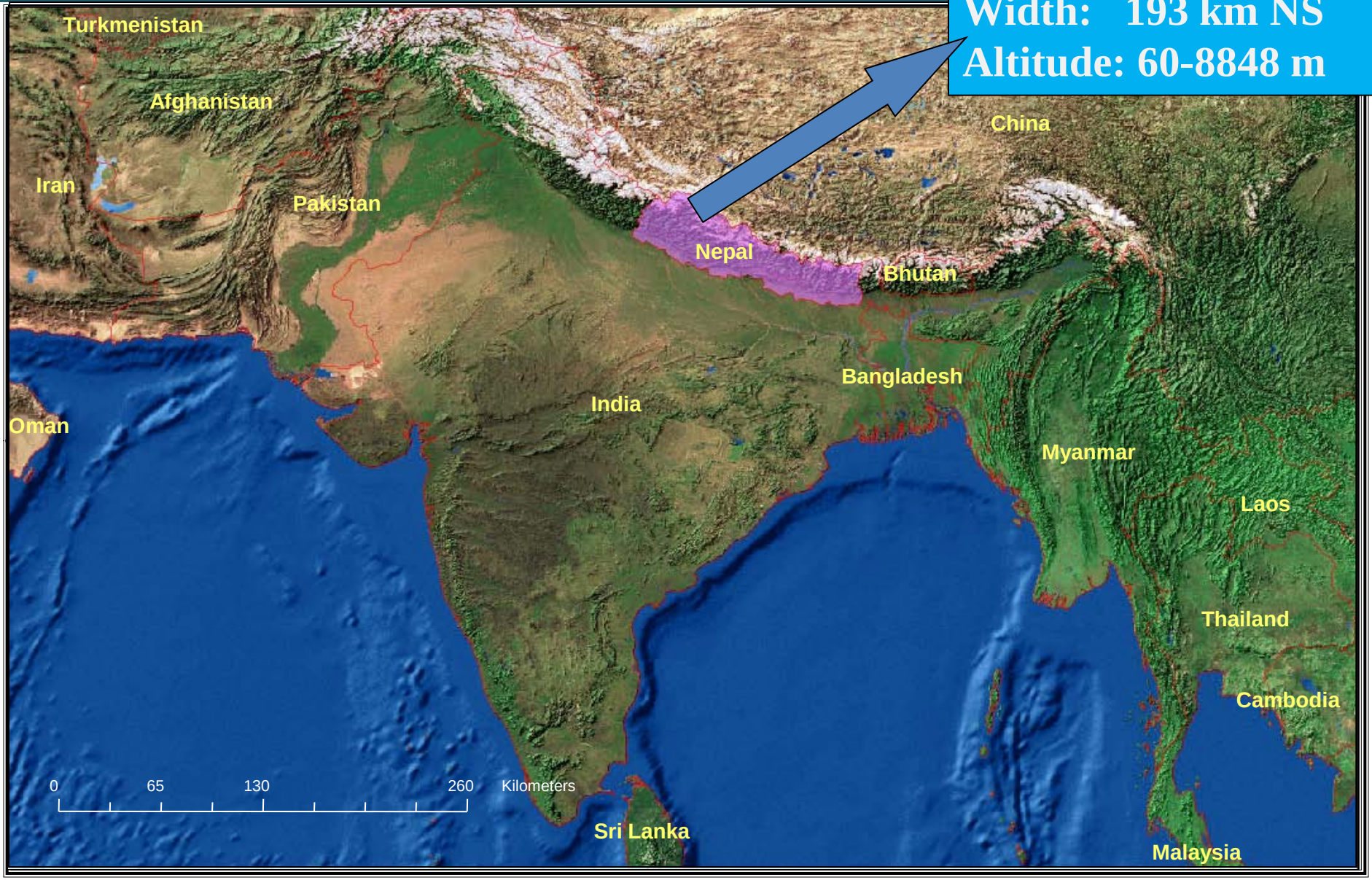
Country Presentation Nepal

TRAINING WORKSHOP ON CALIBRATION AND MAINTENANCE OF METEOROLOGICAL INSTRUMENTS IN RA II (ASIA) 2013

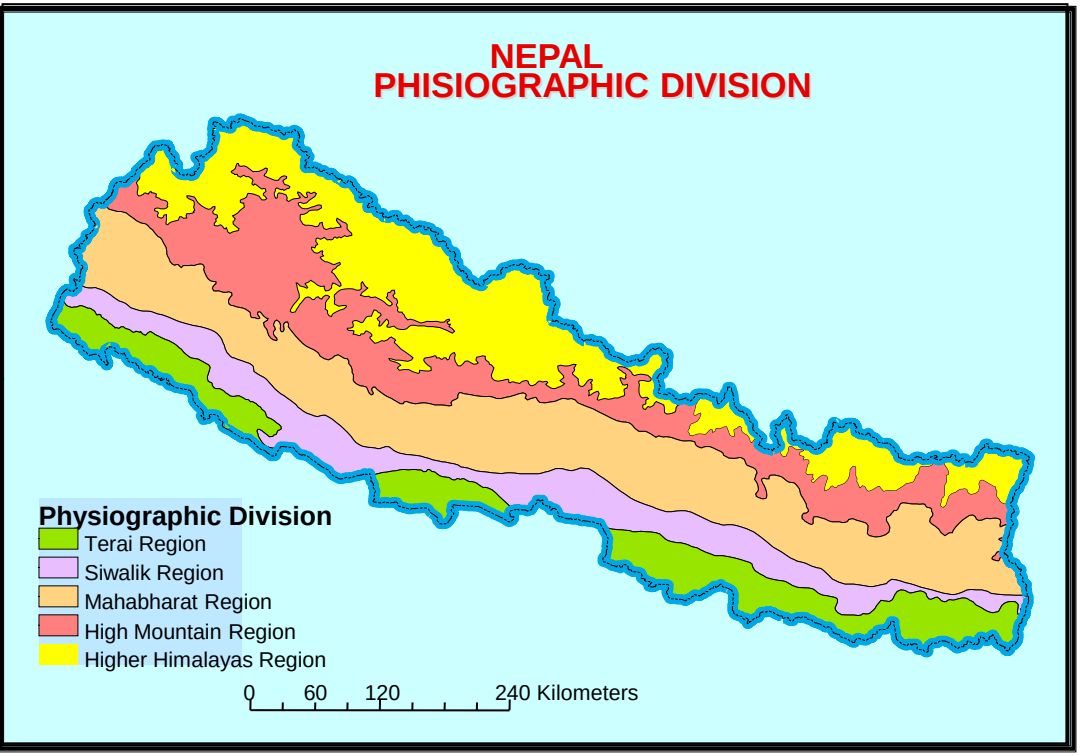
Chiranjibi Bhetuwal
Meteorologist
Department of Hydrology and Meteorology (DHM), Nepal

Nepal: Location

Area: 147,181 km^2
Length: 885 km EW
Width: 193 km NS
Altitude: 60-8848 m



Physiographic Regions

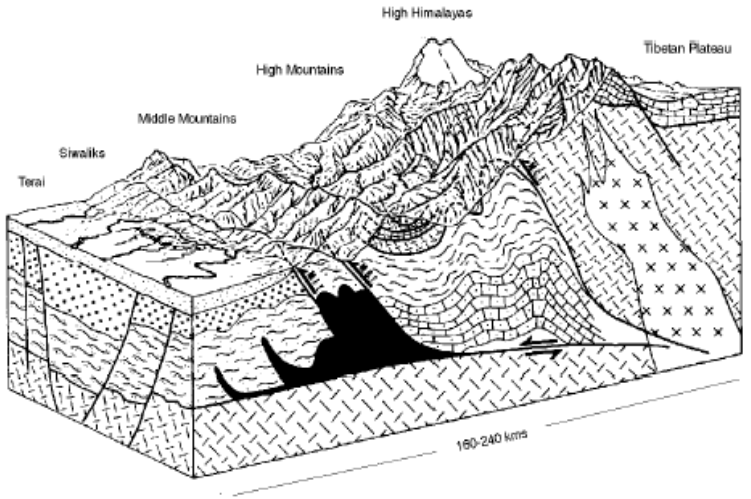


A wide range of climatic conditions from subtropical in the southern plain area to polar and arctic in the high Himalayas are found in this country

Terai➔ hottest part, summer temp. may rise as above 40° C and winter temp is above 5° C

Mountains➔ mild summer, sub-zero to 12° C in winter

Himalayas➔ Coldest part, snow all year round



Department of Hydrology and Meteorology (DHM)

- Mandated from Government of Nepal to monitor all the hydrological and meteorological activities in Nepal.

Organizational Structure of DHM

Professional Staff : 60
Technicians :143
Administrative Staff :30
Total Staff :233

Government of Nepal
Ministry of Environment
Department of Hydrology and Meteorology

