document* (Allen et al., 1998) and other irrigation materials. Soil water depletion in the root zone will be estimated for each crop of the farmers' interest and the level of water stress and adequate irrigation management will be determined.

An initial pilot phase will focus on a limited number of farms, focusing on two to four major crops (potatoes, leafy vegetables, grapes, wheat and tomatoes). The pilot phase will make it possible to calibrate and test the system on a plot scale. At the end of the project LARI will be able to provide operationally alerts and advice on the most efficient irrigation options to registered users on a limited number of major crops at the district and agroecological levels. Moreover, LARI will have the capacity to provide site-specific services for farms with a service contract approach. The overall objective is to increase the water use efficiency in agricultural sector while reducing the waste of water, nutrients and energy (i.e., negative environmental impact) and increasing the farmer's income.

Table 4. Application scales of DWM

Level/phase	Pilot	Scaling-up
District	Test (limited crops)	Operational (limited crops)
Agroecological zone	Test (limited crops/zone)	Operational (limited crops)
Farm	Test (limited crops/farm)	Operational on demand (limited crops)

Concurrently, the demonstration fields will be used for training of farmers, water managers and agricultural advisers. This will be of great benefit to them because it will consent direct involvement in the demonstration program and give a possibility to comprehend the advantages of the proposed EWS and to support its dissemination amongst the farmers in the Beqaa.

Description of Activities

The project proposal is based on two main components, thus corresponding to the expected results that can be independently implemented. Component 1 "EWS infrastructure" is preliminary and functional to the implementation of the other component, which is "water use efficiency and management."

1. EWS infrastructure: Agrometeorological observations and data management, weather forecasting, communication and information
2. EWS application for improvement of water use efficiency and management: modelling, calibration, testing and advice

The overall project length is assumed at 36 months.

Component 1: EWS infrastructure

LARI's EWS assessment clearly identifies the weakness of the actual system run by LARI. Thus far, the observation network optimisation and management and data storage, control and management at LARI are the main weaknesses identified.

1.1 Agrometeorological Observations

1.1.1. Network rehabilitation: LARI has 53 automatic weather stations (AWS) distributed nationwide, with 17 in the Beqaa Valley.[17] Out of the 53 stations, only 35 stations provide continuous data. The network is composed by PESSL AWS model iMETOS 2 and 3. All stations measure multiple climatic parameters including temperature, wind speed and direction, relative humidity, atmospheric pressure, total solar radiation and precipitations. In 20 stations, soil moisture and temperature are measured. Additionally, as in the remaining stations, instruments were damaged by rodents. In major stations (i.e., Class A station of Tal Amara in the Beqaa) leaf wetness and ET0 are also registered. These stations may suffer from reception problem, stop functioning when it snows, and require periodic maintenance and battery substitution. Moreover, the location of many stations isn't appropriate in terms both of placement and representatives of different agro-ecosystems.

- 1.1.1.1. Technical specifications will be prepared on the basis of the inventory of existing AW stations managed by LARI in the Beqaa Valley, in order to rehabilitate the existing network, according with international technical standards, appropriateness of coverage according to LARI needs and maintenance capacity.
- 1.1.1.2. Evaluation of the provision of scientific-grade equipment for high AWS performance
- 1.1.1.3. Tender preparation, purchase and delivery
- 1.1.1.4. Preliminary laboratory tests
- 1.1.1.5. Field Installation and compilation of AWSs' metadata and maintenance log according to "Guide to Meteorological Instruments and Methods of Observation WMO No. 8." Metadata should include: sensors and collected variables, height, exposure and surroundings, error risk assessment)

1.1.2. Network maintenance: LARI disposes of a bench for the reparation and maintenance of the AWSs at Tal Amara. One full time contracted technician is responsible for the maintenance of these stations (one visit/month/station). Additionally, there are eight to twelve technicians, who are responsible over AWS in their respective regions. The current dedicated team is neither sufficient nor qualified to fulfil the tasks of an efficient EWS. Spare parts are procured through annual bidding process, following a predefined tender. The institute has also direct communication with mobile providers in Lebanon to recharge GPRS SIM on an annual basis, through a procurement process.

[17] Tal Amara, El Kaa (two stations), Ras Baalback, Jabbouleh, Mansoura, Douris, Btedii, Mcheytiyeh, Kfardan, Talia, Haouch Omara, Terbol, Bar Elias, Ammik, Khorbet Kanafar, and Saghbine

1.1.2.1. Technical specification for upgrading of the bench for AWS maintenance (materials, software, parts, tools) and for strengthening regional capacities of maintenance (laptops, software, tools)

1.1.2.2. Tender preparation, purchase and delivery

1.1.2.3. Preliminary laboratory tests

1.1.3. Local database: LARI has not its own independent climatic database; AWS data is directly transferred to PESSL server by GPRS, on an hourly basis, and then stored by PESSL in a web climatic database accessible through the web service (www.fieldclimate.com). Actually, data is downloaded in Excel format. Quality control doesn't rely on any software or program, but rather on the expertise of the technical staff that isn't qualified in climatology and in data control. Thus, the institute needs an autonomous central database in Lebanon, fed directly from AWS. Additionally, it is essential to establish data storage with its specific management software and a program for data quality control.

