



Final Technical Report

Component 2.4

Innovation for Climate Adaptation and Resilience

FOR

Building Food Security through Agro-Met Innovative Advisory Services (AMIAS)

CIC 96

Arbonaut Ltd. (Lead) in association with the Clean Energy Nepal
(sub-consultant)

July 2022



Policy lessons from pilot project that supported Belaka farmers to access advanced agro-met advisory services for better harvest

About the initiative

The project supported approx.5000 local farmers in accessing and applying real time weather information for refining their crop planning calendar, thus, saving time, costs and efforts. The achievement was possible through development, testing and application of a mobile app called ProMS , which is equipped with agromet related early warning and varieties of weather information including rainfall, temperature, humidity, risks of flood, landslides and forest fire. The project was executed by a competitive grant from ADPC for innovative climate challenge competition. Arbonaut in partnership with CEN won the competition for this project which they implemented in collaboration with Belaka Municipality and Federation of Farmers Groups between Jan and Jul 2022. Ministry of Forest and Environment of Nepal endorsed the project as a climate compatible initiative for municipal level activities.

Approach

The uniqueness of the project lies on its interactive mobile app that was designed and developed with essential features required for the local farmers. A sophisticated automatic weather station has been established and operationalized in the municipality complex with digital display board. The real time data of the station is accessible to all those using the app. Testing with the farmers who carry a smartphone revealed that the app is quite useful for them to making wise decisions regarding appropriate weather conditions for farming activities such as seedling and harvesting of crops.



Fig: Weather station and Display Board installed in Belaka Municipality

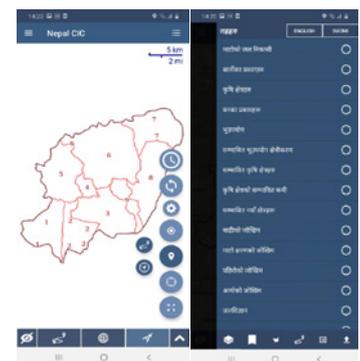


Fig: ProMS mobile application

Major achievements may be categorized into three aspects. The first achievement is the development of a farmer focused mobile app packed with sophisticated weather information backed by locally generated weather data, forecasts and alerting messages along with relevant maps of land use and land cover, flood risk zone and fire incidents, which they find quite interesting and useful to make everyday decisions for farming activities. The second is the delivery model of the project that proved its effectiveness to create enabling environment among the different stakeholders, namely, the target beneficiaries, municipal leaders, facilitating agencies of province and national levels and specialized technical service providers. Without the direct interfaces of the stakeholders, the rich information packed in the app alone won't get through the intended farmers. And, the third achievement is the ownership of the process and product by the municipality and the groups of farmers, which they are committed to maximise benefits of the application by investing more on the process as and when needed basis in the days ahead.



Fig: Training to the farmers to use the ProMS mobile application



Fig: Farmer learning to use the ProMS application

1. Intriguing interest of local farmers on agromet advisory services: In absence of agromet advisory services accessible to local farmers, they are compelled to plan daily farming activities on ad hoc basis. Those available online are scattered, too general, and less relevant. For the first time, they learned to receive the alerting information in their personal phone, interpret the message and apply the same for planning farm activities. This project just served as an initial step forward to address the gap.
2. Innovations at three stages: The three stages include 1) packaging of need-based weather information in the app, 2) phased engagements with farmers, municipal officials and stakeholders, and, 3) physical agromet station not only for generating local weather data but also to familiarize stakeholders with data and messages.
3. Upscaling and outscaling plan for ProMS as a model: The learning of the piloting phase offers adequate grounds for expanding its application for wider and real benefits of farmers. Two approaches may be advised. First, offering continuous support to the Belaka farmers for monitoring effective applications of the app-based information through seasons and crops for a complete annual cycle. Second, develop multiple versions of the app per the need of neighboring areas or those with Belaka like geographical and socio-economic features of the farmers.
4. Ownership and commitment of municipality matters: Support of municipal leaderships and officials is the prerequisite for effective planning, delivery and sustainability of the initiative. On top of this, they are willing to procure services to complement the project so that the agriculture support program of the municipality can produce synergic effects. One year cycle of engagement can be an appropriate project cycle to achieve the intended goals.
5. Producing local champions be a key focus: Youth from agricultural family background demonstrated their eagerness and talents to learn and apply the knowledge throughout the project. Identifying a couple of talents from each cluster of the farming communities not only helps them develop their capacity but also to help peers to go with the newly acquired information for better planning that would save costs and time for the farmers in the days ahead.