Director General

Hydrology Division
Deputy Director General - Hydrology

Meteorology Division
Deputy Director General - Meteorology

Weather Forecasting Division
Deputy Director General - Meteorology

Meteorological Network Division
Deputy Director General - Meteorology

Agromet Section

S.D.M.	1
Meteorologist	1
S. M. assistant	1
J. M. assistant	1

Climate Section

S.D.M.	1
Meteorologist	2
S. M. assistant	1
J. M. assistant	2

Meteorological Data Management Section

S.D.M.	1
Meteorologist	1
S. M. assistant	2
J. M. assistant	3
Data Supervisor	1

Instrument Section

S.D.M.	1
Meteorologist	1
E. Engineer	1
S. M. assistant	2

Weather Section

S.D.M.	3
Meteorologist	3
S. M. assistant	4
J. M. assistant	2

Aviation Weather section

S.D.M.	2
Meteorologist	4
S. M. assistant	4
J. M. assistant	2

Communication Section

S. D. Engineer	1
E. Engineer	1
Comm. Assistant	3
Wireless operator	2

Planning & Network Section

S.D.M.	1
Meteorologist	1
S. M. assistant	2
J. M. assistant	2

Central Development Region Field Offices

Office	S. M. asst	J. M. asst
Simara	1	2
Janakpur	1	2
Total	**2**	**4**

92 Met station under operation

Flood Forecasting section

S.D.H.	1
Hydrologist	2
SH Assistant	4
JH Assistant	3

Hydrological Data Management Section

S.D.H.	1
Hydrologist	1
SH Assistant	2
Data Supervisor	1

River Network Section

S.D.H.	1
Hydrologist E.	3
SH Assistant	3
JH Assistant	3

Technical Relations and Facilitation section

S.D.H.	1
Hydrologist	1
SH Assistant	1
Instrument Mech.	1
JH Assistant	1

Snow, Water Quality & Environment Section

S.D.H.	1
S.D. Chemist	1
Hydrologist	2
Meteorologist	1
Chemist	1
SH Assistant	1
Lab Tech.	1
JH Assistant	1

Posting details

SN	Post/class	No.
1	Director General - TGI	1
2	Deputy Director General, Met TGI	3
3	Deputy Director General, Hyd TGI	1
4	S. D. Met TGII	13
5	S. D. Hyd TG II	5
6	S. D. ChemTGII	1
7	S. D. ElecEng TGII	1
8	Meteorologist TGIII	17
9	Hydrologist TGIII	12
10	Chemist TGIII	1
11	Electronic Engineer TGIII	2
12	Section Officer TGIII	1
13	Account Officer TGIII	1
14	SM. Assist. TNGI	38
15	SH Assist. TNGI	21
16	Instrument Mech. TNGI (Hyd)	1
17	Data Supervisor TNGI (Misc)	2
18	Lab Tech TNGII	1
19	Communication Asst. TNG I	3
20	Admin Asst. NGI	7
21	Assistant Accountant NGI	4
22	JM Assistant NGII	40
23	JH Assistant NGII	24
24	Wireless operator NGII	2
25	Asst. Accountant NGII	1
26	J Admin Assistant non G II	4
27	Driver	8
28	Office Assistant	18
	Total	233

Eastern Regional Office, Dharan

S.D.M.	1
Meteorologist	1
S. M. assistant	2
J. M. assistant	2
Na Su	1
Accountant	1
Driver	1
Office Assistant	2

Western Regional Office, Pokhara

S.D.M.	1
Meteorologist	1
S. M. assistant	2
J. M. assistant	2
Na Su	1
Accountant	1
Driver	1
Office Assistant	2

Mid & Far Western Regional Office, Surkhet

S.D.M.	1
Meteorologist	1
S. M. assistant	2
J. M. assistant	2
Na Su	1
Accountant	1
Driver	1
Office Assistant	2

Koshi Basin Office Biratnagar

Hydrologist	1
SH Assistant	3
JH Assistant	4

Narayani Basin Office Narayanghat

Hydrologist	1
SH Assistant	2
JH Assistant	4

Karnali Basin Office Nepalganj

Hydrologist	1
SH Assistant	3
JH Assistant	5

Account Section

Account Officer	1
Accountant	1
Asst. Accountant	1

Administration Section

Section Officer	1
Admin Asst. NGI	4
J Admin Asst. NGII	4
Driver	5
Office Assistant	12

Field Offices

Office	S. M. asst	J. M. asst
Biratnagar	1	2
Okhaldhunga	1	1
Dhankuta	1	1
Taplejung	1	1
Lukla	1	1
Total	**5**	**6**

54 Met station under operation

Field Offices

Office	S. M. asst	J. M. asst
Pokhara	1	2
Bhairahawa	1	2
Total	**2**	**4**

127 Met station under operation

Field Offices

Office	S. M. asst	J. M. asst
Dadeldhura	1	1
Dhangaghi	1	1
Dipayal	1	1
Jumla	1	1
Surkhet	1	1
Dang	1	1
Nepalganj	1	2
Total	**7**	**8**