1.1.3.1. Design of data flow and system architecture

1.1.3.2. Technical specifications of hardware and software, tenders preparation

1.1.3.3. Realisation of civil works

1.1.3.4. Hardware/software purchase and installation

1.1.3.5. Development of automatic procedures for data download (direct from AWSs and through PESSL DB), including reprogramming of AWSs

1.1.3.6. Development of a relational database and the Database Management System (DBMS), using open source, and freeware software such as PostgreSQL

1.1.3.7. Development of users' interfaces, allowing multiuser remote access to the database, including export formats and standards

1.1.3.8. Development of data validation and Quality Control system (according to the WMO Guide on GDPS, WMO No. 305)

1.1.4. Training on network/database management: Existing staff at LARI, both at Tal Amara and in the regions, needs an articulated capacity building program, not only to implement the new EWS but also to run their routine activities. The main topics identified are AWS maintenance, weather-data quality control, data transfer and storage. Nevertheless at the beginning of the project a training-needs assessment will be performed.

1.1.4.1. Preparation of training modules and training material (in collaboration with the World Meteorological Organization Education and Training Programme and Regional Training Centres)

1.1.4.2. Delivery of training (in collaboration with the World Meteorological Organization Education and Training Programme and Regional Training Centers)

1.1.4.3. Distance learning and backstopping, through the dedicated distance-learning platform.

1.2. Weather Forecasts (Short, Medium and Long-Range)

1.2.1. Numerical weather forecasts relying on national or international providers: for weather forecasting, LARI relies on the web service that METOS (and DACOM) provide using the meteorological data of the four main AWS around the country (Tal Amara, Abdeh, Fanar and Tyre). Forecasts are generated by proprietary numerical mesoscale model and delivered (with subscription) via the webpage www.fieldclimate.com on an hourly basis up to six days. These forecasts aren't gridded, nor are they suitable as feeding agrometeorological or disease models.

1.2.1.1. Identification of requirements for weather forecasts to be used within the EWS

1.2.1.2. NWF retrieval: development of the download chain, test

1.2.1.3. NWF downscaling: development of the downscaling procedures (dynamic and/or statistical)

1.2.2. Training on weather forecasts (in collaboration with the World Meteorological Organization Education and Training Programme and Regional Training Centers)

1.2.2.1. NWF management and downscaling

1.2.2.2. Seasonal forecasts application in agriculture and water management

1.3. Agroecological Zoning

1.3.1. Identification of the requirements for EWS homogeneous zones (variables to be used, scale) is conducted in order to provide targeted information for farmers, modelling of water and pests will adopt an approach per small homogenous zones (or agro-bioclimatic /agroecological zones) where focusing on specific crops/pests.

1.3.2. Data-collection and valorisation of existing data at MoA, FAO, NCRS, etc., encompasses Land Cover/Use, soil (texture, soil water holding capacity, depth, infiltration rate, cover, etc.), morphology (altitude, slope, exposure), irrigation, crops (variety, growing season and calendars, phenological phases duration and sensitivity to water stress, crop coefficients) and cropping practices, irrigation method and practices (full, deficit, regulated, rain-fed), data harmonisation, geo-database development and geographical data analysis.

1.3.3. The Beqaa agroecological zones are comprehensively mapped and described in terms of soil, climate, cropping systems.

1.3.4. GIS advanced training (Spatial Analysis)

1.4. Tools for Information and Communication

Actually LARI uses the LARI LEB mobile app for communicating EWS messages either of a warning/alert and the nature of the advice. The website is also used to disseminate information and advice. Moreover, LARI organizes farmer’s days to inform farmers about research results. Nevertheless, the communication component should be strengthened in order to respond to the emerging needs (information tailored to specific users, inclusion of other stakeholders, reaching farmers less skilled in IT, etc.).

1.4.1. Standard Operating Procedures are defined for the preparation and communication of warnings and advice (technical meeting).

1.4.2. Establishment of a technical committee with MoA and FAO for pests and disease management advice (mainly on the use of pesticides). The technical committee would periodically review the type of messages to be delivered according to the risk and crop.

1.4.3. LARI LEB app improvement and training in order to route warnings and advice to specific users, avoiding the use of a general unified message for all. The LARI LEB app should allow the users to define their needs in terms of information (crops, type of advice/warning, geographical area) and to provide LARI direct feedback information, as well information on the cropping campaign (phenological phase, status of the crop, water management, etc.) to be used for modelling.

1.4.4. Web system improvement (agrometeorological page) and training: The actual LARI web page is improved technically in order to better provide EW information and data.

1.4.5. Non-IT services: In order to bridge the gap existing between a relevant part of farmers' community and IT solutions, LARI is supported to regularly produce analogical information products (i.e., bulletins) to be circulated through local stakeholders and MOA for an extended outreach service.
1.4.6. Training of extension system, organisation of three training workshops of two days in Tal Amara for specific topics (water, pest/disease advice, use of the LARI LEB app)
1.4.7. Information of local stakeholders: Organisation of 10 seminars of one day each for the information of local stakeholders (farmers organisations, chamber of commerce, water management entities) about the system in different areas of the Beqaa
1.4.8. Farmers information campaign: Organisation of an information campaign for farmers (flyers, posters, radio/television emissions, presentation in the main towns of the Beqaa)
1.4.9. Conference: Organisation of a national conference in Beirut to present the EWS. At the end of the project a two-day conference will be organised for different stakeholders (100), including the decision/policy makers from the governmental institutions. This event will have objective to discuss the functionality of EWS and its impact as well as to support further extension of the system in other regions of Lebanon.

Component 2: EWS Application for Improved Water Use Efficiency

The DWM (Drought and Water Management) application will consider different aspects of crop production and corresponding risks although it will focus primarily on drought (water) stress and irrigation management.