For further details

Clean Energy Nepal

Pragati Path, Talchikhel, Lalitpur, Nepal • G.P.O. Box 24581, Kathmandu, Nepal

Phone: +977-1-015538660 • Email: info@cen.org.np • Website: www.cen.org.np

Name of Organization:	Arbonaut Ltd. (lead) in association with Clean Energy Nepal (sub-consultant)
Title of Project:	Building Food Security through agro-met innovative advisory services (AMIAS)
Reporting Dates	1 st of July 2022-31 st of July 2022
Report prepared by:	<u>Arbonaut Ltd. & CEN</u>
Report reviewed by:	
Submitted by:	<u>Barsha Parajuli</u>

Table of Content

Contents

Contents.....	3
1. Executive Summary	4
2. Background to Pilot	5
Description of the pilot solution.....	5
Goals and objectives.....	5
Target groups and beneficiaries	5
Expected impacts short- and long-term.....	6
Innovators profile	7
3. Process, Progress and Results	7
Project implementation	7
4. Challenges and Mitigation Measures	12
5. Lessons Learned and Recommendation.....	14
6. Conclusion and Way Forward.....	15
Conclusions	15
Way forward.....	16
Expanding the use to other provinces	16
Developing collaboration with DHM and NARC	16
Further development of the weather warning system	17
Technical developments of the ProMS platform and mobile app.....	17

List of acronyms

API	Application Interface
CEN	Clean Energy Nepal
DHM	Department of Hydrology and Meteorology
ECMWF	European Centre for Medium-Range Weather Forecasts
GFS	Global Forecast System
IFC	Integrated Forecasting System
NFGF	National Farmers Group Federation of Nepal
NOAA	National Oceanic and Atmospheric Administration
OS	Operating System
ProMS	Project Management System
ToT	Training of trainers

1. Executive Summary

Through AMAIS project, implemented by Arbonaut Ltd. (Lead) in association with the Clean Energy Nepal (sub-consultant), a web and a mobile application which integrates various GIS data (maps) relevant for agriculture as well as local weather observation and weather forecast information has been developed. Furthermore, the mobile app triggers weather warnings to all phones that have the app installed with access to this project, whenever very heavy rain is forecasted.

The project has set up an automatic weather station (AWS) in the Belaka municipality to provide local farmers with access to real-time weather information and to increase awareness of climate-aware farming practices. The station is operational and provides information on ambient temperature, accumulated rainfall and relative humidity in 15-minute intervals. The weather information is visible on a display screen located at the Belaka Municipality Office building.

The project goal is to equip local farmers with information and state-of-the-art technology to engage with smart agriculture and climate-adaptive farming. The project also aims at increasing awareness on climate change and climate-adaptive farming as well as increasing the willingness of local farmers to use new technologies for their daily farming practices. The direct beneficiaries of the pilot project are about 1000 local farmers from the agriculture pocket area in Belaka municipality, Udayapur district of Province 1 of Nepal). In addition, a wide range people have been reached through information sharing of the pilot project results

Major project achievements include easily accessible environmental data for farmers through ProMS, weather warnings (heavy rainfall) information in the app based on forecast predictions, approx. 100 downloads of the ProMS mobile application by the end of the project and approx 300 stakeholders (farmers and agricultural officials) capacitated on using the technology.

Mobile internet coverage is often quite poor or not much used by the farmers. Therefore, it is important to implement also an sms-based weather warning service which reaches all the subscribed phones who have installed the application, in addition to the internet-based warning messages. This functionality should be implemented during the upscaling project.

