Training Workshop on "Regional Severe Weather and Flash Flood Hazard Early Warning Mechanisms"

Bhutan: Status and Future Plans of Severe Weather and Flash Flood Hazard Early Warning Mechanism

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Outline

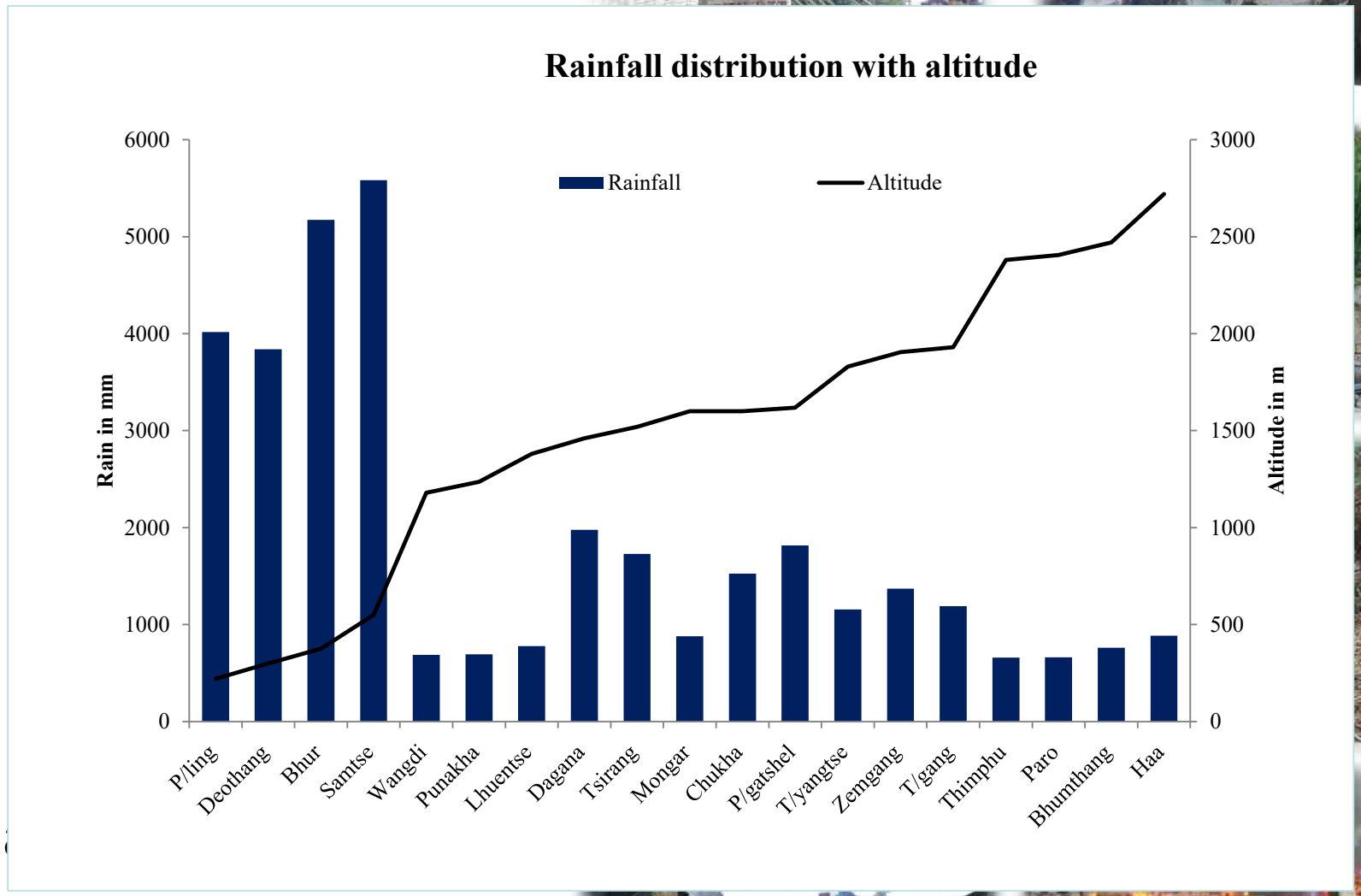
- Country Profile
- Disaster in Bhutan
- Hydrology and Meteorology Services
- GLOF and Flashflood Early Warning Mechanism
- Future plan
- Challenges

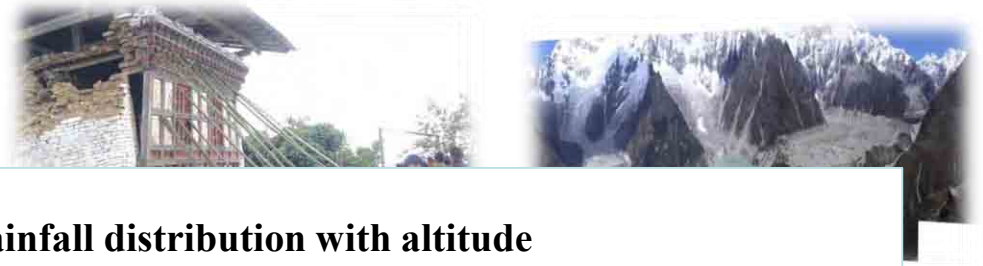
Country Profile

- Total area - **38,394** Sq. Km
- Population – **735,000** (2018)
- **70 %** of population is **farmer**
- Forest Coverage: more than **70%** - Policy is to ensure at least **60%** for all time
- Topography : Rugged mountain terrain
- Altitude : **160 m** to **7500 m** above msl

Bhutan is vulnerable to

a. Floods
   - ✓ Flash Floods
   - ✓ GLOF
   - ✓ LDOF
b. Windstorm
c. Landsides
d. Cyclone
e. Earthquake
f. Forest Fires
g. Epidemics, pests





Potentially dangerous glacial lakes in Bhutan

Pho Chu Sub Basin : 9
Mo Chu Sub Basin : 5
Mangde Chu Sub Basin: 7
Chamkhar Chu Sub Basin: 3
Kuri Chu Sub Basin: 1

Source: DGM & ICIMOD publication

- There are about 677 glaciers and 2674 glacial lakes in headwaters of Bhutan.
- 17 lakes have been identified as potentially dangerous lakes (2018).