173 Met station under operation

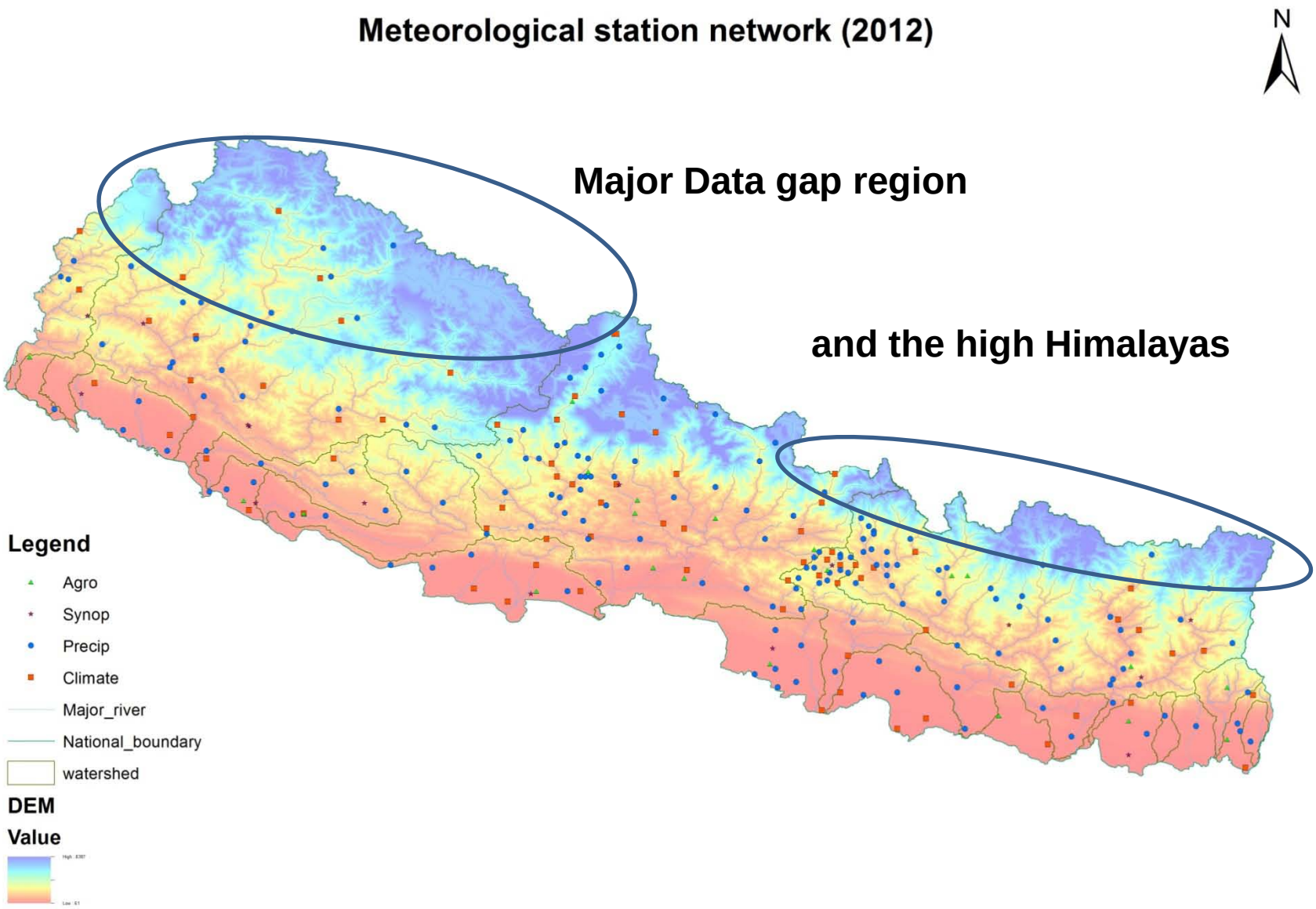
S = Senior, J = Junior, H = Hydrology, M = Meteorology, D = Divisional
T = Technical, G = Gazetted, N = Non

Instrument section
S.D.M 1
Meteorologist 1
Electronic Engineer 1
Met Assistant 2

Existing Observational Network of DHM

A. Manual Stations

• Precipitation stations	173
• Climatic Stations	72
• Agro-meteorological Stations	21
• Synoptic	9
• Aero-synoptic Stations	7
• Hydrometric stations	154
• sediment stations	20


Meteorological station network (2012)
N
Major Data gap region
and the high Himalayas
Legend
Agro
Synop
Precip
Climate
Major_river
National_boundary
watershed
DEM
Value

Automatic Surface Observation systems

1. **Automatic weather stations near real time data** **14 stations**
   (Air temp, R.H. , Precipitation, atm. Pressure, wind speed and direction, solar radiation)

2. **Automatic stations near real time data** **7 stations**
   (air temp, R.H. Rainfall)

3. **Automatic rainfall stations near real time** **51 stations**
   (Data transmission is through GPRS, CDMA system in every 10-30 minute depending on site)

4. **Automatic weather stations offline** **about 7 stations**

5. **Automatic real time river gauge stations** **31 stations**

6. **Few automatic weather stations with iridium satellite data transmission facility are under installations in high altitude**

Existing Automatic meteorological stations parameters

A. Automatic observing stations near real time

S.N.	Observed parameter	No of stations
1	Rainfall	73
2	Air temperature and relative humidity	21
3	Wind speed and direction	14
4	Atmospheric pressure	12
5	Global Solar radiation	9

B. Automatic weather stations offline 7

- **Data from all the automatic stations quality controlled in real time**

Quality Control of Data

- Web based new database system (PostgreSQL 9.0) in Linux based environment installed in 2011 with support from Finnish Meteorological Institute. Database server is installed at National Information Technology Center (NITC) Nepal.
- The database can handle both manual and automatic real time data from AWSs.
- Quality control is done in real time (every 2 minutes).