The developed environmental information system with mobile and web access for the farmers in Belaka municipality has resulted in strong interest by the farmers. Hands-on training sessions with the farmers and feedback collection has shown that the application is very relevant but that the functionality still needs improvements and some additional features would be important to be

implemented in order to increase the usability of the system for the farmers. The learning of the piloting phase offers adequate grounds for expanding its application for wider and real benefits of farmers. Two approaches can be taken. First, offering continuous support to the Belaka farmers for monitoring effective applications of the app-based information through seasons and crops for a complete annual cycle. Second, develop multiple versions of the app per the need of neighboring areas or those with Belaka like geographical and socio-economic features of the farmers. Furthermore, such technological intervention should be adopted by every municipal units.

The possibility to integrate the NWP products of DHM, to replace the use of the global data, has been discussed at the DHM office during the field visit by CEN and Arbonaut teams. This discussion will be continued further in August 2022. Collaboration with the Nepal Agricultural Research Council (NARC) should be established in the follow-up work. The agricultural advisory thorough NAARC if incorporated into the application would be a complete agro-met package for the farmers.

2. Background to Pilot

Description of the pilot solution

The project has developed a web and a mobile application which integrates various GIS data (maps) relevant for agriculture as well as local weather observation and weather forecast information. Furthermore, the mobile app triggers weather warnings to all phones that have the app installed with access to this project, whenever very heavy rain is forecasted. The web system works with the most common browsers on Windows / Linux / iOS operating systems. The mobile app (currently) requires an Android operating system and is available on the Google Play Store.

Goals and objectives

The goal of the project is to equip local farmers with information and state-of-the-art technology to engage with smart agriculture and climate-adaptive farming. The project also aims at increasing awareness on climate change and climate-adaptive farming as well as increasing the willingness of local farmers to use new technologies for their daily farming practices. The general project objective therefore relates to the improvement of local farmers' livelihood as well as uplifting their economic conditions.

Target groups and beneficiaries

The direct beneficiaries of the pilot project are about 1000 local farmers from

the agriculture pocket area in Belaka municipality, and the indirect beneficiaries are 54122 (population of the Belaka Municipality, Udayapur district of Province 1 of Nepal). In addition, a wide range people have been reached through information sharing of the pilot project results through local media in local language.

Key metrics

<i>Indicator</i>	<i>Source of verification</i>
Number of people and organizations (Stakeholders, local authorities, farmers) using the environmental data is increased by the end of the project.	Direct beneficiaries of the pilot project disaggregated by gender.
GIS-based information system is developed and ready for use.	Operational web-based information system.
Mobile application is developed and ready for use.	Operational mobile app.
Number of farmers/youths that are trained to use the system.	Training report (participant list).
Number of active users/farmers/youths that use the mobile app at least once in a week.	Record of monthly logins per User and number of downloads of the application, exported from the Database and visible from Google Play.
One weather station is established and ready for use.	Operational weather station in the pilot project area.
Increased awareness of weather conditions and agro advisory at community level.	Number of participants in awareness campaigns disaggregated by gender.

Expected impacts short- and long-term

The main long-term impact of the project is the improvement of local farmers' livelihood as well as uplifting their economic conditions (economic resilience) by using this application to better plan farming activities by making informed decisions (informed farming practices and climate adaptive farming).

The short-term impact is increased awareness and willingness among the local farmers on smart agriculture and on the advantages of using weather information to make decisions e.g. on harvest times. Furthermore, local farmers are now being trained in using the mobile application and will receive warnings of upcoming heavy rains which contributes to disaster preparedness in the region and decreases the risk of heavy losses of both human life and harvest income in Belaka municipality.

In addition, through the developed application the farmers have now an easy access to the relevant GIS data (web maps) that are existing in the municipality.

Innovators profile

Arbonaut Ltd., founded in 1994, is one of the leading expert companies worldwide in providing technological solutions for natural resource management. We are supporting public and private organization by providing them reliable and accurate digital information that turn data into knowledge and understanding helping them to act towards climate adaptation/mitigation. Arbonaut also acts as a consultant with respect to planning, design and implementation of forest inventory and forest monitoring systems and supports its customers in implementing sustainable forest management. Arbonaut has also been working with climate change adaptation and mitigation projects in developing countries e.g. Nepal, Bhutan, Pakistan. In the case of Nepal, one of the projects focused on building climate resilient of local communities in the urban context.

