Country Presentation Nepal

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

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Meteorologist
Department of Hydrology and Meteorology (DHM), Nepal
Nepal: Location

Area: 147,181 km²
Length: 885 km EW
Width: 193 km NS
Altitude: 60-8848 m
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
• 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

Planning & Network Section

Central Development Region
Field Offices

Eastern Regional Office, Dharan

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

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

Field Offices

Office S.M. assit. J.M. assit.
2
Dharan
1
Pothana
2
Shahbhaktapur
2
Total 9
52 Met station under operation

Field Offices

Office S.M. assit. J.M. assit.
2
Dharan
1
Pothana
2
Shahbhaktapur
2
Total 9
52 Met station under operation

Field Offices

Office S.M. assit. J.M. assit.
2
Dharan
1
Pothana
2
Shahbhaktapur
2
Total 9
52 Met station under operation

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

Posting details

1. Director General - T2
2. Deputy Director General, Met T1
3. Deputy Director General, Hyd 1
4. S.D. Met T1
5. S.D. Hyd T1
6. Hydrologist T1
7. S.D. Hyd T1
8. Meteorologist T1
9. Meteorologist T1
10. Meteorologist T1
11. Electronic Engineer T2
12. Account Officer T2
13. H.M. Assit. TN2
14. H.M. Assit. TN2
16. Data Supv. TN2
17. Commn. Assit. TN2
18. Admin. Asst. TN1
19. Admin. Asst. TN1
20. Asst. Accountant
21. Asst. Accountant
22. Driver
23. Driver
24. Office Assistant
25. Office Assistant

Total: 233

52 Met station under operation

S = Senior, J = Junior, H = Hydrology, M = Meteorology, D = Divisional
T = Technical, G = Guest, N = None
### Existing Observational Network of DHM

#### A. Manual Stations

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation stations</td>
<td>173</td>
</tr>
<tr>
<td>Climatic Stations</td>
<td>72</td>
</tr>
<tr>
<td>Agro-meteorological Stations</td>
<td>21</td>
</tr>
<tr>
<td>Synoptic</td>
<td>9</td>
</tr>
<tr>
<td>Aero-synoptic Stations</td>
<td>7</td>
</tr>
<tr>
<td>Hydrometric stations</td>
<td>154</td>
</tr>
<tr>
<td>Sediment stations</td>
<td>20</td>
</tr>
</tbody>
</table>
Major Data gap region and the high Himalayas
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

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Observed parameter</th>
<th>No of stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rainfall</td>
<td>73</td>
</tr>
<tr>
<td>2</td>
<td>Air temperature and relative humidity</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Wind speed and direction</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Atmospheric pressure</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Global Solar radiation</td>
<td>9</td>
</tr>
</tbody>
</table>

B. Automatic weather stations offline

- 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 value 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
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)
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°C

Minimum Thermometer, 1014 DIN 58653, Scale 0.5°C

Dry and Wet bulb Thermometer, 1033 DIN 58660, Scale 0.2°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, Finland HMP155 Humidity and Temperature Probe
   (Humatic 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
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
Precipitation measurements

a. Manual

☐ US standard Ordinary rain gauge
Manufacturer: Local Galvanized Iron Rain Gauge 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: - Envirodata, 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
### 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**

**Traveling standard**

*Precise Aneroid Barometer*

Baromec, Range 800-1050mb Mechanis Ltd, CroyCon England

Type M1975

**Calibration:** Intercomparison with national standard before and after field intercomparison.

### 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 intercomparison.

### Global solar radiation

CMP6 Pyranometer, Kipp and Zonnen, Netherland
**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
Barometer Intercomparision Chamber:
Company: Theodor Friedrichs and company, Hamburg, Germany
Parts no: 8710  Fabr.No. 8015

Atmospheric Pressure

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 calibrator can be taken as reference for air temperature and humidity sensor calibration and the hand held calibrator 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 maintenace 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

#### Date 20 Nov 2012 Bajhang Chainpur AWS

<table>
<thead>
<tr>
<th>Vaisala HM70 in wooden stevenson screen</th>
<th>Lambrecht Temperature humidity sensor in radiation shield</th>
<th>Thermometers in wooden Stevenson screen</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temp (°C)</td>
<td>Humidity(%)</td>
<td>Temp (°C)</td>
<td>Humidity (%)</td>
</tr>
<tr>
<td>17.63</td>
<td>23.89</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>17.4</td>
<td>23.53</td>
<td>18.2</td>
<td>26</td>
</tr>
<tr>
<td>17.74</td>
<td>23.24</td>
<td>18.2</td>
<td>24</td>
</tr>
<tr>
<td>17.51</td>
<td>22.63</td>
<td>18.4</td>
<td>24</td>
</tr>
<tr>
<td>18.15</td>
<td>20.54</td>
<td>18.9</td>
<td>23</td>
</tr>
</tbody>
</table>

#### Solar radiation sensor intercomparsion (Darchula 23 Nov, 2012)

<table>
<thead>
<tr>
<th>CMP6 Kipp and Zonnen (watt/m²)</th>
<th>LICOR (watt/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>309.12</td>
<td>249.58</td>
</tr>
<tr>
<td>360.44</td>
<td>249.58</td>
</tr>
<tr>
<td>350.06</td>
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<tr>
<td>456.36</td>
<td>373.38</td>
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<tr>
<td>498.3</td>
<td>392.39</td>
</tr>
</tbody>
</table>

**Remarks:**
- Licor value lower than CMP6
- Lambrecht temperature higher than Vaisala