Data has to pass through different quality control stages

1. QC0 done at the station (for manual and some automatic stations)
2. QC1 done as soon as observation enters database
3. QC2 done later, when all neighboring stations have observations etc (**not implemented yet)**
4. HQC done much later (Human Quality Control)

Quality Control (QC1)

Steps on QC1. This is done in data base

1. Persistency check:-

- to check whether data is changing or not (Data values should change with time)

2. Step change:- the data value should not jump suddenly

3. Consistency test:-

Relation between two or more parameters (example Visibility and Present weather should match)

4. Compare test:

- Compare the values between two variables (Maximum temperature>Minimum temperature)

5. Limit test:- General valus limit for different parameter (temperature between -80 to 60 degc and so on)

After applying the quality control data is quality flagged with different flag no for diff quality of data

Instruments on Operational Use

Atmospheric Pressure

a. Manual

a.1 **Mercury Barometer**

- Manufacturer 1: **Dr. A. Muller, R. Fuess Germany**
  Model: Kew pattern type: **11 b9**
- Manufacturer 2 : **Lambrecht, Germany**
  Model: Kew pattern type: **611**
- Manufacturer 3 : **India Meteorological Department, India**
  Model: **Kew pattern type**

b. Automatic

1. Environdata Australia Pressure sensor (These sensors will be replaced with new ones)

2. **Vaisala OYJ, Finland**

- Capacitive absolute pressure sensor **BAROCAP PTB 110 SENSOR**
- Capacitive absolute pressure sensor ***BAROCAP PTB330 Sensor***
- **WXT 520 Compact sensor** (Barocap pressure module)

Mercury Barometer

Instruments on Operational Use

Air temperature and Relative Humidity

a. Manual

Liquid-in-glass thermometer

Manufacturer**: Thermoschneider, Germany and Lambrecht Germany**

Models: **Maximum thermometers, 1002 DIN 58654, Scale 0.5^{0}C**

Minimum Thermometer, 1014 DIN 58653, Scale 0.5^{o}C

Dry and Wet bulb Thermometer, 1033 DIN 58660, Scale 0.2^{o}C

b. Automatic

1. Environdata Australia temperature sensor TA 10

2. Lambrecht Germany combined temperature and humidity sensor Model No 8091 (Capacitive Humidity and Pt100 Temperature sensor)

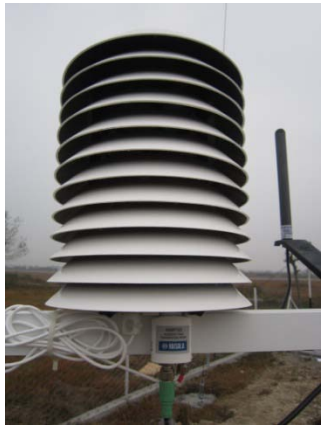
3. Vaisala, Oyj, Finalnd HMP155 Humidity and Temperature Probe (**Humicap capacitive humidity sensor and Pt100 temperature sensor)**

4. Vaisala, Oyj, Finland WXT 520 Compact sensor (capacitive and pt100)

5. Rotronic Instrument Company, Switzerland, HC2S Temperature and Relative Humidity Probe

Manual instruments

automatic



Instruments on Operational Use

Wind speed and Direction

a. Manual

Mechanical Cup anemometer
Manufacturer: **Casella**
Manufacturer 2. :- **Lambrecht, Germany**
Model:- **Mechanical Cup Counter** 1440

b. Automatic

1. **Cup Anemometer:** - Environdata Australia Wind speed cup sensor and wind vane (WS 30 and WS 40 WD 30, 32, 42 etc)

2. Sonic Anemometer:-

a. Vaisala OYJ Finland, Ultrasonic wind speed sensor WMT 702, WXT 520 Compact sensors Ultrasonic
b. Climatronics Corporation USA Sonimometer™ (sonic anemometer) (P/N 102779
c. R.m. Youngs 2 axis ultra sonic anemometer 85000