CEN is an independent, nonprofit service oriented, policy, research and implementation organization registered in 2000, focusing on **research based education** and **advocacy campaigns** with policy inputs and implementation on issues related to sustainable energy use and environmental conservation since its inception . CEN has more than two decades of experience on climate change adaptation, capacity building, policy process and knowledge and information communication.

3. Process, Progress and Results

Project implementation

Arbonaut has developed an online platform for publishing GIS information. The platform is available through internet browser on a PC, as well as through a dedicated app for Android mobile phones. For the purpose of this project, data beneficial for climate-aware agriculture provided by Belaka Municipality has been added to ProMS, including land use maps, crop type maps, forest type maps and maps indicating areas that are under the risk of floods, landslides or fires.

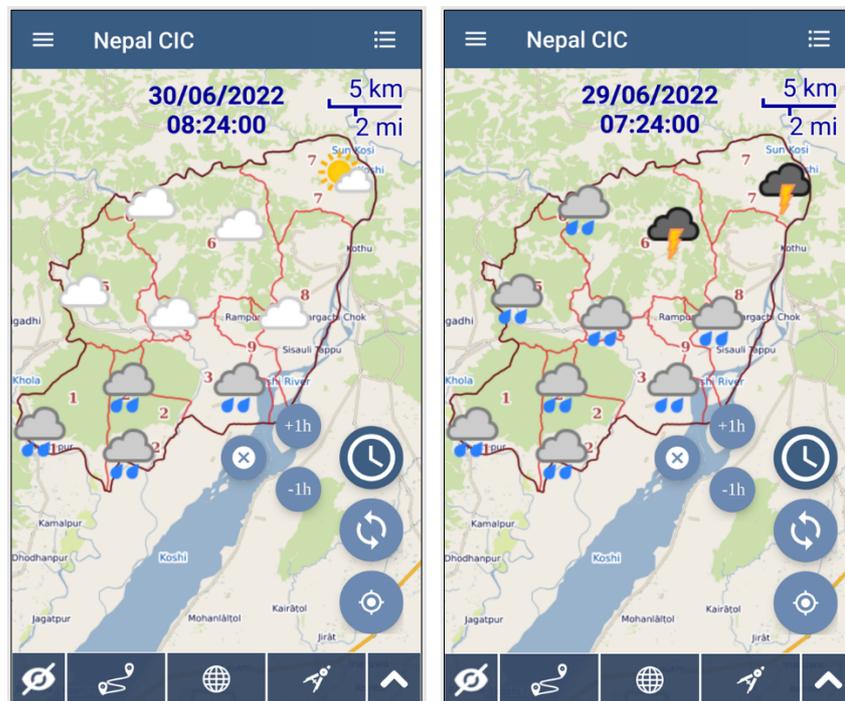
One key goal for the project has been to set up an automatic weather station (AWS) in the Belaka municipality to provide local farmers with access to real-time weather information and to increase awareness of climate-aware farming practices. The station is operational and provides information on ambient temperature, accumulated rainfall and relative humidity in 15-minute intervals. The weather information is visible on a display screen located at the Belaka Municipality Office building. In addition to current weather information from the AWS, access to weather forecast has also been implemented. For this project, weather forecasts from the IFS global numerical weather prediction model run by the European Centre for Medium-range Weather Forecasting (ECMWF) are

used.



Left) The automatic weather station. Right) Inspection of the weather station by CEN and Arbonaut teams during the field visit.

The ProMS platform has been extended to integrate real-time data from the AWS and the most recent weather forecast information. The weather forecast is shown for up to 7 days ahead. For clarity, a simplified subset of standard weather symbols is used to display the general state of the weather (sunny, rain, thunderstorm etc...) on the map.



Example of the weather forecast of the mobile application. The forecast is presented for the selected date using a simplified subset of standard weather symbols.

The weather symbols used are listed below.

