Some recent developments in Hydro-Meteorological data transmission from remote Manual as well as Automatic weather and Hydrological stations in Nepal

Ramchandra Karki and Chiranjibi Bhetuwal
Department of Hydrology and Meteorology
Government of Nepal
P.O. Box 406, Babarmahal, Kathmandu, Nepal
Email: rammetro@hotmail.com, ramchandra@dhm.gov.np (Corresponding Author)

Abstract:

The timely Collection and integration of Hydro-meteorological data and information from remote hydro-meteorological stations is the backbone for providing weather, climate and water related warning, forecast and services.
Because of the poor communication infrastructures and geographical complexities, this was the most challenging job in mountainous countries like Nepal in past and data were collected in the central office after months and year.
Recently, with the rapid expansion of mobile phone networks in the country the CDMA and GPRS (GSM) mobile internet and SMS facilities are available in many places. This development in the mobile wireless technology has improved the timely and more frequent hydro-meteorological data collection, integration and dissemination of warnings and forecast in the country prone to more severe and frequent hydro-meteorological disasters.
This paper describes the recent developments in the data collection process from remote manual as well as automatic weather and hydrological stations in central real time database server using mobile internet and SMS facilities in Nepal.

In the system, the real time data transmission from remote automatic weather and hydrological stations to data server for warning and forecasting is based on CDMA and GPRS mobile internet. Tele-terminals based on CDMA internet are utilized for manual SYNOP data transmission to central server. Similarly, mobile application (SMS to web server)) is developed and being planned to operationalized within few months for manual climate data transmission once a day from remote climate stations to central server for climate services.
Tele-terminals and mobile applications are the very specific tools for developing countries mostly relying in manual measurements.

Introduction:

Globally, by observing, forecasting and warning of weather, climate and water related threats, national hydro-meteorological services (NHMSs) make a significant contribution to safety, security and economic well-being.
The observation and timely collection of data and information from remote Weather and Hydrological stations is the primary source of information for all the services provided by NHMSs.
The timely collection of data from remote stations in the central system was most difficult task in past in Nepal. It used to take months to collect the data via the regular postal mail from most of the remote stations and the synoptic data collection was based on VHF wireless.
Recently, with the rapid expansion of mobile networks in Nepal, the hydro-meteorological data collection process has also been improved from both Manual and Automatic Stations.

The main objective of this paper work is to discuss on the recent developments and future plans for timely data collection in central database server from remote Manual as well as Automatic hydro-meteorological stations maintained by Department of Hydrology and Meteorology (DHM) Nepal.

Data collection Process for different applications:

Flood Forecasting:

The flood forecasting project of DHM was based only on traditional manual observation system in the past. In that system, manual rainfall and water level observation used to be transmitted via telephone or VHF wireless communication set in a regular interval in day time only by the observer. The flood in rivers upto Nepal border are of short lead time and the observation and transmission of limited data by observer during day time only had limited the effectiveness of flood early warning system.

Recently with the expansion of wireless mobile communication technology over the nation, the real time automatic river and rainfall monitoring system are being implemented in some of the river basins of Nepal for frequent observation and data transmission in order to meet the demand of flood forecasting and warning.