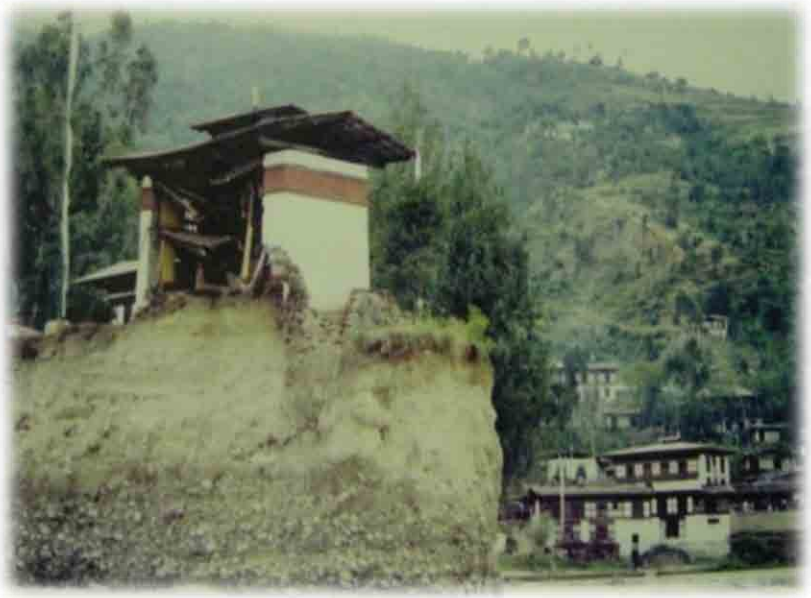
Why GLOF/floods matters for Bhutan??

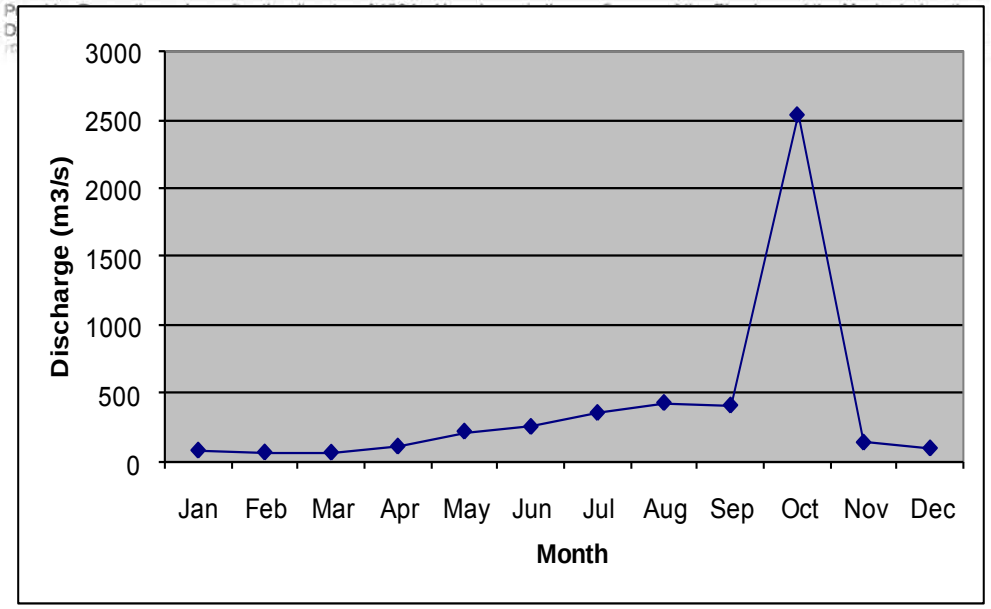
Point data showing the settlement pattern of Bhutan

Source: NSB, 2005

Over 70% of the settlements are locate bas

1994 GLOF




Discharge (m3/s)
3000
2500
2000
1500
1000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

FLASH FLOOD

Thimchhu flood during cyclone Aila May 2009

Floods impacts in Bhutan

Flash Flood: Pasakha August 2000

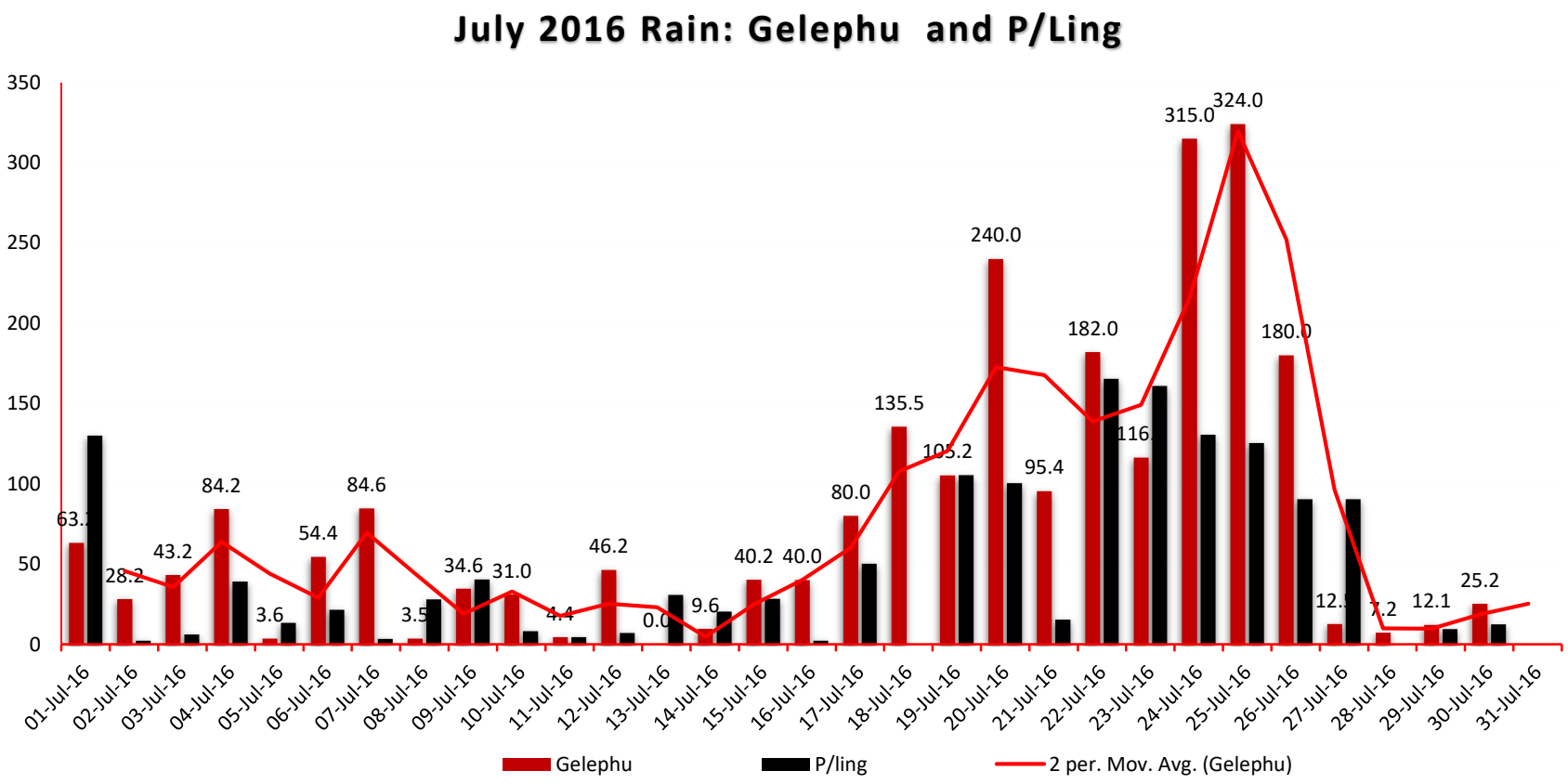
Flash Flood: Pasakha August 2000

Flash Flood: Intake of Ranjung Power Plant destroyed 2004

2004 Flash Flood Eastern Bhutan

Flood July 2016

- Persistence heavy rainfall
- Southern Bhutan huge impact due to flood



NCHM
National Center for Hydrology and Meteorology

Recent GLOF

- Thorthormi – Subsidiary lake II - Drained out 2.73 million cubic meters of water slowly.
- June 20, 2019 caused due to glacier surge
  - Prolonged rise in temperature
  - Delayed summer monsoon