<i>Symbol (day)</i>	<i>Symbol (night)</i>	<i>Description</i>
		Clear sky. Cloud cover < 30%
		Partially clear. Cloud cover between 30% and 70%.
		Overcast. Cloud cover over 70%.
		Rain. Rain probability over 50% and accumulated rainfall over 0.5 mm/h.
		Heavy rain. Rain probability over 50% and accumulated rainfall over 5 mm/h.
		Rainfall warning. Rain probability over 50% and accumulated rainfall over 20 mm/h.
		Thunderstorm. Thunderstorm probability over 50%.
		Windy weather / windstorm. Wind gusts over 20 m/s.

The CEN and Arbonaut teams have visited the project area between 7 – 10 June 2022. The ProMS mobile application has been demonstrated to the Shareholders and local farmers during two training events taking place in the project area between 8 - 9th June and 29 – 30th June 2022. The first training event was held at the Belaka municipality and had two sessions, during the first session 20 participants including core Nepal team, youths, lead farmers and municipality agricultural technicians were oriented whereas the second session was participated by 47 lead farmers. A hands-on training on ProMS mobile application has been provided to the participants as well as feedback for improvements has been collected. The application has been subjected

The second Training was held in Itahari as there was intensive rainfall in Belaka resulting to heavy flooding and electricity cut-offs. The event had 30 participants including farmers, youths & agricultural technicians, municipal authorities, teachers and media persons. The residential training oriented the participants on using the mobile application as well as raised awareness on the multi-dimensional use of the information accessed through the ProMS application. During the first day of the training, participants at first worked in groups and identified flood, landslides and heavy rainfall as the major climate induced disasters that posed major threats to their crops. Following the group work the participants were introduced to agrometeorology and its linkage to climate-smart agriculture as well as impact based forecasting & alerting protocols. Further, ProMS application was demonstrated, and CEN team facilitated to configure the application on individual devices and oriented on the use. During the second day, participants were oriented on different layers of the application and how it could be used. Following the training sessions, participants had a role play. They were divided into four groups and each group was given a specific role i.e. teacher, local government authority, lead farmers & media and after

group exercise, each group showcased how they can use the ProMS application in their daily life. All groups came up with innovative ways for all the roles with reasons of using the application.

Knowledge dissemination through Krishak Chautari: The information on the availability of the local weather data for Bleaka Municipality was disseminated through Krishak Chautari, farmers' forum. 245 farmers were reached with 6 Krishak Chautari held during different time

Krishak Chautari 1: 20th April, 2022 with 39 participants

Krishak Chautari 2: 21st April, 2022 with 36 participants

Krishak Chautari 3: 22nd April, 2022 with 39 participants

Krishak Chautari 4: 9th June, 2022 with 38 participants

Krishak Chautari 5: 1st July, 2022 with 34 participants

Krishak Chautari 6: 3rd July, 2022 with 59 participants

The CEN and Arbonaut technical teams have also visited the office of the Department of Hydrology and Meteorology (DHM) in Kathmandu to discuss possible integration of the weather forecast produced at DHM into the ProMS system to replace the use of the global weather model.

Key outputs/outcomes and major achievements

<i>Outcome</i>	<i>Achievements</i>
Number of people and organizations (Stakeholders, local authorities, farmers) using the environmental data is increased by the end of the project	<ul style="list-style-type: none"> Existing environmental data (maps) relevant for agriculture were collected from Belaka municipality and published in the ProMS web map application and mobile app The environmental data is now easily accessible for farmers through ProMS
Increased awareness on climate change and climate-adaptive farming	<ul style="list-style-type: none"> Automatic weather station in the area has been set up Integration of data from weather station and numerical weather prediction models into the ProMS application Implementation of weather warnings (heavy rainfall) in the app based on forecast predictions

	<ul style="list-style-type: none"> • Training and awareness raising events were held for farmers and agricultural officials
Increased readiness of local farmers to use new technologies for their daily farming practices	<ul style="list-style-type: none"> • Customization of ProMS web and mobile applications for use by farmers • Active participation of about 97 participants including farmers and local officials in the hands-on trainings (2 trainings at local level completed and one planned for 20-21 July with about 30 expected participants) • Wider dissemination through Krishak Chautari among farmers. The ProMS was introduced to 245 participants (farmers and local authority) through 6 Krishak Chautari at different times during the project period. • Approximately 100 downloads of the ProMS mobile application by the end of the project