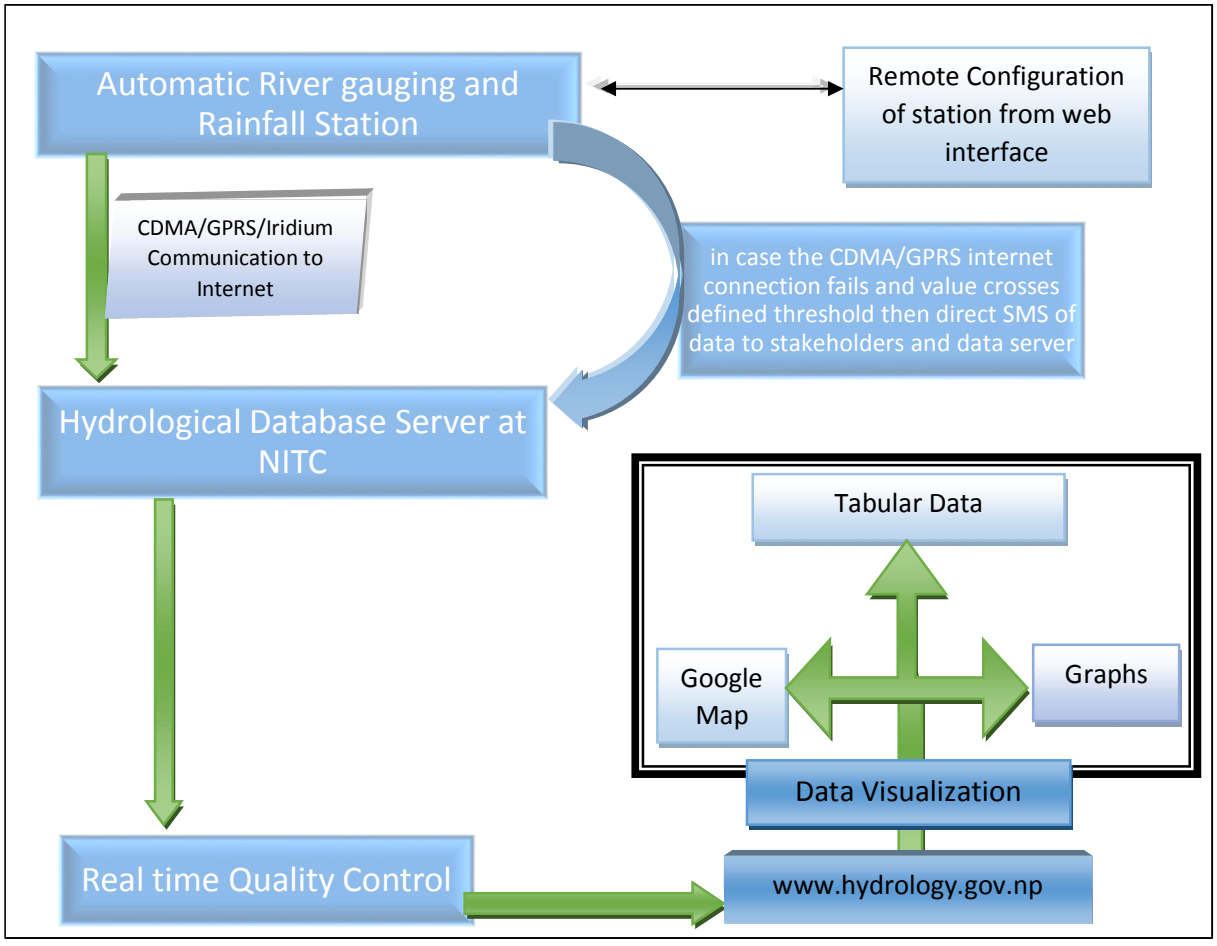


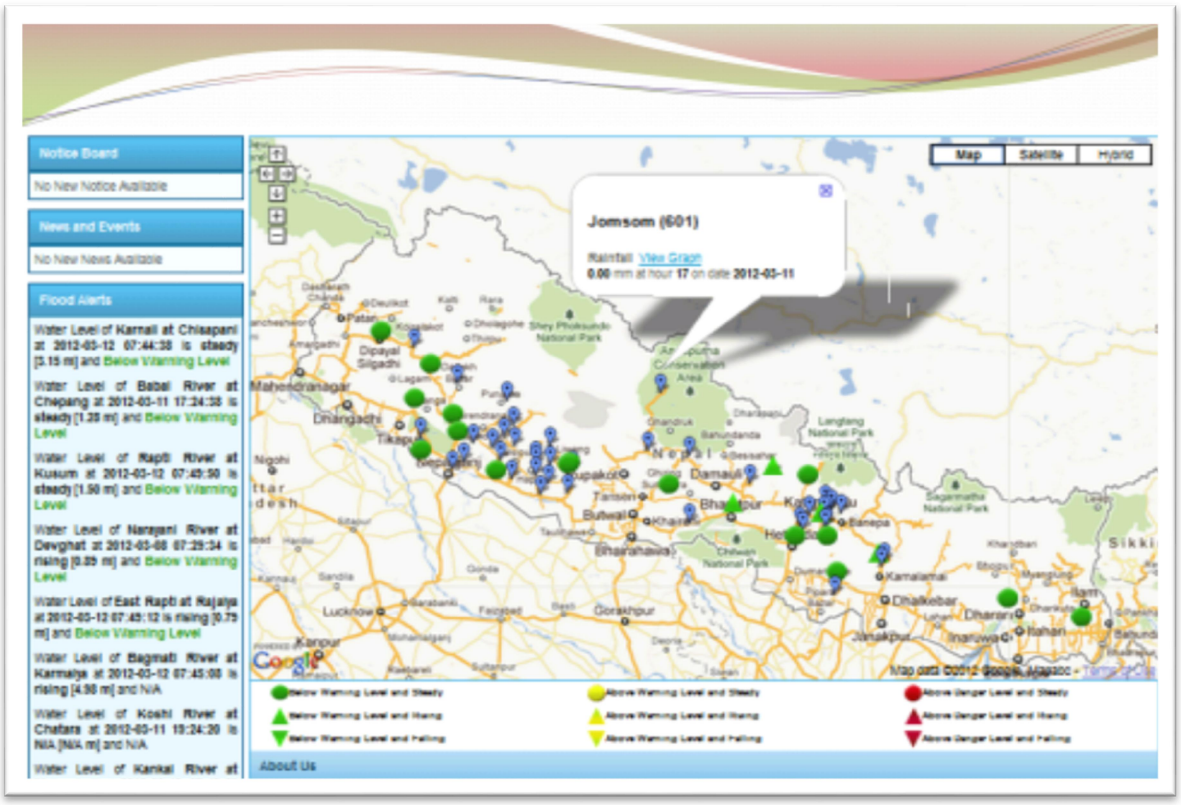
Fig 1: Process Diagram of Flood Forecasting Telemetric data transmission