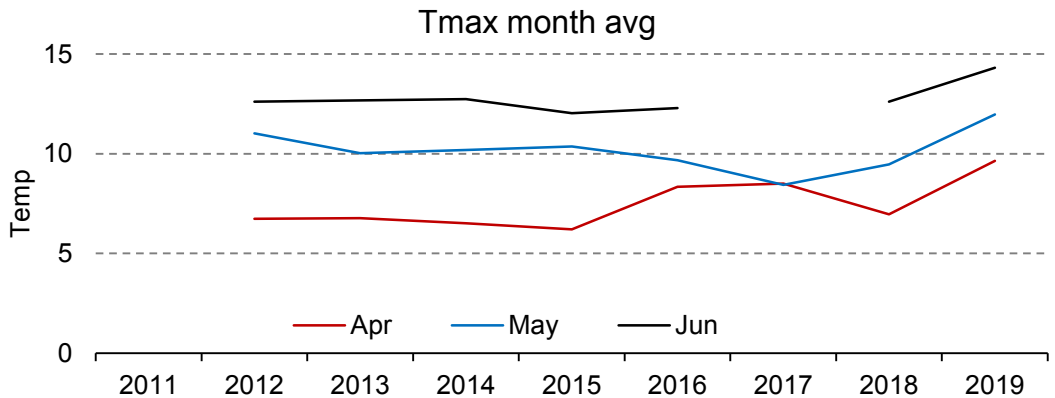


Figure 1: Exceeded Alert threshold of water level at Thorthormi Station

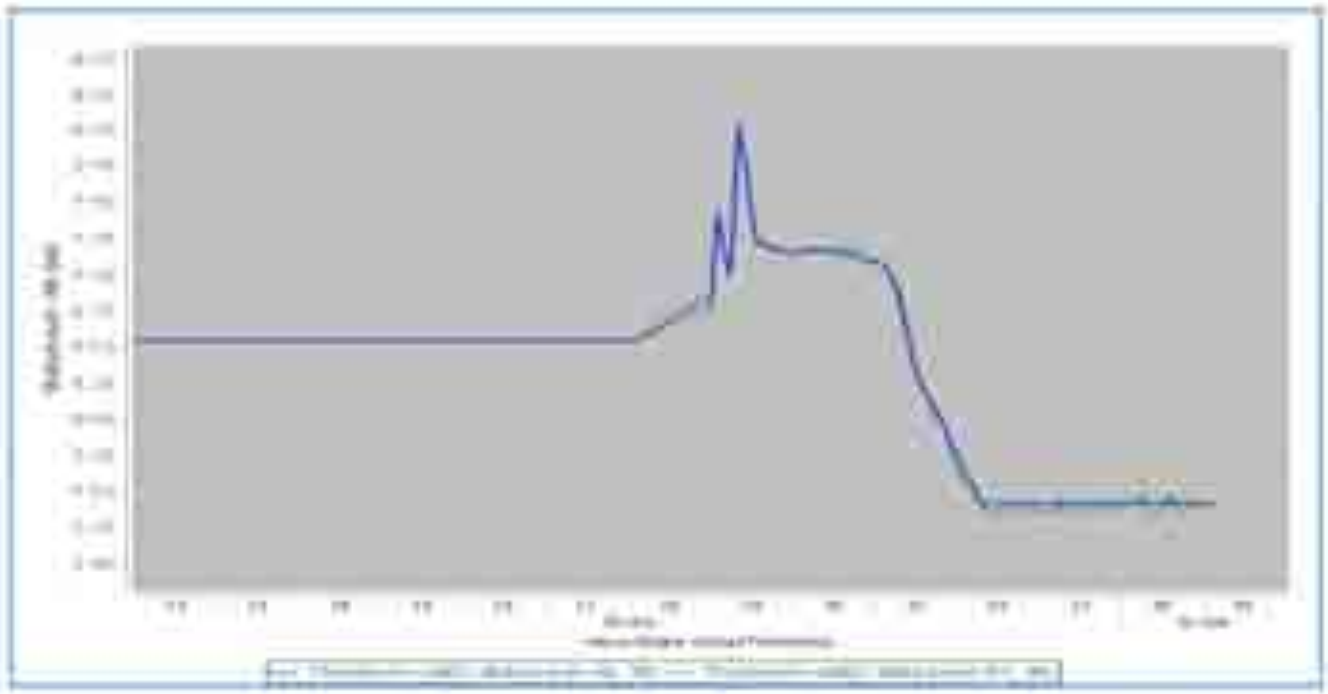


Figure 2: Detection of the rise and fall of water level at Thorthormi Station

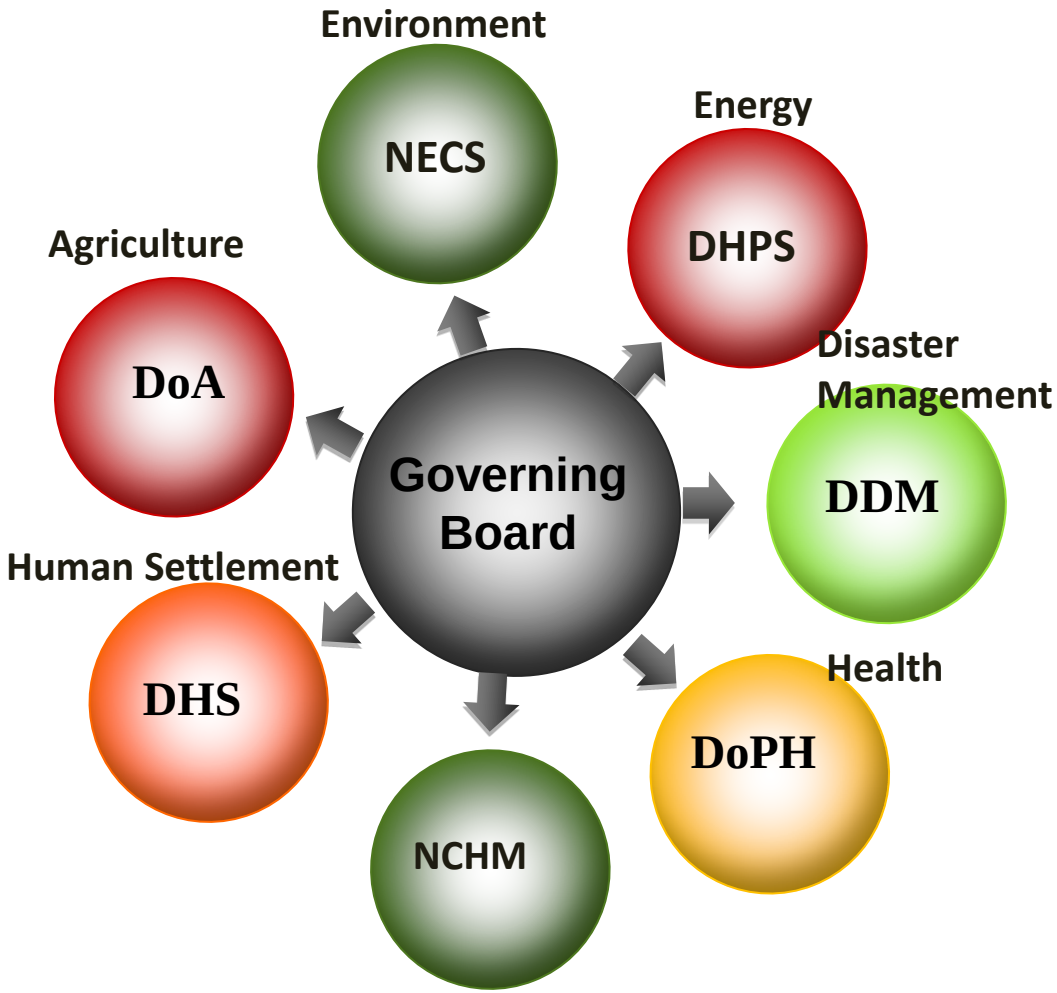
Hydrological and Meteorological Services