Visible early-stage impacts

<i>Indicator</i>	<i>Visible early-stage impact</i>
<ul style="list-style-type: none"> • GIS-based system and mobile application is developed and ready to use 	<p>Approximately 100 downloads of the mobile application from Google Play Store.</p> <p>More than 10 new users have logged in to the web application during June.</p>
<ul style="list-style-type: none"> • Number of farmers/youths that are trained to use the system 	<p>Successful hands-on training sessions were completed during June.</p> <p>Very active feedback session with local farming officials reflected high interest by the farmers in</p>

<ul style="list-style-type: none"> • Number of people and organizations (Stakeholders, local authorities, farmers) using the environmental data is increased by the end of the project 	<p>using this application. For example, forecast information on thunderstorms with lightnings were added in June to the application in response to the farmers' requests.</p> <p>Local farmers indicated already their interest in additional features for the application such as implementation of flood warnings.</p>
<ul style="list-style-type: none"> • One weather station is established and ready for use • Increased awareness of weather conditions and agro advisory at community level 	<p>Awareness towards smart agriculture and climate change has increased among farmers and farming officials.</p> <p>Local farmers have now access to current (real-time) weather information as well as detailed local weather forecast for up to 7 days ahead. This information can be easily accessed through a mobile app and is easily understandable.</p> <p>Real-time weather data from the local station are now shown on a large digital display at the front wall of the Belaka Municipality Office (local authority building).</p>

4. Challenges and Mitigation Measures

Technical challenges

<i>Issue</i>	<i>Mitigation measure</i>
<p>Limited internet connection in the field. Slow or unreliable internet connections poses challenges for displaying the ProMS map data, especially the weather -related layers.</p>	<p>In the first version used in the training, the weather layers were delivered to the ProMS app as map image tiles (WMS protocol). Based on the feedback and experience of the technical team during the training events, this was changed to a vector format (WFS protocol) that offers better responsiveness and update times especially on slow network.</p>
<p>Use of Nepali language in the ProMS platform.</p>	<p>Translation to Nepali has been implemented for the ProMS platform. For some parts, such as the legends of the GIS layers, Nepali language is not working yet due to technical issues. These will be resolved latest by the end of the year on Arbonaut's own initiative.</p>
<p>Use of Bikram Sambat (B.S.) calendar.</p>	<p>The ProMS web and mobile apps only support the Geogrian calendar and implementation of</p>

	<p>the Bikram Sambat (B.S.) calendar used in Nepal is not feasible within the scope of the project. The mobile app has been modified to allow it to be used without using the calendar interface and by referring to the days by "Today", "Tomorrow" etc... (in Nepali).</p>
<p>During its operation, the weather station suffered two breaks in its operation, of which one was caused by the SIM card running out of mobile data credit.</p> <p>While we were reaching the end users, the application was still under progress. Communities were already expecting forecasts to be accurate.</p>	<p>In both cases, the breaks in the station availability were quickly resolved. The provider of the station is committed to maintain the station for 3 years. A planned upgrade for the ProMS system is to send email notifications to selected personnel if no new data is available from the station after a period of time.</p> <p>With the ProMS application still under progress, we were getting common feedbacks during training on one hand and on the other, users were complaining that the forecast was not working. To this we had communicated with the lead farmers on application upgrading under progress and making a follow up when the progress was in place.</p> <p>Though the layers were translated in local language farmers were still unable to get what it meant so in the training portion each of the layers were detailed, meteorological data literacy also needed at some points.</p>

External issues

<i>Issue</i>	<i>Mitigation measure</i>
<p>Monsoon season caused flooding in the project area during orientation training event.</p>	<p>Event was held in Itahari city in Terai region about 2-hour car drive from Belaka. As some of the participants called in advance to let us know of their travel restrictions, we made slight changes shifting these participants for the upcoming training.</p>
<p>Out of 6 Krishak Chautari, 2 scheduled during 1 & 3 July witnessed high rainfall event just before the event.</p>	<p>2 Krishak Chautari, used for wider dissemination of the mobile application reaching the end users were scheduled for the first week of July. However, heavy rainfall occurred during the last week of June so both the events were conducted at locations most feasible for the farmers to attend/travel. This slightly increased the local travel time for the organizers.</p>