The preconditions for the full operational functionality of the DWM application are: i) correct functioning and maintenance of agro-meteorological stations; and ii) remote data delivery, quality control and storage on a dedicated server.

<u>Description of the system and its components</u>

The DWM application will be based on a water balance model managed by LARI and relying for products dissemination on a web interface and a mobile-device app developed in three languages (English, French and Arabic). The DWM application use weather, soil, crops and water management data (according with the scale of application):

- Weather observed (AWS) data: Air temperature (T), precipitation (P), relative humidity (RH), wind speed (WS) and direction, solar radiation (SR). The same data will be available also through the weather forecasting service.
- Soil data: At least soil texture, soil water holding capacity (SWHC) and effective depth.
- Crop data will include the crop specific phenological parameters, root depth, crop coefficient (Kc), stress coefficient (Ks), yield response factor (Ky), potential yield, market price range and other data.
- Management data will include the characteristics of the irrigation system (method, discharge, water source, quality and availability) as well as the costs of specific management practices. A part of management data will be inserted during the feeding of the system while another part, related to the effective inputs of water will be uploaded by the user of the system via web service during the crop growing season.

2.1 Weather-Data Assessment

Each weather station (AWS) will be characterised in terms of:

- Data availability period
- ETo methodology assessment
- Climatic zones assessment (P/ETo)
- Climatic deficit assessment (P-ETo)

For each location (AWS) a database will be developed including the following: soil characteristics, crops of interest and growing period, (expected) climatic risks, surface area around the station (estimated using the Thiessen polygons determination based on the locations of all AWS), availability of water for irrigation. Database and report will be delivered. The main activities are:

2.1.1 Field survey and data collection

2.1.2 Data elaboration and database development

2.2 Soil, Crop and Management Database Development for Irrigation Modelling

A set of databases will be developed for the water modelling needs, including soil, crop and management data, respectively. Soil data will be gathered using the available soil maps in the digital and hard-copy formats, including soil characterisation and analysis (farm/plot level). Most important soil data will be texture, soil water holding capacity, depth, infiltration rate, cover, etc. Crop data will include the name, variety, growing season, root depth, phenological phases duration and sensitivity to water stress, crop coefficients, yield response to water coefficient, expected risks, allowed water stress threshold, potential yield, market value, etc.. Management data will include common irrigation method, management practices (full, deficit, regulated, rain-fed), water source and quality, layout of irrigation system, operational discharge and pressure, etc. Crop, soil and management data will be arranged in a standard format to permit their easy use for specific scenarios. Database and report will be delivered. The main activities are:

2.2.1 Field survey and data collection

2.2.2 Data elaboration and databases development

2.3 Data Integration

Procedures and standards for the interoperability of databases and the water balance model will be developed. Moreover, procedures for weather data interpolation will be developed for the use at district and agroecological zone scales. Database and report will be delivered.

The main activities are:

2.3.1 Development of procedures and standards for interoperability

2.3.2 Weather data interpolation procedures

2.3.2 Development of relational links for generalised crop and management data

2.4 Model Development

The model and other components will be developed and integrated as explained before in the methodological chapter. A daily-basis soil/water balance model will be developed (FAO 56 Irrigation and Drainage Technical document, Allen et al., 1998, and other irrigation material). The web and mobile app interfaces will be developed, and a user manual will be produced and delivered.

The main activities are:

2.4.1 Model design and modules development

2.4.2 Modules integration and functional testing

2.4.3 Design and integration with user interface and apps

2.4.4 User-manual preparation

2.5 DWM Application Calibration and Testing

The testing of DWM application and its components will be done at the pilot sites selected by LARI. The number of pilot sites should be at least six, and they should be distributed in such a way to consider the priority crops, irrigation requirements, farmers' needs and operation functionality. Each of priority crops should be tested at least at two sites for a period of at least two growing seasons. The pilot sites will permit the calibration and testing of EWS as well as the operational functionality of the entire system related to the data transmission and elaboration, alert/advice messages and their effective implementation. The EWS will be tested in combination with the specific best management practices defined for each target area by LARI experts and farmers. Demonstration protocols will be developed for each site. Each demonstration site will be equipped with a set of sensors for the measurement of soil moisture and conductivity in the root zone, which will permit the calibration and testing of the soil water balance module used within the EWS and irrigation support module. If necessary, leaf-water potential will be measured at predawn and midday. EWS calibration and testing database and report will be produced and delivered.

The main activities are:

2.5.1 Site selection, identification of reference AWS and setup of demonstration protocols

2.5.2 Soil characterisation

2.5.3 Acquisition and installation of soil sensors

2.5.4 Experimental work, data collection and calibration and testing of EWS

2.5.5 Final report on DWM application report preparation

2.6 **Training, Communication and Dissemination**

In the pilot, demonstration fields will be used for training and organisation of field days for farmers, water managers and agricultural advisers. Four training courses will be organised, each for approximately 20 participants and a duration of three days. The objective of the courses will be to teach water managers, farmers, extension service staff, etc., how to use the system. Ten field days will be organised (during the second and third years), mainly for farmers (each for 25 participants) in order to promote the system, show how it can be used and to try to extend the calibration and testing also to another farms according to the farmers' interests. Moreover, during these events will be possible to discuss the functionality of EWS and to receive the feedbacks from the direct users of the system.

The main activities are:

2.6.1 Organisation of training courses and reporting

2.6.2 Organisation of field days and reporting

Project Management

The project-management component has been designed to ensure proper management, accounting, monitoring and reporting mechanism as well as transversal issues as the training-needs assessment and the development of an e-learning platform.