Overview of NCHM

- NCHM: **National Centre for Hydrology & Meteorology**

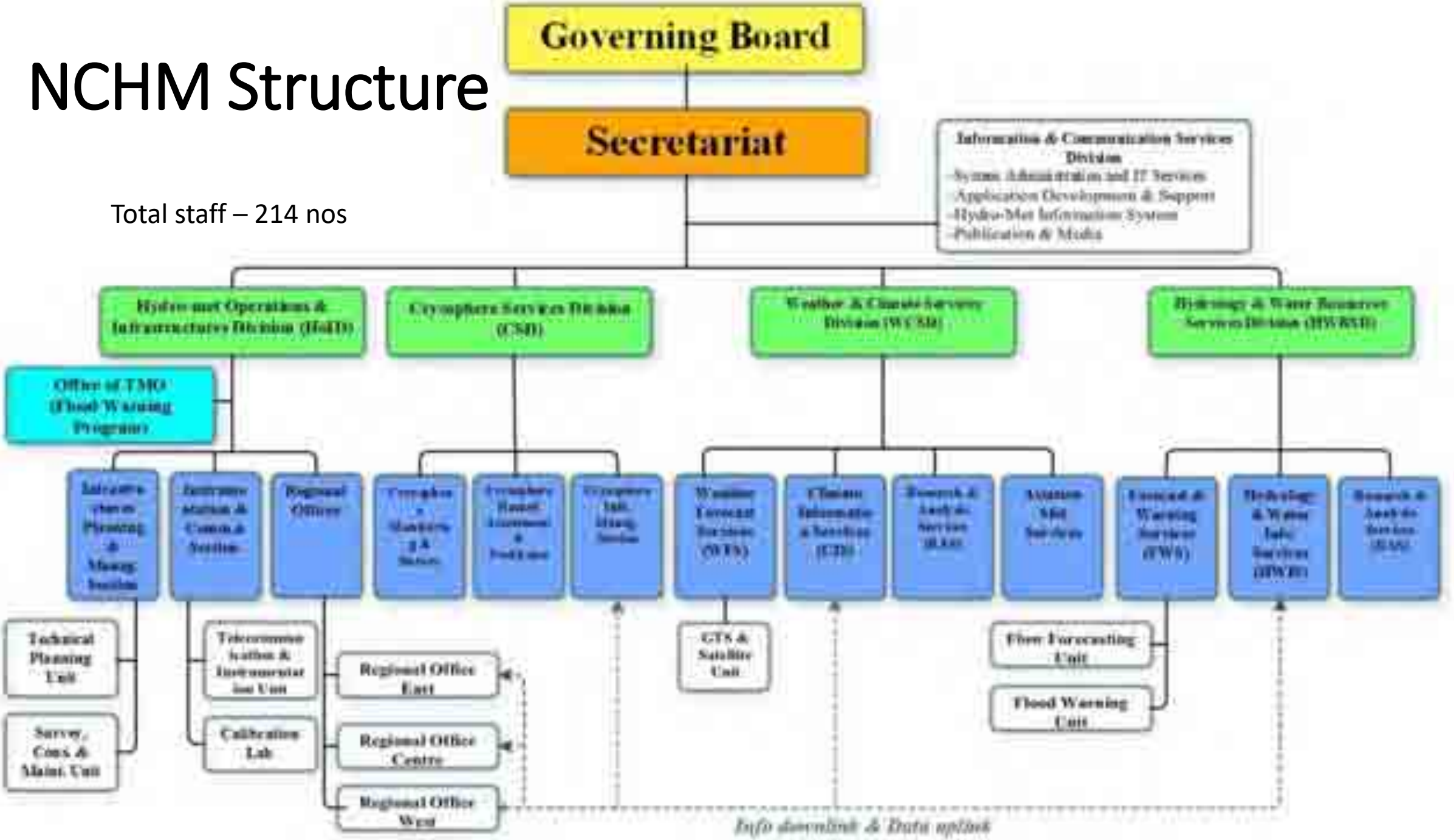
- Autonomous Agency from August 2016: it is an independent organization of the Royal Government of Bhutan

- NCHM is governed by a Governing Board and Board Members (BM) are from the relevant sectors.