Internal issues

<i>Issue</i>	<i>Mitigation measure</i>
Arbonaut team is located in Europe and was not able to participate in more than one field visit/training event	Regular communication and virtual meetings between CEN and Arbonaut. Training-of-trainers to CEN staff by Arbonaut technical team, so that CEN team was able to conduct trainings in the field.
Challenging time-schedule of the project as 6 months are very tight for developing a new system and get it accepted by the users	As not all requested functionality was possible to be implemented during this project due to time and budget constraints, some improvements to the software (such as Nepalese language translations) will be done on Arbonaut's own cost after project end. Additional requested functionalities will be implemented during the planned upscaling project.
6 months time schedule of the project has been very tight. During the project period Nepal had local election. When we were so close to project end, the municipality chief was a newly elected.	During the project period Nepal witnessed local election and we were not able to proceed with the project activities. Further with the newly elected team, not fully aware of our project at Belaka Municipality, our team held series of meeting with the municipality chief & authorities to keep him updated on the project objectives and the progress.

5. Lessons Learned and Recommendation

The technical team from Arbonaut went on field visit only during June. This visit has helped the technical developers very much to really understand the needs/requirements on the software. As the project work was ending already about one month after the field mission, the implementation of several requests from the farmers (feedback session) was not possible anymore due to time constraints. For future projects it is therefore recommended that the technical staff should participate in a fact-finding mission to the project site early on during the user-needs assessment phase of the project.

It is important to have a first prototype of the software during early project stage and to demonstrate this prototype to the users, so that feedback on the user interface and functionality can be received early on to leave enough time for technical staff to implement the requested changes.

Mobile internet coverage is often quite poor or not much used by the farmers. Therefore, it is important to implement also an sms-based weather warning

service which reaches all the subscribed phones who have installed the application, in addition to the internet-based warning messages. This functionality should be implemented during the upscaling project.

It is recommended to develop jointly with CIC and Belaka municipality a maintenance plan for the system to ensure a smooth operation of the application also after project end. This can be part of the upscaling project as well.

CEN team interacted with the farmers and visited the project area several times during the project period. Adoption of a new technology by a community needs time and motivation. So to have the wider reach of such technology, continued support for some period is necessary. Users may encounter issues when they start exploring.

Local communities could face multiple hazards during different time of the year so they have different expectations e.g. When CEN team interacted on their priorities to risk, people were more concerned about forest fire during the dry season. However, with the onset of monsoon, flood induced disasters and thunder were the major concern. So while we design layers, consultation with wider stakeholders will be helpful.

6. Conclusion and Way Forward

Conclusions

The developed environmental information system with mobile and web access for the farmers in Belaka municipality has resulted in strong interest by the farmers. The main aim of the project was to deliver a system that allows the farmers to have very easy access to relevant map data as well as access to real-time local weather information and local weather forecast. All data is accessed through a single mobile app, relieving the farmers from having to learn using multiple applications. An important feature of the system for the farmers are the weather warning messages which are delivered directly to user's phone via push notifications.

Hands-on training sessions with the farmers and feedback collection has shown that the application is very relevant but that the functionality still needs improvements and some additional features would be important to be implemented in order to increase the usability of the system for the farmers. For example, the weather warning messages need to be tailored to the needs of the farmers, and weather forecast information should be replaced by more

accurate forecast data available from the Department of Hydrology and Meteorology in the future. Considering the strong interest from the farmers' side as well as the need for continued improvement of the application, the project team suggests the following upscaling plan.

Way forward

During the current project, the ProMS system developed by Arbonaut Ltd. has been extended to offer useful information for local farmers in the Belaka municipality. Farmers can use this information for better planning their activities as we all to prepare and respond to potentially dangerous weather events. The scope of the project has been selected so that it is possible to create a functional prototype of the ProMS system, which can be scaled to offer similar services also in other provinces in the future. The feedback collected during the implementation and testing of the system has also been invaluable for identifying additional services that would be useful if offered via the ProMS platform.