3. Propeller anemometer
R.M. Youngs Company 08274 EPS PROPELLER

Manual instruments

Instruments on Operational Use

Precipitation measurements

a. Manual

□ **US stanadard Ordinary rainague**

Manufacturer: Local Galvanized Iron Raingauge 8inch diameter with internal cylinder and measuring stick

b. Automatic

❑ **Weighing gauge**

Manufacturer: Ott, Germany

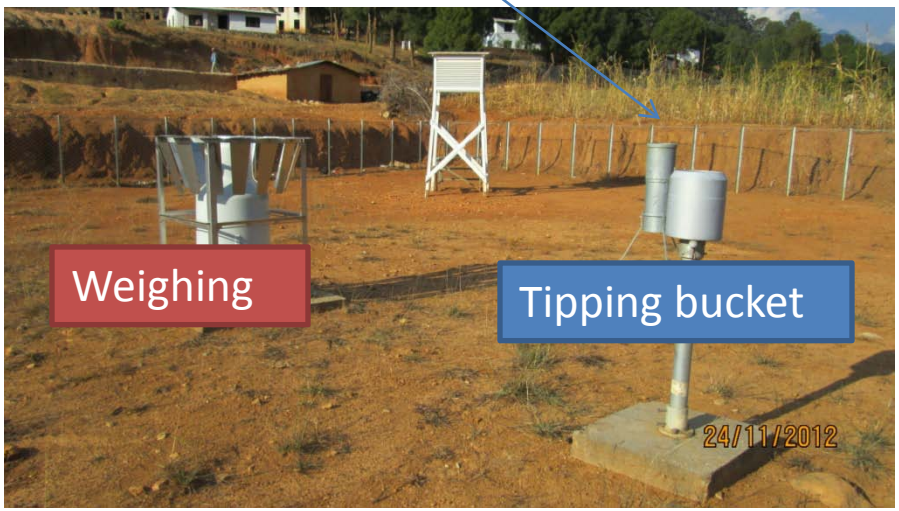
Model: Pluvio 2 version 2 and 4 (200cm2 with 1500mm capacity and 400cm2 with 750mm capacity (load cell)

□ **Tipping bucket gauge**

1. Manufacturer:- Environdata, Australia 8inch diameter
2. Manufacturer: - Casella, London 8 inch diameter
3. Manufacturer: - Texas electronics INC USA TR525S.2mm 8" dia
4. Manufacturer: - TB3 Hydrological Services, Australia
5. Manufacturer:- Lambrecht, Tipping bucket (200cm2 orifice)

□ **Float gauge**

Manufacturer: Lambrecht Germany



Instruments on Operational Use

Solar Radiation/ Sunshine Duration

b. Automatic

❑ **Global solar radiation**

1. Manufacturer: Kipp and Zonnen, Netherland

   Model: **CMP6 Thermopile**

2. Manufacturer: Licor silicon sensor

   Model: **Licor PY7615**

3. Environdata, Australia

   Model: SR10 Silicon type

□ **Net Radiometer**

1. Manufacturer:- Kipp and Zonnen, Netherland

   Model CNR4

   Thermopile sensor 4 components of radiation

❑**Sunshine Recorder**

Campbell-Stokes sunshine recorder

1. **Casella, London HB3190-04, 02271D (Tropical 0- 45 deg)**

Sunshine cards Pawan export India

National Standard /Travelling Instruments

Atmospheric pressure

National Standard

Kew pattern type mercury barometer

Lambrecht, KG Gottingen

Model: **611/420176**

last calibration with a superior standard: **1992 AD with Indian standard**

Interval of calibration with a superior standard: **No**

Traveling standard

Precise Aneroid Barometer
Baromec, Range 800-1050mb Mechanis ltd , CroyCon England
Type M1975
Calibration:- Intercomparision with national standard before and after field intercomparision.

Air Temperature/Relative Humidity

National Standard

Mercury and Alcohol thermometer

Model: **8911194** , **Thermoschneider Germany**

last calibration with a superior standard: No

Interval of calibration with a superior standard: **No**

Traveling standard

Vaisala Oyj, Finland, Hand-Held Humidity and Temperature Meter HM70

Model:- HMP75B G4810001

Calibrated date Jan 30/31, 2012 NIST traceable

range of calibration:- -40 to 60 deg C

6 point temperature calibration and 7 point humidity calibration

calibrated in measurement standard laboratory Vaisala OYJ Finland

Wind Speed and Direction

No standard Instruments

Precipitation

Measuring cylinder graduated for 20cm diameter raingauge is used for field Intercomparision

Global solar radiation

CMP6 Pyranometer, Kipp and Zonnen, Netherland

Calibration laboratories

Relative Humidity

Hygrograph Chamber:
Company: Theodor Friedrichs and company, Hamburg, Germany
Parts no: 8222.0, Fabr.No. 8025

Air Temperature

Originally Thermograph chamber(Can be used for sensors as well):-
Company: Theodor Friedrichs and company, Hamburg, Germany Parts no: 2391, Fabr.No. 8015

Thermometer bath Intercomparision chamber:
Company: Theodor Friedrichs and company, Hamburg, Germany
Parts no: 8221.2, Fabr.No. 8035

Calibration laboratories

Atmospheric Pressure

Barometer Intercomparision Chamber:
Company: Theodor Friedrichs and company, Hamburg, Germany
Parts no: 8710 Fabr.No. 8015

Problems in Operation of Calibration Lab and Solutions

•No intercomparision of calibration instruments with international standard has been done after its establishment in 1980s.