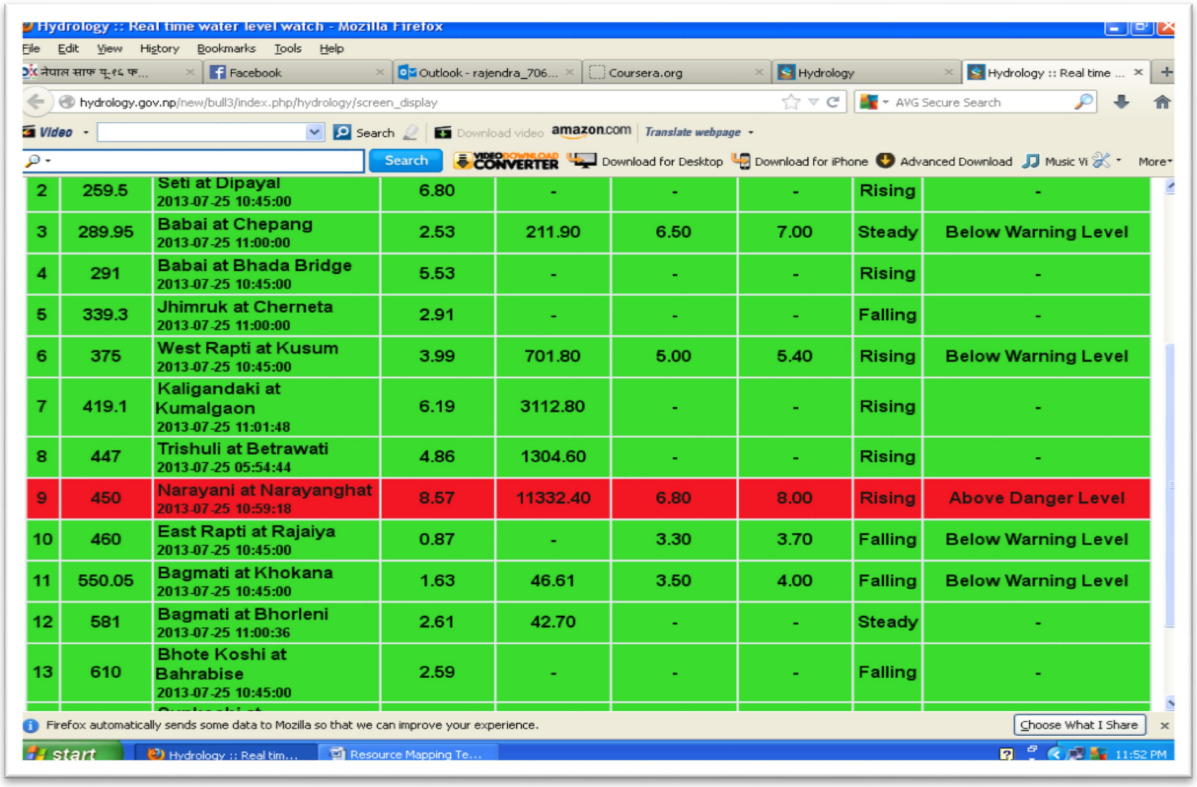
In the system, meteorological and hydrological sensors from reputed manufactures are utilized and data acquisition and communication model locally developed by private company of Nepal is used.