Expanding the use to other provinces

The learning of the piloting phase offers adequate grounds for expanding its application for wider and real benefits of farmers. Two approaches can be taken. First, offering continuous support to the Belaka farmers for monitoring effective applications of the app-based information through seasons and crops for a complete annual cycle. Second, develop multiple versions of the app per the need of neighboring areas or those with Belaka like geographical and socio-economic features of the farmers. Furthermore, such technological intervention should be adopted by every municipal units.

Developing collaboration with DHM and NARC

The weather forecast information is very useful for local farmers to prepare for potentially dangerous weather events. The current system uses weather forecast data from the Integrated Forecasting System (IFS) operated by the European Centre for Medium-range Weather Forecasting (ECMWF). While the IFS model is a state-of-the art implementation of a global numerical weather prediction (NWP) model, its resolution is limited. The Department of Hydrology and Meteorology (DHM) of the Ministry of Energy, Water Resources and Irrigation in Nepal has acquired the capability to produce local weather forecasts in cooperation with the Finnish Meteorological Institute (under the FNEP-1 – FNEP-3 programmes). The possibility to integrate the NWP products of DHM, to replace the use of the global data, has been discussed at the DHM office during the field visit by CEN and Arbonaut teams. This discussion will be continued further in August 2022.

Collaboration with the Nepal Agricultural Research Council (NARC) should be established in the follow-up work. The agricultural advisory through NAARC if incorporated into the application would be a complete agro-met package for the farmers. However, the focus should remain on immediate disaster and risk preparedness, rather than other services such as seasonal planning for which applications are already being developed.

Further development of the weather warning system

A prototype of a weather warning system has been implemented for notifying local farmers if very strong rainfall is expected. Such rainfall can devastate crops, especially near or during the harvest season, or can lead to extensive flooding in the area. According to the feedback provided by the local community, early warnings for flood risk, lightning risk and drought forecast would be very useful. Such warnings can be implemented in a follow-up project based on data already collected by DHM, including data from the automatic weather station network and data from lightning detection.

The weather warnings are currently delivered to registered phones via Android push notifications. Many of the local farmers however may not have internet access while in the field and the use of SMS for the delivery of the warnings has been highly requested. Such development is technologically relatively easy to implement and will be considered in the future. Additionally, DHM currently has an agreement with NCell (a phone network provider in Nepal) that allows disaster event warnings to be broadcasted by DHM via SMS. This or a similar agreement could be used.

Technical developments of the ProMS platform and mobile app

The ProMS mobile application used in the current project offers some degree of customization but what can be done is limited by the fact that the application is used by other projects and clients as well. A standalone mobile app built from the ProMS components can be created with little effort and this would allow the application's user interface to be designed specifically with the project's needs in mind. As an example, the interface could be streamlined so that only relevant information is shown in the most understandable format. While the map component is adequate for the display of the static maps (such as the land use map, crop type map etc...), the weather information could be presented in form of a 3 or 5-day weather chart based on the GPS location of the device. The current display using weather symbols on a map could be retained as more "advanced" view. Similarly, the weather warnings could be displayed directly in the app and past warnings could also then be made easily accessible. Localization of the user interface to Nepali language would be easier in a

standalone application when the needs of other projects and clients do not need to be considered. The current user interface also works with Gregorian (Anno Domini) calendar rather than the Bikram Sambat used in Nepal. This proved to be difficult for the local farmers to use the date controls in the app and some effort has been made to make the use of the app easier (i.e. it is possible to change the weather forecast time without using the calendar control). Full implementation of the Bikram Sambat calendar has however not been possible during the project timeline and has therefore been left for a follow-up work.

Annexes:

Annex 1: Transfer Donation Plan for all equipment (durable items with a value of over USD 500) and any remaining consumables/goods (with a value of over USD 500 per category of items, namely identical or similar items used for the same purpose) purchased under the Agreement (refer to Clause 7f, page 4 of the Grant Agreement)

Annex 2: An Endorsement letter or certificate of completion from the endorser.

Annex 3: Dissemination products (case studies, brochures, links to videos etc)

[Link for Video : https://youtu.be/3MF4PGMZLUY](https://youtu.be/3MF4PGMZLUY)

Annex 4: Final Invoice

