Terms of Reference for

CONSULTANCY SERVICE TO CONDUCT TRAINING COURSE ON "USING MODERN WEATHER OBSERVATION SYSTEM FOR NOWCASTING

(Contract ID No: PPCR/DHM/S/CQS-92)

Submitted by:

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1. Background

The objective of the BRCH project is to enhance government capacity to mitigate climate related hazards by improving accuracy and timeliness of weather and flood forecasts and warnings for climate vulnerable communities, as well as developing Agricultural Management Information System (AMIS) services, administered by the Ministry of Agriculture and Livestock Development (MoALD), to help farmers mitigate climate related production risks. The project comprises four components:

A. Institutional strengthening, capacity building and implementation support of Department of Hydrology and Meteorology (DHM);

B. Modernization of observation networks and forecasting;

C. Enhancement of the service delivery system of DHM; and

D. Creation of an agriculture management information system (AMIS).

Component A aims to develop and/or strengthen DHM's legal and regulatory frameworks, improve institutional performance as the main provider of weather, climate and hydrological information for the nation, build capacity of personnel and management, ensure operability of the future networks, and support project implementation. Component B and D are most relevant to the present assignments; Component B aims to modernize DHM observation networks, ICT and data management systems, improve numerical prediction systems and tools for forecasting. Similarly, Component C aims to enhance the service delivery system on weather and hydrological phenomena, and provision of information services to key weather dependent sectors, particularly to climate-vulnerable communities. Component D will enhance specialized agro-climate and weather services, including agro-advisories that help farmers to increase productivity and reduce losses caused by meteorological and hydrological hazards.

2. Introduction

Now-casting in meteorology is forecasting of atmospheric phenomena from present situation up to 3-6 hours lead time. These phenomena, such as localized thunderstorms or gust fronts cannot be predicted with adequate accuracy by Numerical Weather Prediction (NWP) models operating over longer lead times.

Now-casting in meteorology uses real time data provided predominantly by automated weather stations, weather radar networks, lightning detection networks, upper air soundings, wind profilers (if available) and weather satellites. High resolution local area Numerical Weather Prediction (NWP) models can be benefitted in now-casting when supported by high power computing. Modern workstation can analyse these data and provide indicators for the rapid development of severe weather phenomena thereby allowing meteorologists to issue warnings e.g. on heavy precipitation and strong wind gusts.

DHM is presently implementing Remote Sensing networks such as one weather radar, a country wide lightning location network, a Sounding station and 88 automated weather stations as part of the BRCH project component B. Additionally, DHM is acquiring an advanced Hydro-Meteorological Workstation (Synergie from Meteo France International) with tools for displaying the information provided by the aforementioned systems and weather satellites as well forecast data produced by the NWP models. With this system, forecasters will need to learn to monitor development of severe weather phenomena and issue associated warnings. In addition, the archived observations can be used for post disaster and risk analysis.

The implementation of new systems at DHM requires intensive training to understand the principles of each observation tool and learning how to use the tools for monitoring and obtaining situational awareness of the state of the atmosphere. This Terms of Reference (ToR) is for a Consulting firm (here after Consultant) to conduct training courses that will be broken down into modules to concentrate separately on functioning and use each observation system and at the end to learn using the systems jointly for now-casting.

3. Objective of the Assignment

The objective of the assignment is to provide training to DHM's meteorological and hydrological forecasters to obtain know how and skills on using the newly established observation tools for real time monitoring and now-casting of weather situations and issue warnings on severe weather when appropriate.

The objectives are more specifically to

- Learn the principles of operation of each system and learn how to use them for now-casting
- Obtain skills to attain situational awareness on prevailing weather conditions
- Predict immediate development of weather conditions
- Anticipate possible development of hazardous weather and issue warnings related to the severe phenomena
- Study spatial characteristics and representativeness of the observations obtained with different methods
- Learn to recognize importance of particular weather phenomena for key users of weather services such as aviation operators, farmers, trekkers, etc.
- Prepare Standard Operational Procedures (SOPs) for working with each observation system, especially for analysis and prediction of severe weather situations.

4. Scope of Work

The training course contains 5 modules, each focusing on use of the particular observation system specifically for now-casting purposes.

4.1 Training modules

The contents of each training module shall cover at least, but not limited to, the following Topics:

Module 1: Weather radar-Principles of operation of a weather radar for weather services (5 days)

- Basic principles of weather radar: how a pulsed-Doppler radar works, signal characteristics, how the radar information is processed, and the effect of meteorological factors on the propagation and attenuation of radar waves in the atmosphere; comparison of radar and rain gauges
- Introduction to different types of weather radars
- What can we see with radars (including non-meteorological phenomena, distractions and limitations)
- Weather radar data types (reflectivity, Doppler and dual-polarization)
- Properties of radar products: PPI, CAPPI, MaxEcho, EchoTop, Wind profile, Hydrometeor Classification
- Usage of the radar products for nowcasting, aviation weather forecasting and early warning applications
- Working with Quantitative Precipitation Estimates and Forecasts (QPE & QPF),
- Detection, monitoring and forecasting (now-casting) of significant local weather phenomena (thunderstorm, hailstorm (hail size), lightning strikes (thunderbolt), monsoon, gust fronts, heavy precipitation, flash flooding, heavy convection, dry season)
- Recognize important weather parameters and phenomena for aviation safety by using radar data.
- Distinguish between heavy, moderate or light precipitation on radar
- Study spatial characteristics and representativeness of radar data
- Instruct trainees to develop and document Standard Operational Procedures (SOP's) on use of radar data in weather forecasting.