NCHM Structure

Total staff – 214 nos



Hydrological Services

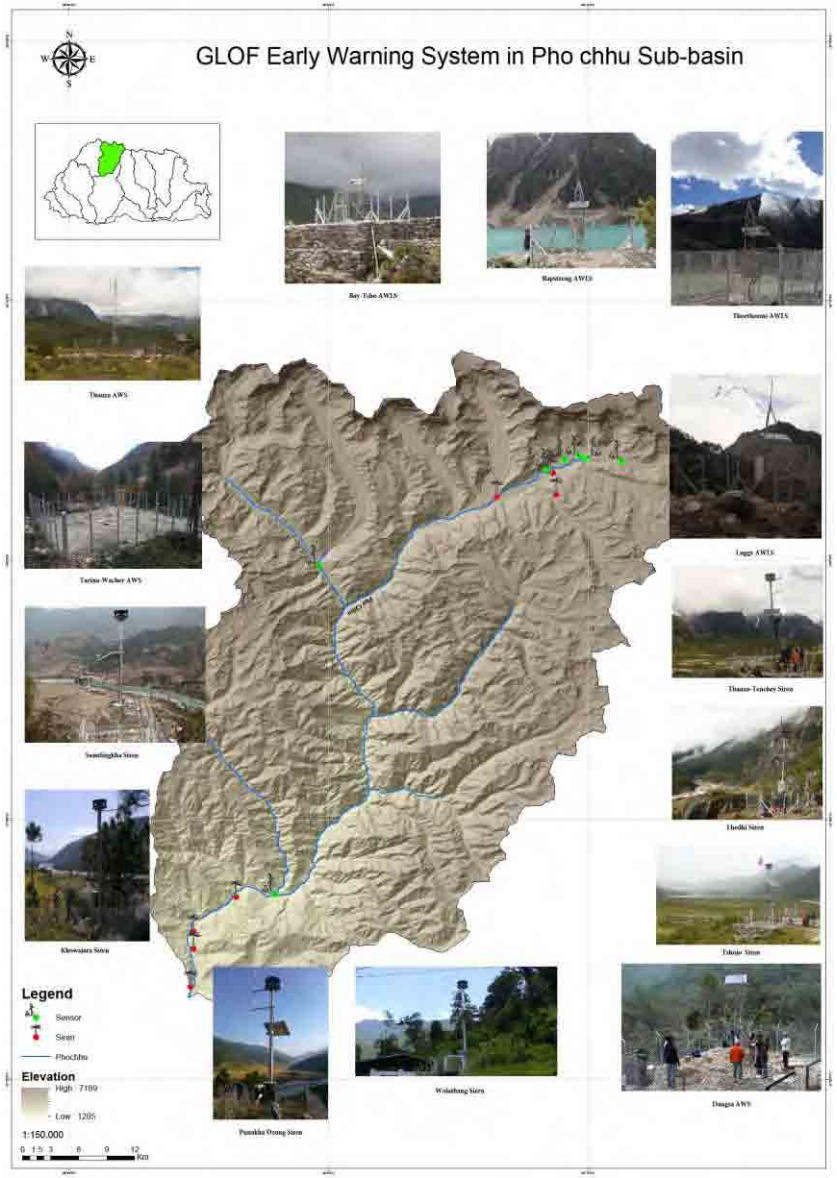
- Historical hydrological data services (1990-till date)
- **Early warning system –GLOF and rainstorm floods**
- **Flood monitoring**
- **Flood advisory**
- Flood/GLOF Hazard mapping & zonation
- Hydrological Modelling
- **Hydrological/flow forecasting**
- Technical back stopping in hydrometry
- Water Resource Assessment in future

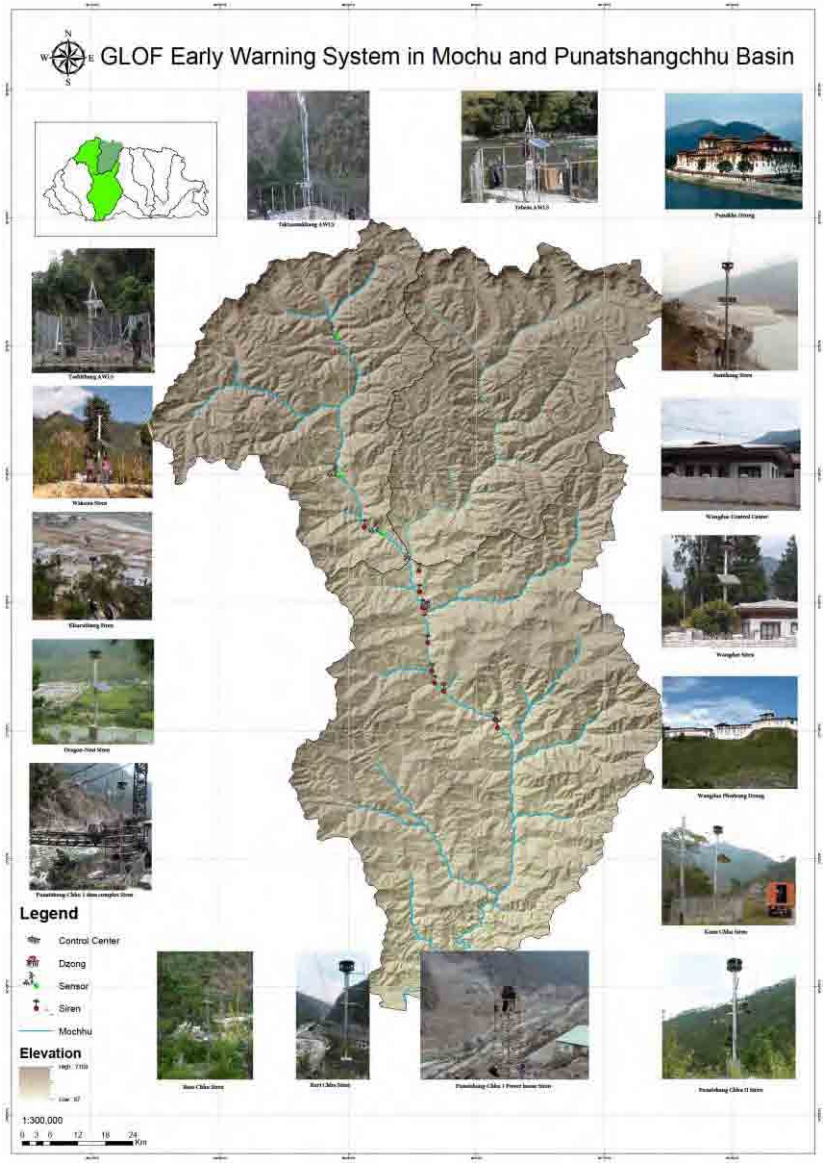
Weather and climate services

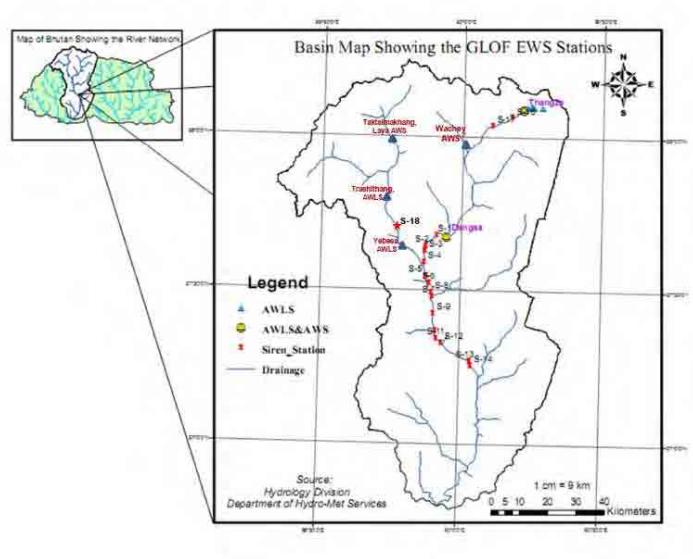
- Weather services
  - Historical climate data
  - **Public Weather Forecast – 3 days**
  - Adhoc route forecast
  - **Weather advisory and warning**
- Aviation Met Services
  - METAR (Paro and 3 Domestic Airport)
  - VFR
- Climate services
  - Extended range prediction (pilot phase)
  - Seasonal forecasting (summer and winter)
  - **National Climate Outlook Forum (NCOF)**
  - Climate projection for Bhutan