0.1 Overall project management and coordination through project coordinator
0.2 Establishment and operation of project offices at LARI's Tal Amara station
0.3 Selection and contracting of external auditor
0.4 Establishment of administrative procedures (accounting, documentation, tender procedures, etc.)
0.5 Establishment of a Steering Committee (SC) and organisation of one SC meeting per year
0.6 Training-needs assessment: A TNA will be performed at the beginning of the project in order to identify the main training topics needed to strengthen LARI central and peripheral capacities to run the EWS
0.7 Development of a dedicated distance-learning platform (Moodle or other freeware and open source system) in order to provide training material and distance learning courses to be used for LARI internal training activities.
0.8 Project communication activities (website, press releases, etc.)
0.9 Donor reporting (technical and financial) semi-annual reports or other, based on donor requirements
0.10 Establishment of external technical evaluation: Final or other, based on donor requirements, including a survey for user-satisfaction assessment.

Staffing

The following figures are deemed essential to the conduct of activities described in the previous chapter:

N	Key experts	Expertise	Input (working days)
1	Team leader	Institutional capacity development, early warning, project management, agrometeorology	779
2	IT and database expert	Relational databases and geo-databases design, PostgreSQL, PostGIS and PL/pgSQL, REST WebServices development, model engineering, Java2EE, C language, GIS technology knowledge	485
3	Agrometeorologist	Crops growth modelling, irrigation scheduling, DSS, GIS, EWS and in-field implementation/demonstration programs in the Mediterranean	385

4	Web/app programmer	Web application development, mobile application development (Android, iOS), Java2EE, C Languages, Android stack technology, iOS and Swift knowledge, OneSignal technology (or equivalent)	170
5	Communication expert	Communication tools, information project design and web application GUI (Graphical User Interface)	121
		TOTAL KEY EXPERTS	**1,940**
	Short-term experts	**Expertise**	**Input (working days)**
6	Weather observation network expert	Experience in installation and maintenance in AWS networks, data transmission, AWS maintenance, calibration and reparation, and weather-data quality control	93
7	Meteorologist	Numerical weather forecasting, downscaling, programming	80
8	GIS expert	GIS, geo-databases, spatial analysis, remote sensing, QGIS, ESRI software	55
9	Training expert	Training-needs assessment, preparation of institutional capacity building programmes, distance learning tools	52
10	Irrigation expert	Irrigation engineer with deep knowledge of Beqaa irrigation systems	30
11	Soil expert	Soil scientist, pedologist with deep knowledge of Beqaa soils	30
		TOTAL (SHORT-TERM)	340
	TOTAL		**2,280**

National Technicians	Months
Data management and quality-control technicians	36
IT technician	14
Field technicians	38
AWS technicians	7
Agricultural technicians	6
TOTAL	**101**

Hypothesis

The existence of an operational EWS for farmers in Lebanon is a fact rather than a hypothesis, as well as LARI's technical capacity to run it. The demand for tailored, specific and timely information, advice and warnings on weather, water and pests/diseases is also an ascertainment (more than 13,000 subscribers to LARI LEB app), reassured by the needs assessment conducted by the ClimaSouth project in 2016.[18] Thus the conditions for an investment in reinforcing LARI EWS are present. The main hypothesis is that the investment for improving the actual EWS is minimum related to the expected benefits for the agricultural

[18] J. Stephan, Needs assessment for early-warning system in the Beqaa, ClimaSouth, 2016

sector, even without considering environmental and social benefits. If the improved EWS could reduce costs or damages to agricultural production by 1%, €7 million would be the annual benefit of the project. Environmental and social considerations nevertheless would deserve even more attention. Accordingly, potential donors for the project should not be lacking. In the perspective of a funding for the EWS, Lebanese Government would probably grant the recruitment for technical staff that LARI already needs.

Even if LARI has not yet established a strong partnership with the extension system and local stakeholders in the Beqaa Valley (e.g., the Chamber of Commerce, farmers' organisations, private sector), in the perspective of the improved EWS, such actors become strategic and essential. The hypothesis is therefore that LARI will establish new fruitful partnership and collaboration and that those actors are willing to join the EWS.

Risks

The human capacities of LARI should be reinforced. The project will take charge of the capacity building of LARI staff, while it cannot overcome LARI understaffing. In fact, contracted technical and administrative staff during the project period isn't a guarantee for the sustainability of the EWS service. A prerequisite for a successful implementation of a EWS is the recruitment, through the appropriate administrative channels, of the technical profiles identified by LARI at the moment of the EWS needs assessment (June 2016). The following table presents the needs in terms of staff for proper management of the EWS.

Human resources
1 technician for data control and management (IT)
1 electrician
1 technician (IT) to develop, maintain and use new software for data storage, programming, etc.
2 Engineers and technicians for the irrigation pilot project
2 agriculture engineers with phytopathology background
2 agriculture engineers with entomology background
1 technician with at a Master degree in agriculture or modelling or IT to follow-up the pest/disease models
1 assistant for data entry of pest and disease

The absence of governmental decision for recruitment could be the major risk for the project sustainability in the long term, while there are no risks concerning LARI technical and scientific capacity to run the EWS.

The project will also strengthen the automation of EWS procedures, such as data management and control, pest and water-needs modelling, in order to reduce the pressure on LARI staff for time-consuming activities.

Concerning the observation network, two threats have been identified: the theft of AWS, which is definitely very rare and the difficulties in finding locations for AWS representing all the agro-bioclimatic zones.