Module 2: Weather satellites: Principles of operation of weather satellites and their use in weather services, especially for nowcasting(5 days)

- Short recap on remote sensing in general, satellite type and orbits and coverage
- Satellites and satellite products available in Nepal and Asia
- Meteorological satellite products for forecaster. Advanced satellite applications and products of RGB and Land SAF images. Working with different channels (VIS, IR, enhanced pictures, water vapour, microwave)

- Satellite products for hydrologists; e.g. on quantitative precipitation estimate
- Monitoring characteristics of Earth's surface and the atmosphere using satellites: Interpret and utilize satellite images of atmospheric, surface and oceanic features such as (but not limited to) snow cover, glaciers, surface soil moisture, forest fire, drought, land use, cloud layers, cloud types and formations, floods, ash clouds.
- Forecasting significant local weather phenomena (monsoon season: deep convection, heavy rain, thunderstorm, storms, fog, etc.)
- Using satellite data in now-casting and early warning applications
- Suggestion/Identification new products included in operational forecasts
- Instruct trainees to develop and document Standard Operational Procedures (SOP's) for using satellite data and products in operative weather forecasting.

Module 3: <u>Use of upper air vertical soundings in nowcasting (5 days)</u>

- Overview of availability and use of the global upper air 'sounding data' obtained by different methods such as, radiosondes, Aircraft Meteorological Data Relay (AMDAR), wind profilers (optional) and high resolution NWP data. DHM has established one upper air sounding station at Kirtipur near the Tribhuvan International Airport with the sounding data sent to the WIGOS and stored at the DHM Data Management System. DHM will have access to AMDAR data via the DMS and the data can be displayed at the hydro-met workstation. DHM is planning to acquire a wind profiler in the near future. High resolution WRF model is run operatively on a HPC cluster with data available from the DHM file server.
- Introduction to different types of graphs illustrating vertical structure of the atmosphere
- Introduction to various types of indices calculated from sounding data
- Working with Skew-T, Tephigrams, and various types of indices
- Use of soundings as part of the observation system (lightning detection, satellite, AWS data etc.) in all types weather forecasting
- Forecasting significant local weather phenomena such as deep convection, heavy rain, thunderstorm, mesoscale storms, fog, formation of low clouds, icing conditions, wind shear, turbulence, characteristics of sounding during monsoon and dry season
- Using TEMP data in early warning applications
- Suggestion/Identification new products included in operational forecasts
- Instruct trainees to develop and document the Standard Operational Procedures (SOP's) to ensure operability of the future systems.

Module 4: <u>Lightning detection (5 days)</u>

- Introduce lightning as physical phenomena
- Lightning detection/location instruments and networks
- Working with lightning data; developing related statistics and other products

- Use of archived lightning location data from Nepal
- Use of lightning information as part of the observation system (upper air soundings, satellite, AWS data etc.) in all types weather forecasting
- Detection and monitoring of local convective weather during pre-monsoon and monsoon season
- Using lightning information for severe weather forecasting along with radar and other observation and NWP data
- Instruct trainees to develop and document the Standard Operational Procedures (SOP's) to ensure operability of the future systems.

Module 5: <u>Automatic Weather Stations (AWS), use of all systems in parallel and case studies (5 days)</u>

- Principles of operation and representativeness of an AWS network
- Typical sensor configuration of an AWS;
- Use of AWS data in detection and nowcasting of extreme phenomena
- Importance of recorded extreme phenomena for different customer safety/comfort, (e.g. visibility, wind speed, gusts, freezing rain, frost, precipitation, snow accumulation etc.)
- Principles of Quality Control and Quality assurance.
- SOPs for QC, HQC, fault monitoring & notices, maintenance of AWSs
- Demonstrations (at least 5 different case studies) on nowcasting extreme weather situations using the introduced observation systems.

4.2 Practical Arrangements

The trainings will be conducted at DHM, Kathmandu. The consultant shall plan the training course so that all listed topics are covered with sufficient detail and completed during the allocated 5 training days.

The estimated maximum number of trainees is about 30, with 15 persons in two groups for each module. Twenty additional workdays are reserved for course and report preparation, making a total of 70 workdays for the completion of 5 training modules.