•Intercomparision chambers for Barometer and thermometer bath are not in operational use these days but it can be used after comparison with international standard and necessary trainings for its operation.

•The calibration laboratories are not accredited, ISO and other certified.

•Thermograph calibration chamber is easy to operate and can be utilized for sensor calibration as it has outlet for sensor ports

•Modifying the design of hygrograph calibration chambers to calibrate for humidity sensors (already consulted with company and they can modify the existing design for sensor calibration) its also easy for operation.

•Frequent Power Outage is the main problem for operational use of Calibration Chamber in the Energy Crisis environment of Nepal

•Lack of Trained technical personals to do calibration

Immediate Plans for Calibration and Intercomparision.

- ❖Purchasing high speed data logger (high speed processor (32bit or more), and 10 bit or more analog to digital converter) with enough analog (0-1v, 0-…microvolt, 0-1A etc), RS232, RS485, SDI12, Frequency, Counter channels to use for calibration purpose only.
- ❖Vaisala HM70 calibrater can be taken as reference for air temperature and humidity sensor calibration and the hand held calibrater will be regularly (every 2 years) calibrated in Vaisala Lab in order to ensure quality.
- ❖Modifying the design of hygrograph calibration chambers to calibrate for humidity sensors (already consulted with company and they can modify the existing design for sensor calibration)
- ❖Continuous Power is the main problem for now.
- ❖Purchasing simple calibrator for rainfall.
- ❖Purchasing hand held SOLRAD logger from Kipp and Zonnen for field intercomparision of global solar radiation sensors.
- ❖Purchasing Vaisala PTB330 pressure sensor with digital display for field intercomparision back up.
- ❖Purchasing recently calibrated wind speed and direction sensor (high quality sensor) for intercomparision of other sensors in head office premises.

Plans for Establishment of Calibration Laboratories and Problems

- New calibration instruments are planned to be purchased under Pilot Project for Climate Resilience (PPCR) project funded by World Bank (WMO will provide the technical support).
- Management of uninterrupted power supply.
- Lack of spare instruments, working procedure documentation (SOP and others), trained and motivated manpower.
- Financial constraints for regular maintenance, calibration and monitoring works.

Problems, Maintenance and Calibration efforts

Problems in Manual Instruments

1. Leakage from Manual Raingauge.
2. Frequent Break in Alcohol column of minimum thermometers specially during winter season and break in mercury column of maximum thermometer some times. Many observers are unaware about the break in thermometer column.
3. Most of the technicians are not trained to correct the break in thermometer column.
4. Many observers always keeps the value of maximum, minimum thermometer reading after setting same as dry bulb without caring for real values of thermometers. The observers are either trained to do the same by some technical staff in order to make the data quality acceptable or some observers they try to cheat. This makes difficult to identify the real problems with thermometers.
5. Lack of training to observers and technical staffs and not taking observation on exact time.
6. Frictional effect on cup anemometer rotation and decrease in wind speed value with aging.
7. Sunshine recorder setting not done properly or changing of settings by untrained personals.
8. Regular cleaning and upkeeping of instruments and observatory not done.

Problems, Maintenance and Calibration efforts

Efforts for maintenance in Manual Instruments

1. Thorough checking of all the instruments during visit.
2. Training to local observers and technicians for general maintenance of instruments, correcting the break in thermometer column. (particularly to minimum thermometers)
3. The efforts to provide spare thermometers, measuring cylinder and measuring stick of manual raingauge is in process as far as the budget permits.
4. Cleaning, greasing and upkeeping of instruments.
5. Proper fixing of sunshine recorder if traces on cards are not properly burning.
6. Intercomparison of instruments with travelling standards.
7. Replacing defective instruments with new one during visit.
8. Updating the Metadata.

Problems, Maintenance and Calibration efforts

Problems in Automatic

1. The AWS is powered with solar and operated by battery back up. the failure in battery results in non-functioning of the system and hence data loss.
2. Loose connections of sensor connecters, water leaking inside cable and breakage in cable connections from sensors to data logger.
3. dust deposits, mud housings (by wasps), webs by spiders and other insects and bird nests in instruments.
4. Clogging of tipping bucket rain gauge due to bird droppings, dried leaves and twigs etc
5. Rusting in instruments.
6. The sensors are not heated type due to power problems. Very high wind speed values of more than general limit has been observed from the Ultrasonic wind sensors when the snow get deposited in between transducers.
7. Growth of trees and bushes in the observatory.
8. Block in mechanical wind sensors and difficulty in maitenance as most of the mast are not tiltable or foldable types. The breakage in wind sensor has been observed in many instances.
9. Lack of proper leveling of instruments
10. Theft of equipments like battery and solar panel in the energy crisis environment of Nepal leading to non-functional status of an AWS and hence loss of data.