Concerning this second point, LARI DIAM already planned to invest in a general relocation of many AWSs in 2017. Even if the entire network would not be reorganised, the project will ensure to complete the process in order to have the best representation of the Beqaa Valley's agroecological zones.

Concerning agroecological zoning, data availability at appropriate scale could be a threat to homogeneous mapping and characterisation. At the workshop held in Beirut on June 28 for the validation of EWS concept, FAO and NCRS claimed the availability of cartographic layers on soil, land cover and an existing previous agroecological zoning, which is probably not useful for the EWS purpose but could be a basis for departure.

The risk of discontinuous Internet connection at Tal Amara could hinder the management and updating of the climatic database. For this reason, a dual method of feeding the database is foreseen: directly from AWSs and indirectly through the existing PESSL online database. If LARI cannot directly receive real-time data from the stations, such data could later be downloaded from the PESSL database.

The recent history of LARI indicates that a major threat in pest modelling is the model calibration for Beqaa conditions and pathogens. The project, in order to avoid this possible threat, will invest time and resources in the model calibration, preferring to concentrate at the beginning for specific crops/diseases and only in a second phase enlarge to others.

Poor collaboration with MoA Extension system is actually a limit for EWS efficacy, the project will invest in the strengthening of the collaboration between LARI and the extension system, through different means such as information, training, technical committees, etc.

The EWS will be developed relying on LARI capacities, assuming that the collaboration with the Lebanese Meteorological Service is actually impossible due to legal constraints. Complementarity between LARI and LMS is currently the only possible relation. Nevertheless, the project will try involve LMS where and how it would be possible, even inviting LMS personnel to attend trainings related to meteorological and climatological issues.

The assessment of EWS needs done by ClimaSouth in 2016 revealed that limited ICT literacy hampers the use of EWS by farmers. Thus the project, thanks to improved collaboration with the extension system and other local stakeholders, will also invest in non-IT solutions for providing less skilled farmers with advice and warnings.

Gantt

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
0	**Project management**																																				
0.1.	*Overall project management and coordination through project coordinator*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
0.2.	*Establishment and operation of project offices at LARI's Tal Amara station*	*x*	*x*																																		
0.3.	*Selection and contracting of an external auditor*		*x*																																		
0.4.	*Establishment of administrative procedures (accounting, documentation, tender procedures, etc.)*		*x*	*x*																																	
0.5.	*Establishment of a steering committee*			*x*																																	
0.6.	*Training-needs assessment*			*x*																																	
0.7	*Development of a dedicated distance-learning platform.*				*x*	*x*	*x*	*x*																													
0.8	*Project communication activities*				*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
0.9	*Donor reporting (technical and financial)*						*x*						*x*						*x*						*x*						*x*						*x*
0.10	*Establishment of external technical evaluation*																																		*x*	*x*	

	Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
1	**EWS infrastructure**																																				
1.1	*Agrometeorological observations*																																				
1.1.1	Network rehabilitation			x	x	x	x	x	x	x	x	x	x	x	x																						
1.1.2	Network maintenance			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.1.3	Local database				x	x	x	x	x	x	x	x	x	x	x	x	x	x																			
1.1.4	Training on network/database management							x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2	*Weather forecasts*							*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*			*x*																	
1.2.1	Numerical weather forecasts relying on national or international providers							x	x	x	x	x	x	x	x	x	x																				
1.2.2	Training on weather forecasts										x						x			x																	
1.3	*Agroecological zoning*																																				
1.3.1	Identification of requirements for EWS homogeneous zones			x																																	
1.3.2	Data collection				x	x	x																														
1.3.3	Data harmonisation, geo-database development and analysis							x	x	x	x																										
1.3.4	Mapping of the Beqaa agroecological zones											x	x	x																							
1.3.5	GIS advanced training (spatial analysis)										x																										

	Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
1.4	*Tools for information and communication*																																				
1.4.1	Standard operating procedures													x																							
1.4.2	Establishment of a technical committee with MoA and FAO for pest/disease management													x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
1.4.3	LARI LEB app improvement																		x	x	x	x	x	x										x	x		
1.4.4	Web system improvement																								x	x	x								x		
1.4.5	Non-IT services																												x	x	x	x	x	x	x	x	x
1.4.6	Training of extension system																								x									x		x	
1.4.7	Information of local stakeholders																											x								x	
1.4.8	Farmers information campaign																															x	x	x	x	x	x
1.4.9	Conference																																			x	

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
2	**EWS application for improvement of water use efficiency: modelling, calibration, testing and advice**																																				
2.1	*Weather-data assessment*																																				
2.1.1	Field survey and data collection										x	x																									
2.1.2	Data elaboration and database development											x	x																								
2.2	*Soil, crop and management database development for irrigation modelling*																																				
2.2.1	Field survey and data collection							x	x	x																											
2.2.2	Data elaboration and databases development							x	x	x	x																										
2.3	*Data integration*																																				
2.3.1	Development of procedures and standards for interoperability									x	x	x																									
2.3.2	Weather-data interpolation									x	x																										
2.3.3	Development of relational links for generalised crop and management data												x	x	x																						
2.4	*Model development*																																				
2.4.1	Model design and module development		x	x	x	x	x	x	x	x	x	x	x	x																							
2.4.2	Module integration and functional testing									x	x	x	x	x	x	x	x	x																			
2.4.3	Design and integration with user interface and apps												x	x	x	x	x	x																			
2.4.4	User-manual preparation																		x	x	x																

	Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
2.5	*DWM application calibration and testing*																																				
2.5.1	Site selection, identification of reference AWS and set-up of demonstration protocols									x	x	x	x	x	x																						
2.5.2	Soil characterisation									x	x	x																									
2.5.3	Acquisition and installation of soil sensors										x	x	x	x	x	x																					
2.5.4	Experimental work, data collection and calibration and testing of EWS														x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2.5.5	Final report on DWM application report preparation																																		x	x	x
2.6	*Training, communication and dissemination*																																				
2.6.1	Organisation of training courses																													x		x		x		x	
2.6.3	Organisation of field days and reporting																			x	x	x	x	x								x	x	x	x	x	

Deliverables

Deliverables	Month					
Training-needs assessment	3					
Project reports	6	12	18	24	30	36
Distance learning platform	7					
Soil, crop and management database	10					
Trainings	10	to	35			
Agroecological zoning and database	13					
AWS network rehabilitated	14					
Local climatic database	17					
DWM Model	20					
LARI EWS APP	34					
LARI EWS website	34					
Final Conference	35					
Calibrated DWM Model	36					
Evaluation report	36					

Budget

Component 1

N.	Item	Unit	No. of units	Unit cost €	Total cost €	Notes
1	**Personnel**					
1.1	International Experts (Key experts)	day	890	600	534,000	
1.2	National experts	day	0	300	0	
1.3	Allowances LARI researchers	month	36	2,000	72,000	
1.4	Support personnel					
1.4.1	*Secretary*	*month*	*0*	*600*	*0*	
1.4.2	*Drivers*	*month*	*0*	*500*	*0*	
1.4.3	*Technicians*	*month*	*63*	*1,500*	*94,500*	*Field technician, IT technician, AWS technicians and maintenance technicians*
2	**Travels**					
2.1	International travel	travel	24	500	12,000	
2.2	DSA	day	275	260	71,500	
2.3	Local per diem	day	300	30	9,000	
2.4	Local accommodation	day		100	35,500	
3	**Equipment and works**					
3.1	AWS	number	7	11,000	77,000	
3.2	Spare parts	lots	1	60,000	60,000	For AWS maintenance branch
3.3	Server	number	1	8,000	8,000	For climatic database
3.4	Workstations	number	10	2,000	20,000	
3.5	Scientific equipment	number	2	2,000	4,000	Equipment for AWS check, test and calibration
3.6	Vehicles	number	0	35,000	0	
3.7	Civil works	number	7	0	123,000	Server room, AWS maintenance branch, AWS protection
3.8	Power/air conditioning		0	2,000	0	
3.9	Informatics other	number	108	3,000	5,200	Laptops/tablets, small devices, USB keys, smartphones
3.10	Hardware other	number	13	692.31	9,000	Storage for data, hardware for laboratories, hardware for AWS installation
3.11	Software	number	1	1,000	1,000	
4	**Training**					
4.1	Premises	day	53	200	10,600	
4.2	Logistics	session	29	1,000	29,000	
4.3	Materials	session	29	500	14,500	
4.4	Coffee/lunch breaks and participation fees	person/day	1,360	40	54 400	
5	**Other**					
5.1	Offices	month	0	500	0	
5.2	Consumables	month	0	300	0	

5.3	Offices running costs	month	0	200	0	
5.4	Communication/internet	month	0	150	0	
5.5	Vehicles running costs	month	0	400	0	
5.6	Publications and dissemination materials	number	2	2,500	5,000	
5.7	Translations	number	4	3,000	12,000	
5.8	Other Services	number	40	1,200	48,000	GPRS, PESSL, media, advertising, devices, web hosting, allowances partners, printing, data provision and formatting, training services WMO RTC
5.9	Evaluation	number	0	20,000	0	
5.10	Audit	number	0	30,000	0	
5.11	Reporting	number	0	1,000	0	
5.12	Steering Committees and other project meetings	number	0	2,000	0	
5.13	Project management costs	month	0	2,000	0	
	TOTAL Component 1				**1,309,200**	

Component 2

N.	Item	Unit	No. of units	Unit cost	Total cost €	Notes
1	**Personnel**					
1.1	International experts (key experts)	Day	760	600	456,000	
1.2	National experts	Day	60	300	18,000	
1.3	Allowances LARI researchers	Month	28	2,000	56,000	
1.4	Support personnel		0	0	0	
1.4.1	*Secretary*	*Month*	*0*	*600*	*0*	
1.4.2	*Drivers*	*Month*	*0*	*500*	*0*	
1.4.3	*Technicians*	*Month*	*38.00*	*1,500*	*57,000*	
2	**Travels**					
2.1	International travel	Travel	36	500	18,000	
2.2	DSA	Day	252	260	65,520	
2.3	Local per diem	Day	322	30	9 660	
2.4	Local accommodation	Day	120	100	12,000	
3	**Equipment and works**					
3.1	AWS	Number	0	11,000	0	
3.2	Spare parts	Lot	0	60,000	0	
3.3	Server	Number	1	8,000	8,000	
3.4	Workstations	Number	0	2,000	0	
3.5	Scientific equipment	Number	6	2,000	30,000	Soil sensors
3.6	Vehicles	Number	0	35,000	0	
3.7	Civil works	Number	0	0	0	
3.8	Power/air conditioning	Number	0	2,000	0	