Hydrological and Meteorological Services

GLOF Early Warning System







- **10 Remote** Automatic Water Level Stations (AWLS) /Automatic Weather Stations (AWS)
- **18 Sirens** to warn vulnerable communities along the river valley downstream.
- **Iridium satellite** communication is used to transmit data from remote stations to control room for monitoring and detection of GLOF in real time, and linked to a network of sirens that are activated in the event of eminent GLOF threats.
- **Control Room 24x7** operators that can view the latest data from any of the 28 stations using custom developed software by M/s Sutron Corporation, USA

Components of EWS GLOF/rainstorm floods

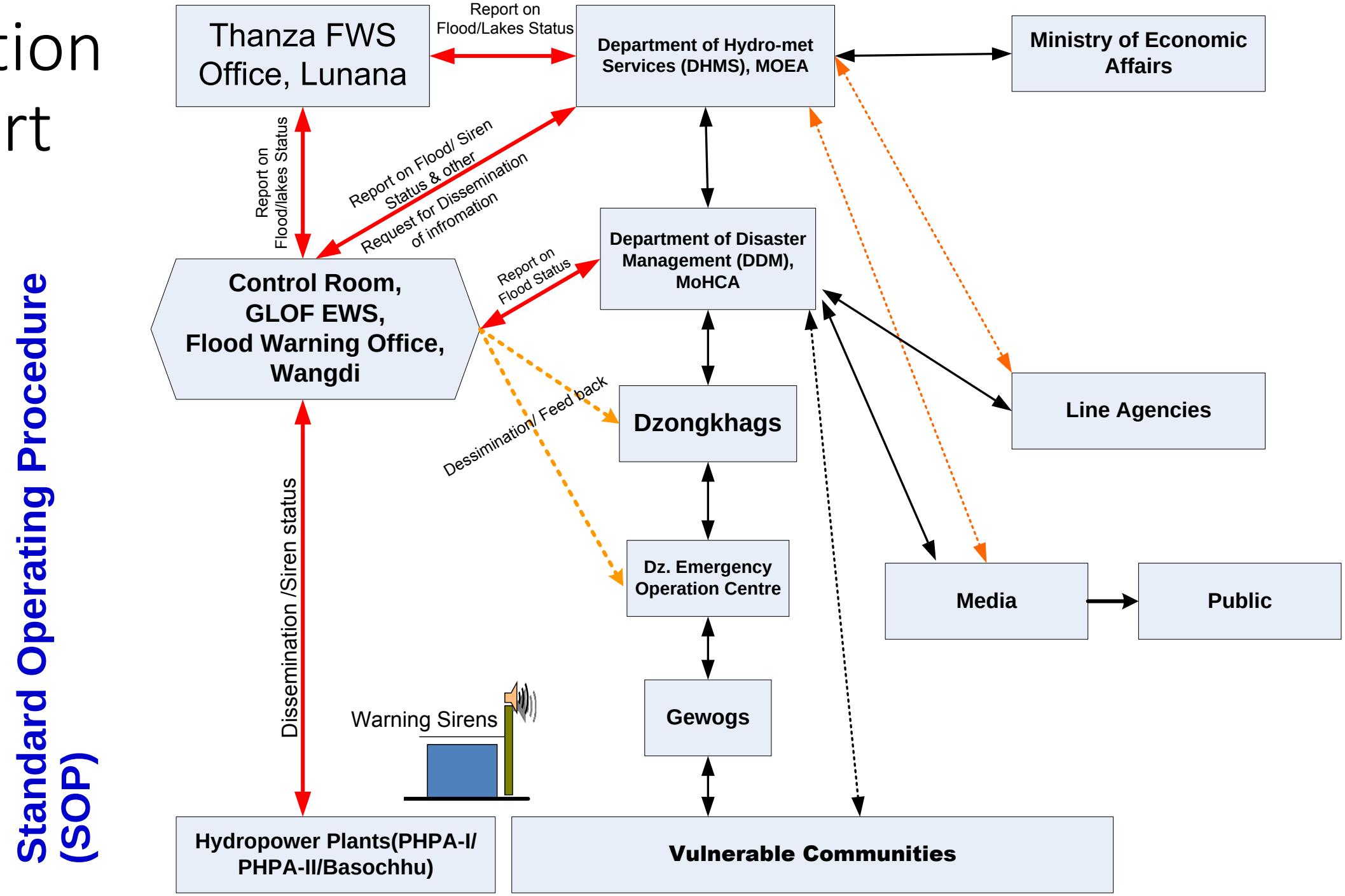
1). Remote Monitoring Stations

2). Communication

3. Control Room

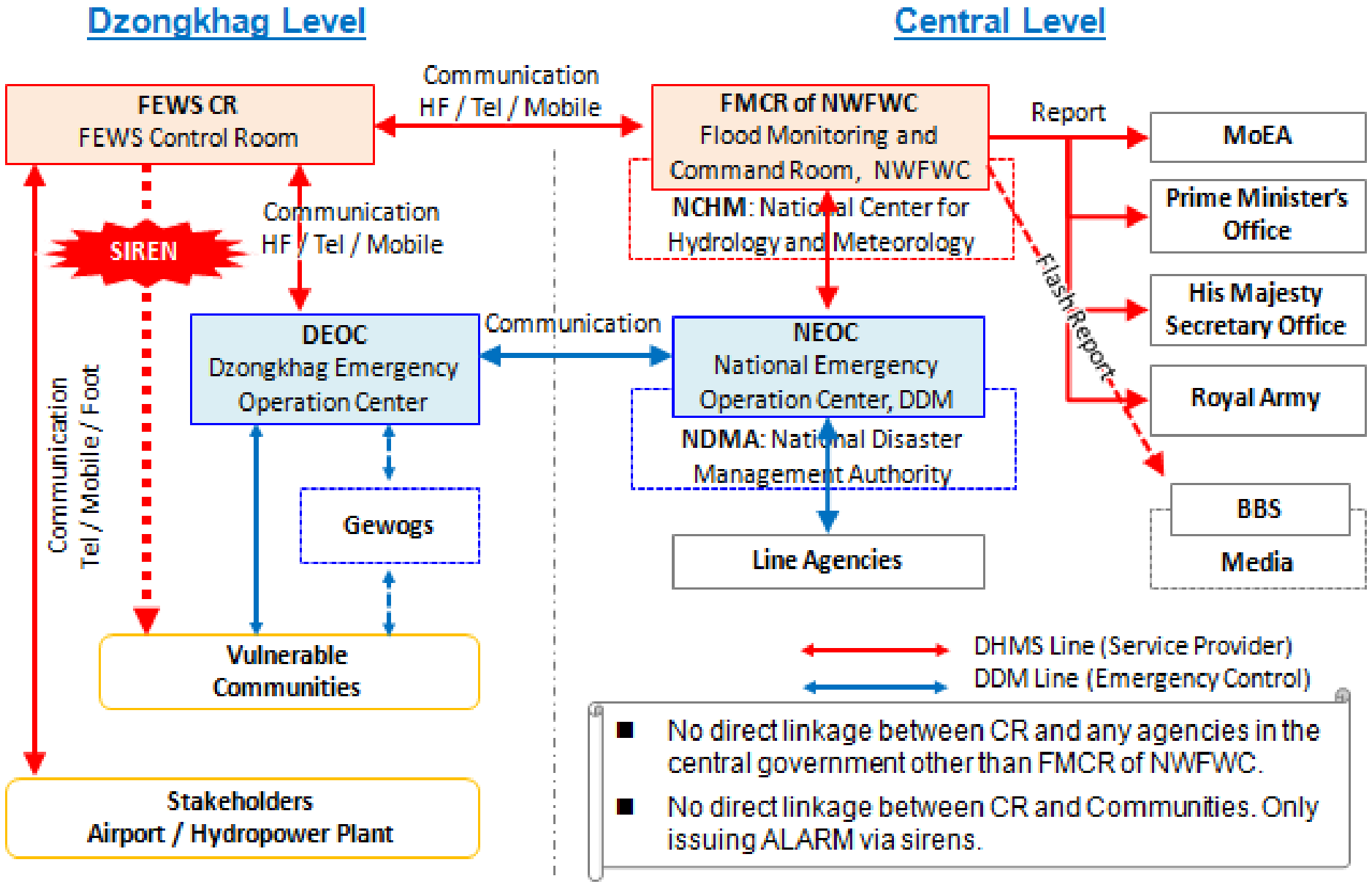
4). Sirens

Information flow chart



Standard Operating Procedure (SOP)

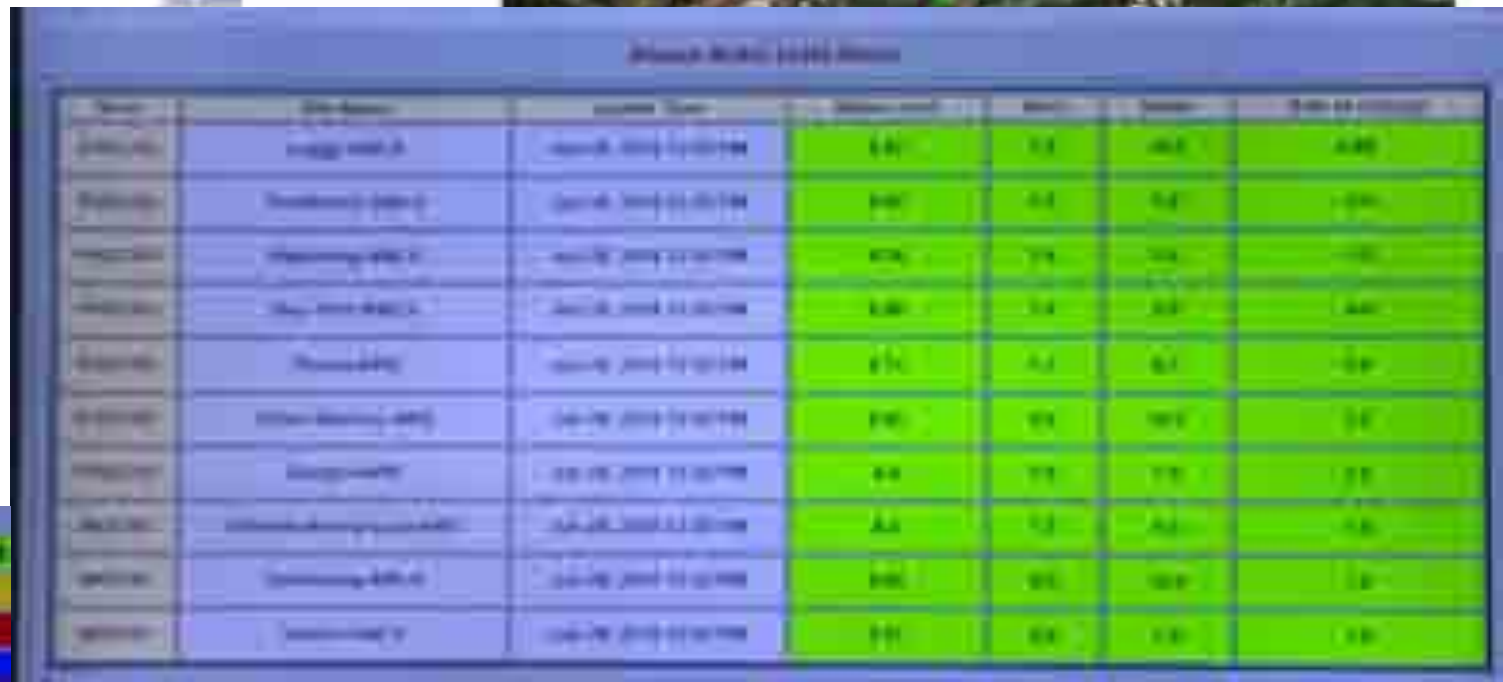
General Communications and Information Flow in the Central and Dzongkhag Levels



GLOF EWS monitoring

Website:

- Purpose is to display and disseminate hydro-met data
- Password protected. NCHM has control over who can use the website
- Control Room monitor – 24/7