The data communication is based on dual GSM (GPRS) and CDMA (PSDN) mobile internet embedded in single communication module for uninterrupted data transmission to the central server. The use of dual modem is due to the low network of mobile communication in the rural remote areas. In the recent module iridium satellite communication modem is also embedded in the single communication module for the data transmission in harsh condition.

If the data sending via mobile internet with GPRS and CDMA is not possible and the value crosses the threshold level then the system works with SMS data transmission to the central server and the related main stakeholders for early warning and necessary planning.

The data from the remote stations are transmitted to the server in every 5 minutes during monsoon season. The system also logs and transmits the system information like battery voltage, charging, mobile signal levels, sensors status and mobile balance for fault identification and maintenance. The error message are transmitted via SMS and email as well. The other important feature is the remote setting of all configuration of the system using simple web interface.





2	259.5	Seti at Dipayal 2013-07-25 10:45:00	6.80	-	-	-	Rising	-
3	289.95	Babai at Chepang 2013-07-25 11:00:00	2.53	211.90	6.50	7.00	Steady	Below Warning Level
4	291	Babai at Bhada Bridge 2013-07-25 10:45:00	5.53	-	-	-	Rising	-
5	339.3	Jhimruk at Cherneta 2013-07-25 11:00:00	2.91	-	-	-	Falling	-
6	375	West Rapti at Kusum 2013-07-25 10:45:00	3.99	701.80	5.00	5.40	Rising	Below Warning Level
7	419.1	Kaligandaki at Kumalgaon 2013-07-25 11:01:48	6.19	3112.80	-	-	Rising	-
8	447	Trishuli at Betrawati 2013-07-25 05:54:44	4.86	1304.60	-	-	Rising	-
9	450	Narayani at Narayanghat 2013-07-25 10:59:18	8.57	11332.40	6.80	8.00	Rising	Above Danger Level
10	460	East Rapti at Rajaiya 2013-07-25 10:45:00	0.87	-	3.30	3.70	Falling	Below Warning Level
11	550.05	Bagmati at Khokana 2013-07-25 10:45:00	1.63	46.61	3.50	4.00	Falling	Below Warning Level
12	581	Bagmati at Bhorleni 2013-07-25 11:00:36	2.61	42.70	-	-	Steady	-
13	610	Bhote Koshi at Bahrabise 2013-07-25 10:45:00	2.59	-	-	-	Falling	-

Fig 2: Different visualization features in Flood Forecasting System.

Tele-terminals for SYNOP data transmission:

The traditional SYNOP data transmission from the synoptic stations for weather forecasting and global data transmission was based on the wireless VHF communication system to the meteorological head quarter in Kathmandu. This communication was based on voice communication and copying the information in sheet. The voice communication from the system had a lot interference and had dependency on person. In order to overcome these problems, Tele-Terminal systems based on CDMA internet data transmission manufactured locally was implemented and is in operation since more than 5 years in 14 Synoptic stations of Nepal.

In the system, the observer from synoptic offices enters the data in coded SYNOP format in Tele-terminal unit in every synoptic hours and data is posted to the server and available via web interface. The SYNOP from different stations are then quality checked in meteorological forecasting division headquarter at Kathmandu and manually transmitted in regional hub in GTS. This system is comparatively more reliable then VHF communication as the data are transmitted and integrated in one web page. The data are also decoded and stored in database for different uses (Fig 4).