3.9	Informatics other	Number	28	3,000	11 800	Laptops, smartphones with data-transfer cards
3.10	Hardware other	Number	0	0	0	
3.11	Software	Number	0	0	0	
4	**Training**					
4.1	Premises	Day	12	200	2 400	
4.2	Logistics	Session	4	1,000	4,000	
4.3	Materials	Session	14	500	7,000	
4.4	Coffee/lunch breaks and participation fees	Person/day	490	40	19,600	
5	**Other**					
5.1	Offices	Month	0	500	0	
5.2	Consumables	Month	0	300	0	
5.3	Offices running costs	Month	0	200	0	
5.4	Communication/internet	Month	0	150	0	
5.5	Vehicles running costs	Month	0	400	0	
5.6	Publications and dissemination materials	Number	0	2,500	0	
5.7	Translations	Number	0	1,000	0	
5.8	Other Services	Number	6	1,000	6,000	Soil characterisation at plot sites
5.9	Evaluation	Number	0	20,000	0	
5.10	Audit	Number	0	30,000	0	
5.11	Reporting	Number	2	1,000	2,000	
5.12	Steering Committees and other project meetings	Number	0	2,000	0	
5.13	Project management costs	Month	0	2,000	0	
	TOTAL Component 2				**782,980**	

Project Management

N.	Item	Unit	N. of units	Unit cost €	Total cost €
1	**Personnel**				
1.1	International Experts (Key experts)	Day	540	600	324,000
1.2	National experts	Day		300	0
1.3	Allowances LARI researchers	Month			
1.4	Support personnel				
1.4.1	*Secretary*	*Month*	*36*	*600*	*21,600*
1.4.2	*Drivers*	*Month*	*72*	*500*	*36,000*
1.4.3	*Technicians*	*Month*		*1,500*	*0*
2	**Travels**				
2.1	International travel	Travel	17	500	8,500
2.2	DSA	Day	102	260	26,520
2.3	Local per diem	Day		30	0
2.4	Local accommodation	Day		100	0
3	**Equipment and works**				

3.1	AWS	Number		11,000	0
3.2	Spare parts	Lot		60,000	0
3.3	Server	Number		8,000	0
3.4	Workstations	Number	2	2,000	4,000
3.5	Scientific equipment	Number		2,000	0
3.6	Vehicles	Number	2	35,000	70,000
3.7	Civil works	Number		0	0
3.8	Power/air conditioning	Number		2,000	0
3.9	Informatics other	Number	1	3,000	3,000
3.10	Hardware other	Number		0	0
3.11	Software	Number		0	0
4	**Training**				
4.1	Premises	Day		200	0
4.2	Logistics	Session		1,000	0
4.3	Materials	Session		500	0
4.4	Coffee/lunch breaks & participation fees	Person/day		40	0
5	**Other**				
5.1	Offices	Month	36	500	18,000
5.2	Consumables	Month	36	300	10 800
5.3	Offices running costs	Month	36	200	7,200
5.4	Communication/internet	Month	36	150	5 400
5.5	Vehicles running costs	Month	72	400	28 800
5.6	Publications and dissemination materials	Number	4	2,500	10,000
5.7	Translations	Number	4	1,000	4,000
5.8	Other Services	Number	1	10,000	10,000
5.9	Evaluation	Number	2	20,000	40,000
5.10	Audit	Number	1	30,000	30,000
5.11	Reporting	Number	6	1,000	6,000
5.12	Steering Committees & project meetings	Number	6	2,000	12,000
5.13	Project management costs	Month	36	2,000	72,000
	TOTAL PM				**747 820**

Overall budget

N°	Item	Unit	N. of units	Unit cost €	Total cost €
1	**Personnel**				
1.1	International experts (key experts)	Day	2,190	600.00	1,314,000.00
1.2	National experts	Day	60	300.00	18,000.00
1.3	Allowances LARI researchers	Month	64	2,000.00	128,000.00
1.4	Support personnel	Day			-
1.4.1	*Secretary*	*Month*	*36*	*600.00*	*21,600.00*
1.4.2	*Drivers*	*Month*	*72*	*500.00*	*36,000.00*
1.4.3	*Technicians*	*Month*	*101*	*1,500.00*	*151,500.00*
2	**Travels**				-
2.1	International travel	Travel	77	500.00	38,500.00
2.2	DSA	Day	629	260.00	163 540.00
2.3	Local per diem	Day	622	30.00	18,660.00
2.4	Local accommodation	Day		100.00	47,500.00
3	**Equipment and works**				
3.1	AWS	Number	7	11,000.00	77,000.00
3.2	Spare parts	Lot	1	60,000.00	60,000.00
3.3	Server	Number	2	8,000.00	16,000.00
3.4	Workstations	Number	12	2,000.00	24,000.00
3.5	Scientific equipment	Number	17	2,000.00	34,000.00
3.6	Vehicles	Number	2	35,000.00	70,000.00
3.7	Civil works	Sites	7	17,571.43	123,000.00
3.8	Power/air conditioning	Sites	0	-	-
3.9	Informatics other	Forfeit	137	145.99	20,000.00
3.10	Hardware other	Forfeit	13	692.31	9,000.00
3.11	Software	Forfeit	1	1,000.00	1,000.00
4	**Training/Seminars**				
4.1	Premises	Day	65	200.00	13,000.00
4.2	Logistics	Session	33	1,000.00	33,000.00
4.3	Materials	Session	43	500.00	21,500.00
4.4	Coffee/lunch breaks & participation fees	Person/day	1,850	40.00	74,000.00
5	**Other**				
5.1	Offices	Month	36	500.00	18,000.00
5.2	Consumables	Month	36	300.00	10,800.00
5.3	Offices running costs	Month	36	200.00	7,200.00
5.4	Communication/internet	Month	36	150.00	5 400.00
5.5	Vehicles running costs	Month	72	400.00	28 800.00
5.6	Publications & dissemination materials	Number	6	2,500.00	15,000.00
5.7	Translations	Number	16	1,000.00	16,000.00
5.8	Other Services	Number	17	3,764.71	64,000.00
5.9	Evaluation	Number	2	20,000.00	40,000.00
5.10	Audit	Number	1	30,000.00	30,000.00
5.11	Reporting	Number	8	1,000.00	8,000.00
5.12	Steering Committees & project meetings	Number	6	2,000.00	12,000.00
5.13	Project management costs	Month	36	2,000.00	72,000.00
	TOTAL				**2,840,000.00**