GLOF/Rainstrom flood EWS

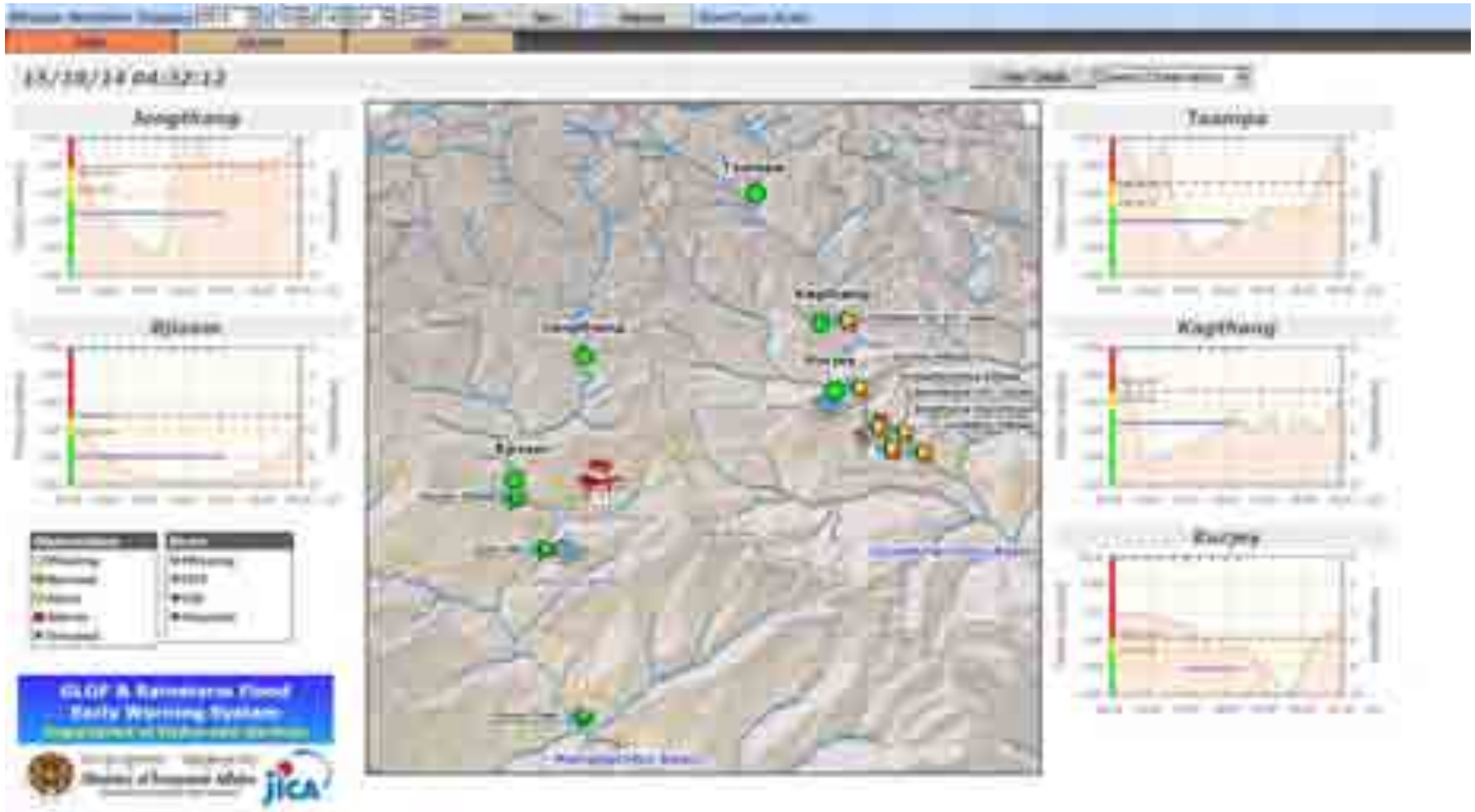
Basin Control Room

Control Room, Kurjey, Bumthang

Chamkharchhu

Control Room, MHPA Dam Colony(Mangdechhu)

Monitoring System at Control Room



Monitoring Interface

- Water level and rainfall of each AWLS can be monitored in the interface.
- Control Rooms and NWFWC are automatically synchronized via Internet.

Communication between Remote Monitoring Station and Control Room

Meteorological Satellite (METEOSAT)

DCP

Automatic Water Level Stations

WMO GTS Network

HF

Control Rooms

HF(Voice)

Internet

NWFWC, DHMS Thimphu

HF

Warning Sirens

Warning Sirens

Mangdechhu Sub-basin (3 Sirens)

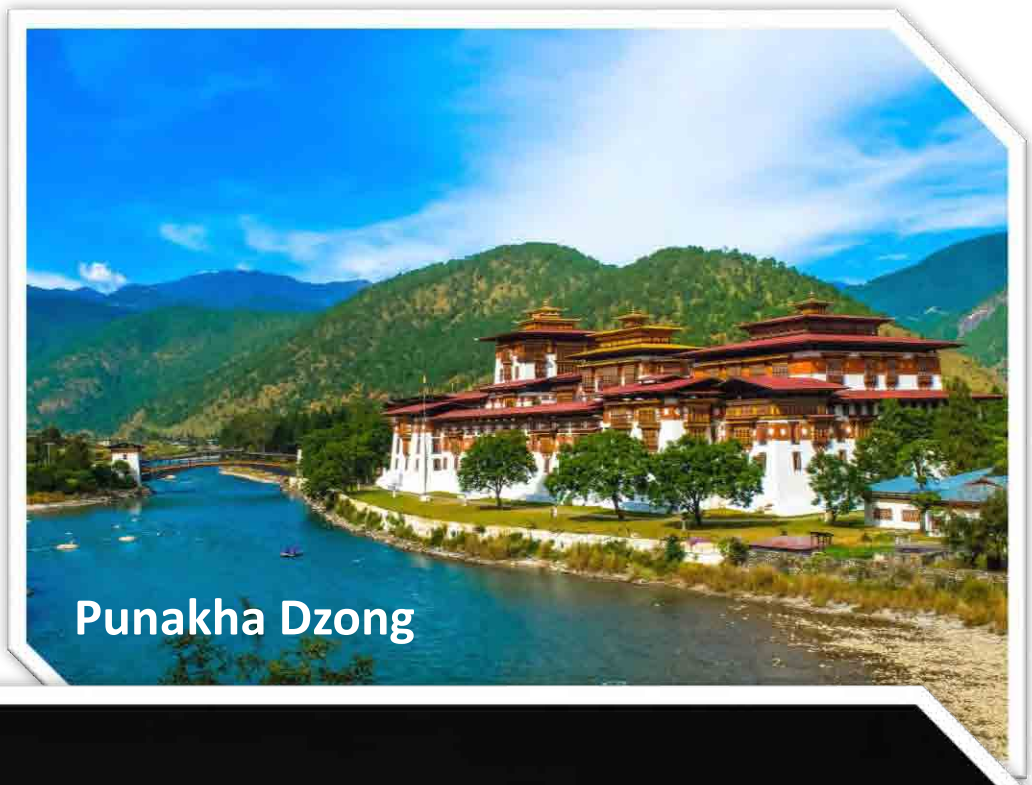
Chamkharchhu Sub-basin (6 Sirens)

Future Plan

- **GLOF/Flashflood EWS integrate forecasting component**
- Integrate EWS to all river basin for flash flood – Wangchu basin planned
- Introduce Medium Range Forecasting + Seamless forecasting services
- **Impact based forecasting – SWFDP/WMO**
- Weather forecasting studio planned
- **Strengthen DSS – FFGS/SERVIR/RIMES**
- Capacity building - climate projection and impact studies relevant sectors
- Strengthen Aviation Met Services
- **Strengthen collaboration with sectors**
- Education, advocacy and awareness for efficient use of the services

Challenges

- Small mountainous country – chaotic atmospheric condition – challenging forecasting
- Quantitative forecasting is very challenging (precipitation) – Flash flood
- Snow and wind forecast is challenging
- Access to Glacial lakes is challenging
- Huge maintenance cost of EWS
- Limited professional in hydrological and meteorological/climate modelling
- Lack of collaboration between the line agency – information valueless if not utilized



Thank you