Fig 3: Tele-terminal and VHF Set

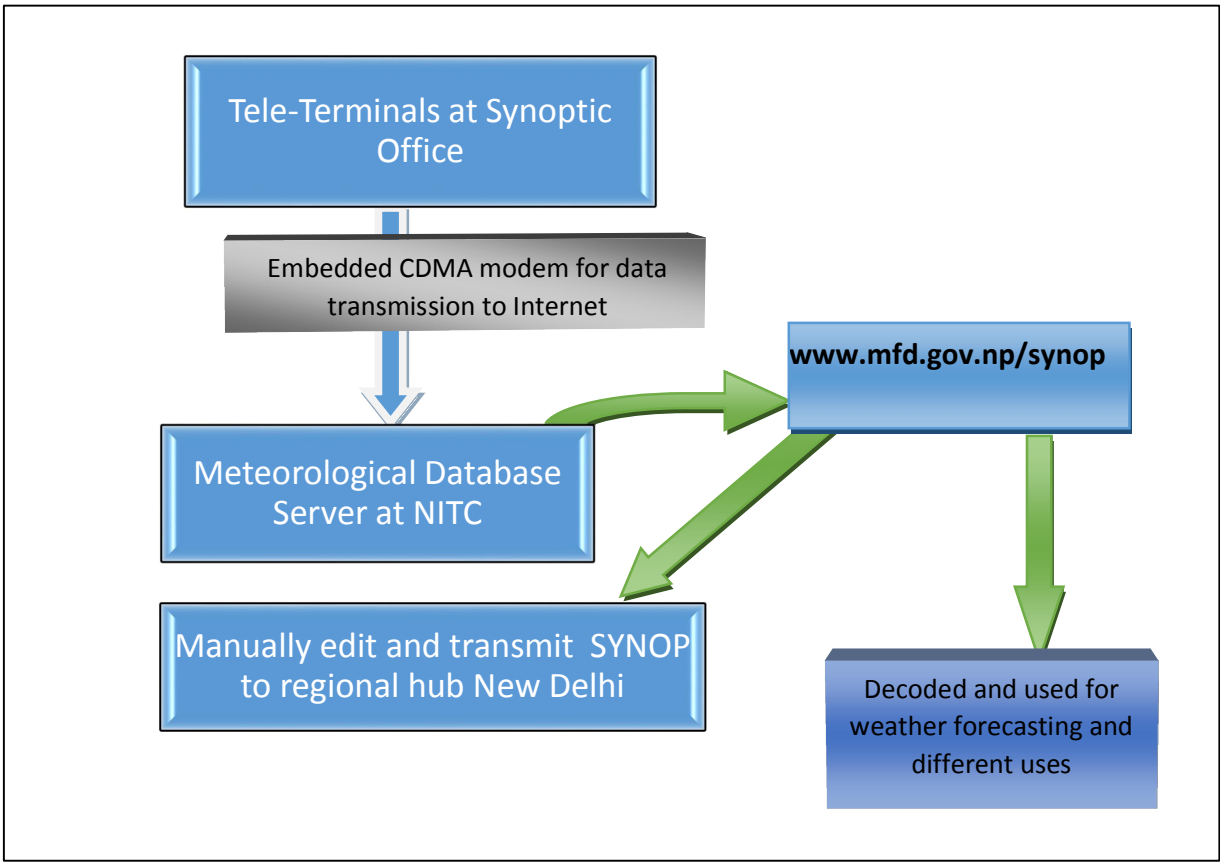


Fig 4: Process diagram of Tele-terminal system data flow

Recently, the new modern online database system based on PostgreSQL language system is installed with the technical support from Finnish Meteorological Institute. This database system will soon replace the traditional database system of the department

It is the real time database system with the capability to handle both automatic and manual stations data. This new system is sophisticated with all the quality controlling features like limit test, persistency check, consistency check and human quality control. The data are then quality flagged according to the WMO guidelines and stored in final database table. The database also includes the METADATA page for station information.

Most of the historical climate data from the old database system is already transferred to the new database and a simple online page is created from where the remaining historical data files of old database can be directly uploaded to the new database. The real time automatic weather stations are also directly linked to the database.

Online data entry forms are also developed for data entry (from manual stations) from regional offices and stations. This will reduce the time for transferring the data to central office as the entered data will be available in the integrated way in central database as soon as soon as they are entered. The data entry personal can also see the error message in the data in the same online form. The online forms are in the final stage of testing and will be implemented very soon.