Logical Framework

	Intervention logic	Objectively verifiable indicators of achievement	Sources and means of verification	Assumptions
General objective of the project	To enhance the resilience of farmers towards climate change and extremes in the Beqaa	Farmers in the Beqaa receive targeted warnings and advice responding to their requirements	External evaluation	
Specific objective of the project	*To strengthen LARI EWS to support farmers improving management of adverse impacts of climate variability on their agricultural activities through agro-meteorological information and advice in the Beqaa Valley*	At least the 13,000 actual users of LARI EWS benefit of improved system and tailored advice The number of EWS users in the Beqaa is doubled	LARI,EWS APP registered users, extension service, farmers' organisations	LARI and other national partners (MoA, etc.) endorse the project.
Expected Result 1	LARI EWS is strengthened through improved capacity of data collection and management and operating procedures for information production and communication	AWS in the Beqaa are fully operational and transmitting data to LARI database. Climatic database at LARI is operational and data from AWS are stored and checked. The new version of LARI EWS APP is available for downloading. Advice is disseminated to target users each day. The agroclimatic zoning of the Beqaa is available at LARI. The new version of the website is online.	LARI, EWS APP, Google Play, LARI Web Site, project Reports, Press	LARI provides the facilities for project implementation, and the Lebanese Government recruits the technical staff needed for LARI EWS proper management.
Expected Result 2	The water use efficiency in agriculture is improved through provision of alerts and advice for farmers in the Beqaa.	DWM application is operational at district and agroecological zones levels, advice is regularly sent to users.	LARI, EWS APP, LARI Web Site, project Reports, Farmers and farmers' associations	The EWS infrastructure is completed, and data is available for DWM modelling.

	Activities	Means	Costs €	Preconditions
1	**EWS infrastructure**		**1,309,200**	
1.1	*Agrometeorological observations*	*Personnel, travel, equipment, services, civil works, spare parts, hardware and software, and logistical facilities*	*727,055*	Assessment of network conditions, security in the area, access to AWS places, availability of local technicians, GPRS coverage, availability of trainees, and facilities for training
1.2	*Weather forecasts*	*Personnel, travel, services, hardware, software and other equipment*	*119,075*	Internet access, availability of local technicians, availability of trainees, and facilities for training
1.3	*Agroecological zoning*	*Personnel, travel, services and logistical facilities*	*88,270*	Data accessibility and availability, Availability of trainees and facilities for training
1.4	*Tools for information and communication*	*Personnel, travel, services, logistical facilities and information materials*	*374,800*	Information chains developed, agreements with the national stakeholders, Engagement of MoA and FAO, Internet access, web server access, availability of local technicians, engagement of extension service, and engagement of national and local stakeholders

	Activities	Means	Costs €	Preconditions
2	**DWM application**		**782,980**	
2.1	*Weather data assessment*	*Personnel, travel, hardware*	*52, 560*	*LARI AWS network and database availability*
2.2	*Soil, crop and management database development for irrigation modelling*	*Personnel, travel*	*76,720*	*Data availability*
2.3	*Data integration*	*Personnel, travel, hardware*	*80,920*	*Database developed*
2.4	*Model development*	*Personnel, travel*	*168,080*	*Access to input data in real-time*
2.5	*DWM application calibration and testing*	*Personnel, travel, hardware, scientific equipment and services*	*297,500*	*Time to cover at least two growing seasons, accessibility and security to six test areas, AWS near each site*
2.6	*Training, communication and dissemination*	*Personnel, travel and logistics*	*107,200*	Engagement of local stakeholders

0	**Project management**		**747,820**	
0.1.	*Overall project management and coordination through project coordinator*	*Personnel, travel*	*301,420*	*Stability, security, LARI engagement*
0.2.	*Establishment and operation of project offices at LARI's Tal Amara station*	*Personnel, offices, running costs, vehicles and equipment*	*204,800*	*Availability of office space at Tal Amara*
0.3.	*Selection and contracting of external auditor*	*Personnel*	*30,000*	
0.4.	*Establishment of administrative procedures (accounting, documentation, tender procedures etc.)*	*Personnel*		*Depending on donors' procedures*
0.5.	*Establishment of a steering committee*	*Personnel, services and logistics for meetings*	*12,000*	Engagement of National
0.6.	*Training-needs assessment*	*Personnel, travel*		*LARI engagement*
0.7	*Development of a dedicated distance learning platform.*	*Personnel, services*	*139,600*	*High-quality Internet service*
0.8	*Project communication activities*	*Personnel, travel and information materials*	*14,000*	
0.9	*Donor reporting (technical and financial)*	*Personnel*	*6,000*	
0.10	*Establishment of external technical evaluation*	*Personnel, travel*	*40,000*	