Maintenance efforts AWS and automatic raingauge

- Replacing the battery with a new one, at least once in two years for uninterrupted functionality.
- Thorough checking of sensors, cable connections.
- Cleaning of sensors, rusting cleaning, greasing etc.
- Checking the value of solar radiation before and after cleaning.
- Pouring know volume of water in raingauge and checking the values.
- Intercomparison of values with travelling standards.
- Cross validation of wind speed value with beaufort scale and wind direction values with prevailing direction.
- Proper fixing of cables and other mechanical parts.
- Changing the filter of relative humidity.
- The problem of cable damage between tipping bucket raingauge and data logger is unknown for long time. therefore SDI interface which can do two way communication between data logger and sensor is used in tipping bucket in order to identify the cable damage (cuts due to mouse or other reasons)
- Carefully cross validating the sensitivity factors (for solar radiation) and tip amount in tipping bucket gauge.

Some Examples and Photos

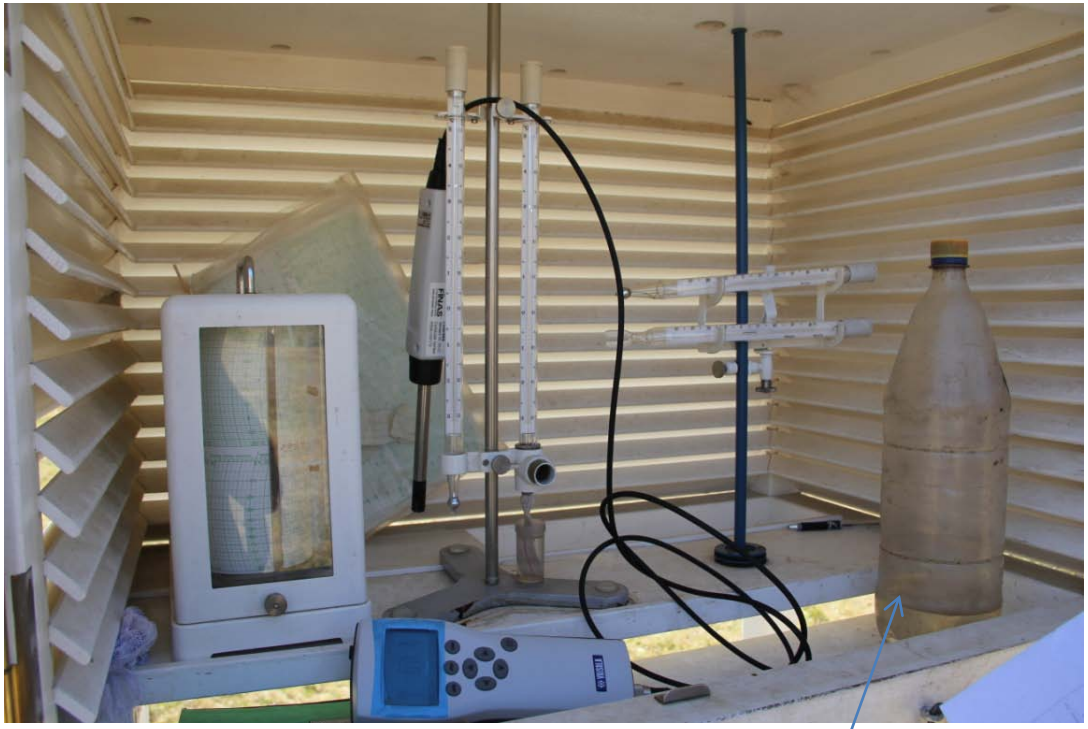
Mud housing by Wasps blocking tip of raingauge

Cleaning temperature humidity filter

Tilted wind sonic sensor

Temporarily fixing the sensor during visit

Intercomparison



Solar radiation sensor intercomparsion (Darchula 23 Nov, 2012)

CMP6 Kipp and Zonnen (watt/m2)	LICOR (watt/m2)
309.12	249.58
360.44	249.58
350.06	333.19
368.77	323.77
380.87	350.38
390.00	350.38
398	319
455.02	368.32
455.02	376.66
452.46	376.66
452.46	373.38
456.36	373.38
498.3	392.39

Remarks:- Licor value lower than CMP6

Date 20 Nov 2012 Bajhang Chainpur AWS

Vaisala HM70 in wooden stevenson screen		Lambrecht Temperature humidity sensor in radiation shield		Thermometers in wooden Stevenson screen			Time
Air Temp (°C)	Humidity(%)	Temp (°C)	Humidity (%)	Dry Bulb (°C)	Wet Bulb (°C)	R.H.(%)	
17.63	23.89	18	26	17.2	8.8	24	10:00 AM
17.4	23.53	18.2	26	17.4	8.8	23	
17.74	23.24	18.2	24	17.4	8.8	23	12:15PM
17.51	22.63	18.4	24	17.3	8.9	24	
18.15	20.54	18.9	23	18.2	8.9	19	12;48

Lambrecht temperaure higher than Vaisala