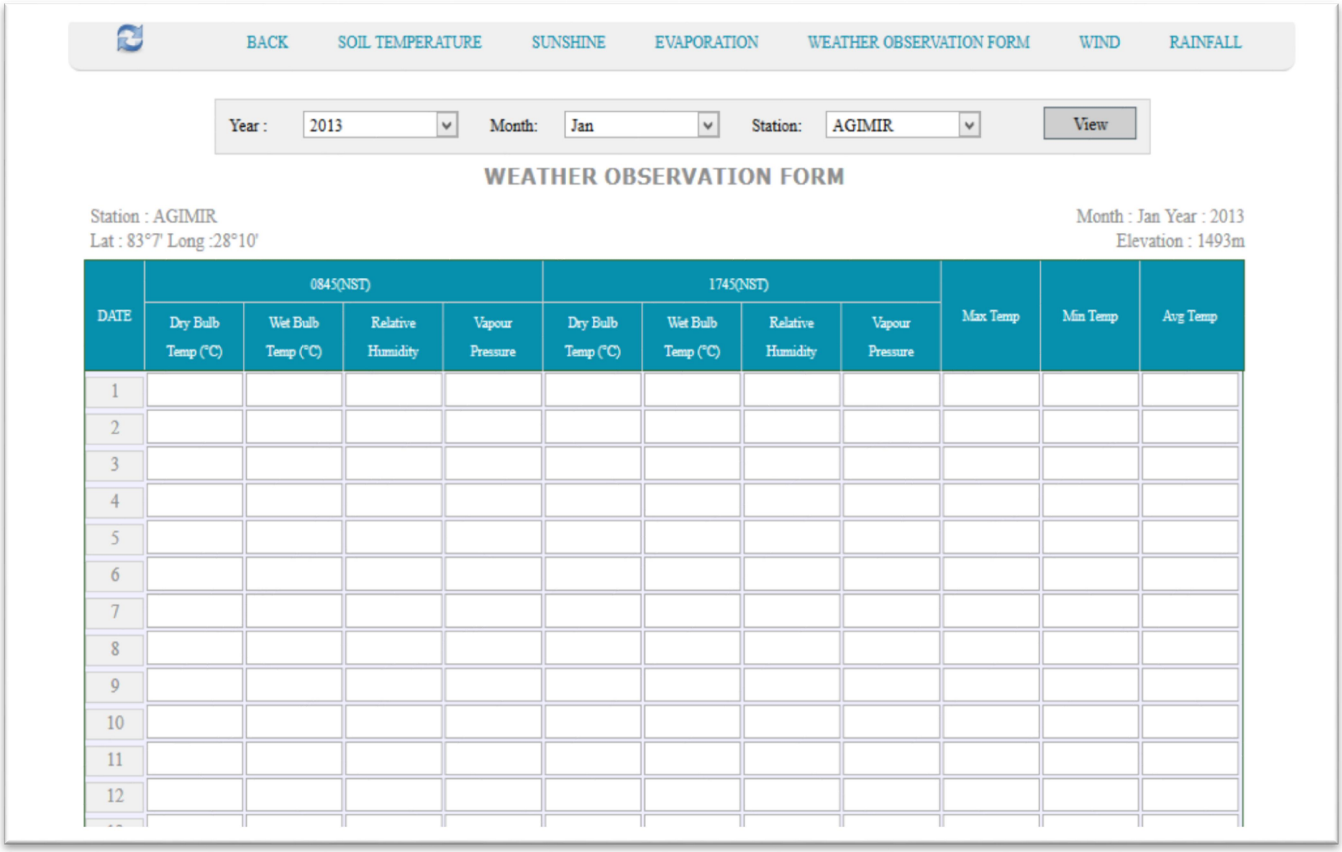


Fig 5: Online climate and SYNOP data entry form.

The next features in final stage of deployment for timely data collection from manual stations is the mobile SMS to WEB system. In this system, the observers of manual climate stations observe the rainfall and air temperature data and send the data as SMS from mobile using simple mobile apps daily. The data will be then transferred as SMS to the central SMS receiving device (SMS to WEB gateway locally manufactured) installed at head office. This device will then further transfer the data to the meteorological database server using internet. The details process of this data transmission is presented in ***Fig 6.***

With the full implementation of this whole system, the meteorological data collection will be timely and integrated in one system and very beneficial for weather forecasting and warning and climate services.