Observation data for all above mentioned modules as well as the NWP data and the workstations shall be available during the course of training. However, in case of unavailability of such data, the Trainer shall arrange access to or bring adequate set of observation and forecast data to be used during the training. Also, online data sources via Internet can be downloaded by the Trainer at the DHM facility.

Training courses are normally held on official working days (between Sunday and Friday), from 10 a.m. until 16 p.m. Lunch break is between 13:00-and 13:45. The Consultant shall provide list of requirements for the training facility and equipment in advance.

5. Reporting requirements, Time-line and Deliverables

The Consultant shall submit a detailed training plan and a Final report as follows. Both reports shall be submitted in 3 hard copies along with corresponding e-copies. These two reports are subject to approval by DHM.

5.1 Detailed Training plan: one week before agreed start date of training.

The detailed Training Plan must include but not limited to objectives of training for each module, detailed list contents of the training course, proposed schedule, daily agenda's, training methods used, detailed arrangements of training as regards the training facility and equipment, required qualification of participants to attend the course, learning targets which comply with the international requirements quoted above, evaluation methods and scoring.

5.2 Final Report: Report on results of Training: Due after two weeks of completion of all training modules

The Final Report shall be submitted within two weeks after completion of all Modules. The training report shall cover all training material (Submitted in the Annex) in printed (3 copies) and digital form including appropriate demonstrative video files covering complete course of each module. The report shall consist of basic information of the courses (list of participants, daily agendas etc.), summary of course evaluations based on questionnaire submitted to the participants, and results on learning i.e. assessment of the competencies and skills acquired by the participants.

All training material shall be submitted (listed as Attachments to the Final Report) in appropriate digital format(s) (e.g. .ppt, .doc, .pdf files) covering the lectures (presentations) and demonstrations.The training material should include a comprehensive list of references to published literature that complement the content of the training.

6. Client's Commitments (Inputs)

Staff of DHM/PMU will provide basic organizational support to the Consultant. At the request of the Consultant, DHM will provide following documents/ information:

- Information and data related to the project including information on status of observation networks, monitoring/lab equipment, communication, computing resources, and data processing tools;
- Project Appraisal Document (PAD), reports submitted by SI and other relevant publications;
- Other related documents as requested in support of activities.
- Training logical facilities
    - Training Hall
    - Projectors

- Audio/Video recording (If necessary)
- Stationeries
- Refreshments/lunch

- Necessary transportation and other logistics for field visits (if any)

7. General Requirements of the Consultant

7.1 Company requirements

The Consultant should have provided training on the use of observation systems relevant for short range weather forecasting (described above) and related NWP data.

- The Consultant shall have an extensive experience, of at least 7 years in holding training courses on Hydro-Meteorological Services both in developed and developing countries).
- Proven track record with statements of satisfaction of at least two(2) similar training courses related to hydro-meteorological fields conducted during the last ten(10) years(year, name and length of the course, course feedback grade), as applicable for proof of the qualifications.
- Consultant must provide CVs of Trainers (Refer 7.1).

7.1 Training Experts

The consulting firm shall put forward a team of professional trainers best qualified to carry out the assignment as described in chapter 4 and 5. The proposed trainers must be fluent both in spoken and written English.

Qualifications:

- A minimum of Bachelor's degree in Physics/Atmospheric sciences/Meteorology/ Mathematics is required. Master's degree in any aforementioned disciplines is considered an advantage.
- Evidence of having at least 5 years of experience in weather forecasting, longer experience is considered as an advantage
- Letters of reference of holding at least three (3) training courses related to short range weather forecasting including use of relevant observation systems. More training courses and courses held in international context[1], are considered as an advantage.
- Co-operation skills, as well as a flexible, innovative and solution-oriented approach to work, customer-orientated mentality and ability to use ICT tools.

[1] *Courses held abroad or having participants from other countries than Trainer's home country*

8. Schedule of Training Modules

The contract will start in May and will end in August 2019.

The Trainer is expected to carry out all tasks in a total of 70 workdays. The tentative time of the training is from June to August 2019. Each training Module will be held one at a time and cannot be overlapped. Details are summarized in the Table below:

Module	Preparation and reporting	Training-Group 1 (max 15trainees)	Training-Group 2 (max 15 trainees)	Planned Training month
Weather radar	4 days	5 day	5 day	June 2019
Weather satellite	4 days	5 day	5 day	June 2019
Upper air sounding	4 days	5 day	5 day	July 2019
Lightning detection	4 days	5 day	5 day	July 2019
AWS & case studies	4 days	5 days	5 days	August 2019
Totals	20days	25 days	25 days	

9. Payment schedule

- 20 percent of contract value after approval of the Detailed Training Plan by DHM.
- 50 percent after completing all the training courses
- 30 percent of contract value after submission and acceptance of the Final report by DHM.

10. Duration of service

May-August 2019

11. Selection Criteria

The consultant will be selected based on the individual consultant selection method of the World Bank's Guidelines on "Selection and Employment of Consultants, January-2011, revised on April, 2015". Main criteria for the selection will be relevant work experience and qualifications.