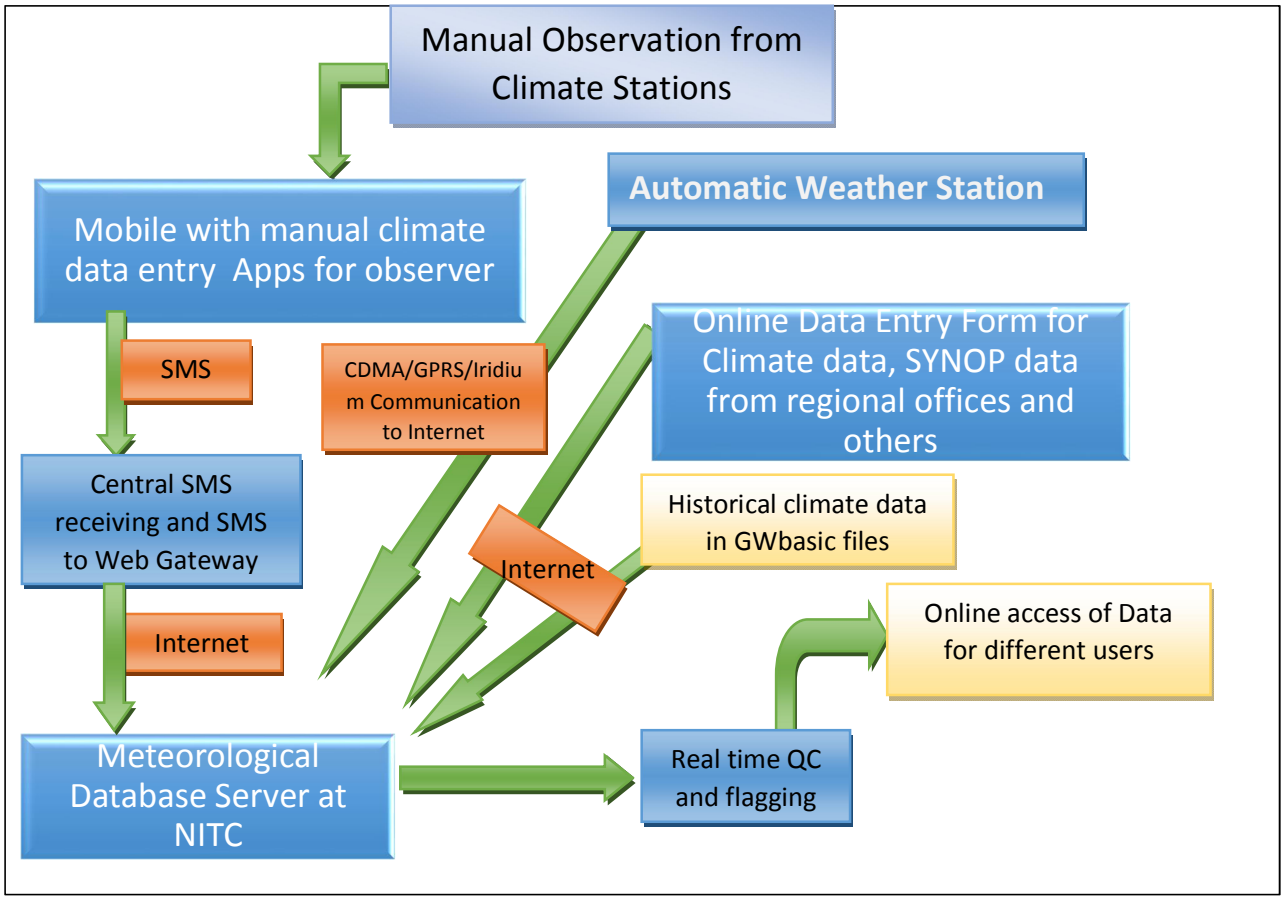


Fig 6: Process diagram of Meteorological data collection.

Conclusions:

The timely data collection process from remote hydro-meteorological stations has been improved with the mobile network coverage in most parts.

Different mobile internet and SMS data transmission systems and online data entry systems have been implemented and some are in the planning phase for timely data collection and integration. The communication systems are locally manufactured by private company of Nepal and it has been relatively easier for maintenance and operational support due to the availability of all the technical manpower in Nepal. The Mobile SMS to WEB data transmission system and online data entry forms are the effective tools for the timely data collection for developing countries mostly relying on manual observations.

Acknowledgements

The authors are thankful to Saraju Kumar Baidya, Deputy Director General of DHM for his valuable comments and suggestions during the preparation of this Paper.

The authors would also like to express their sincere thanks to Mr. Bishal Dahal for designing and editing all the Figures and diagrams.

References:

Flood Forecasting through Communication M2M (available in www.rts.com.np)

Gautam, D.K., Web Based Real Time Data Acquisition System for Flood Early Warning, National Stakeholders Workshop on Weather Forecasting and Flood Early Warning System in Nepal, April 8, 2011, Kathmandu

Real time data acquisition system for Flood Forecasting, Final Report, 2008 (available in www.rts.com.np)

Reference Websites for Figures and Information: www.hydrology.gov.np, www.dhm.gov.np, www.mfd.gov.np