FLOOD FORECASTING AND WARNING IN THE PHILIPPINES

Initial Planning Meeting on the Establishment of a Flash Flood Guidance System (FFGS) for Southeast Asia-Oceana Region
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Outline of Presentation:

1. Background
2. Extreme flood events
3. Types and causes of flooding & flood mitigation measures
4. Flood forecasting and warning system
5. Other Activities
1. BACKGROUND:

Why is the Philippines prone to flooding?

The climate of the PH is influenced by the complex interactions of various factors such as:

- Philippine Geography and Topography
- Ocean currents
- Semi-permanent cyclones and anti-cyclones
- Principal Air Streams
- Linear systems
- Tropical Cyclones

Meteorological maps and diagrams illustrating these factors are shown on the slide.
2. EXTREME FLOOD EVENTS IN THE PHILIPPINES

2004
- Flashfloods in Quezon in December 2004

2006
- Typhoon Reming in November 2006

2008
- Typhoon Frank (Fengshen) in November 2008

2009
- Tropical Storm Ondoy (Ketsana) and Pepeng (Parma) September-October 2009

2012
- Typhoon Pablo (Bopha) in December 2012

2013
- Typhoon Yolanda (Haiyan) in November 2013

A man walks past debris of destroyed houses in Tacloban City on Nov 10, 2013.
Impacts of Hydromet hazards in PH

- More extreme weather events are expected.
- More and more people are affected by hydromet-related hazards.
- Frequency, duration and intensity of rainfall events have changed.

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily Rainfall mm</th>
<th>Mo Normal Rainfall, mm</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Sep 2009</td>
<td>455.0</td>
<td>504.2 (90.24%)</td>
<td>Sci. Garden Quezon City</td>
</tr>
<tr>
<td>6-7 Aug 2012</td>
<td>714.8</td>
<td>504.2 (144%)</td>
<td>Sci. Garden Quezon City</td>
</tr>
<tr>
<td>18-19 Aug 2013</td>
<td>801.4</td>
<td>457.2</td>
<td>Sangley, Cavite</td>
</tr>
<tr>
<td>22-23 Sep 2013</td>
<td>503.3</td>
<td>695.8</td>
<td>Cubi Point, Zambales</td>
</tr>
</tbody>
</table>
Impacts of STY Yolanda

A view of the Tacloban airport (REUTERS/Romeo Ranoco)

An airport lies in ruins in the city of Tacloban in the Philippines. CNN

Overturned vehicles are seen at a ricefield in Tacloban City. (REUTERS/Raul Banias)

A survivor in Tacloban City holds the statue of Jesus Christ. (REUTERS/Raul Banias)

Houses are destroyed by the strong winds caused by the typhoon in Tacloban City.

A man walks past debris of destroyed houses in Tacloban City on Nov 10, 2013.

Devastation is everywhere in Iloilo in the aftermath of the typhoon.

Houses are destroyed by the strong winds caused by the typhoon in Tacloban City.

An aerial view shows the damaged houses in Iloilo province. (REUTERS/Raul Banias)

Impacts of STY Yolanda

3a. TYPES OF FLOODING:

A. Based on location or place of occurrence:

A.1 River flooding occurs when a large amount of rain falls in river system(s) with tributaries that drain large areas containing many independent river basins and inundates the adjacent low lying areas. They may last a few hours or many days depending on the intensity, amount and the distribution of the rainfall.

Source of photos: various internet sites
A.2 Coastal flooding may occur due to storm surges, high tide and tsunamis (waves produced by earthquakes at sea).

Communities with a steeper continental will not see as much surge inundation.

A shallow slope off the coast will allow a greater surge to inundate coastal communities.
A.3 Urban flooding occurs in an area where roads are usually paved. During rainy episodes, water cannot infiltrate the ground and is normally retained in the surface. This type of flooding is often associated with the limited capacity of the sewerage system to drain the heavy rains that are falling.

Source of photos: from different internet sites
B. Based on duration of occurrence:

B.1 Flash Flooding is the result of heavy rainfall or cloudburst over a relatively small drainage area. Flash floods carry highly destructive flood waves and are most common in mountainous areas or in steep places that have streams flowing through narrow canyons. It happens quickly and move with little warning.
B.2 **Sheet Flooding** is caused by comparatively shallow water flowing over a wide area and is very common in the flood plain area which is normally flat. Sheet flooding may also result when water from a river channel with insufficient carrying capacity overtop its bank, inundating the adjacent areas.

Flooding in Poblacion Mainit, Surigao Del Norte, January 2011

Rosales, Pangasinan, Typhoon Pepeng, October 2009

Source of photos: from different internet sites
3b. CAUSES OF FLOODING:

1. Heavy, continuous rains that persist for days or ceases only briefly.
2. Heavy siltation of the river system which decreases the carrying capacity of the river.
3. Timeliness of dam spilling
4. Over tapping of dikes and levees
5. Insufficient Carrying Capacity of drainage system
Aggravating Factors:

1. Influence of Urbanization - Small streams in urban areas can also rise quickly after heavy rain due to higher run-off generated and the smaller time of concentration.
Aggravating Factors:

2. Improper waste disposal and encroachment along the river channel which constricts the pathway of floodwaters.
Aggravating Factors:

3. Population size, growth rate and distribution have influence shaping the environment of a region.

Philippines stats:
2000 Population: 76.0 M
10-year Avg. Annual Pop. Growth: 2.2%
GDP: 2000$310.0 billion
GDP per capita: $4,079
GDP growth: 3.6%
GNI per capita2000: $1,040
World Bank Classification
Lower Mid. Inc Population
Below Poverty Line: 25.5 M

Ave. Population density:
1903 – 517
1960 – 3,872
2000 – 16,495

Distribution among cities/municipalities as of 2000:
e.g. Navotas – 88,617
Pateros – 5,520
Growth rate: 2000 to 2007 = 2.11%
Other factors: Cultural & religious attitudes

Certain cultural and religious attitudes to disasters may also need to be overcome.

According to Oxfam, an assessment of participatory capacities and vulnerabilities found that disasters “were perceived as “God’s punishment” or a “fact of life”.

Since a disaster was considered to be a “natural phenomenon”, many people expressed doubts that they can actually do something about it.

This fatalistic attitude is also reinforced by strong religious beliefs. “Bahala na ang Diyos” (“God will take care of everything”) is the usual prayer in the face of an impending disaster in the community. – Oxfam, 2001:66
3c. COMPREHENSIVE FLOOD MITIGATION AND MANAGEMENT MEASURES

**Structural Measures**
- River Improvement
  - Dikes and Flood Walls
  - Channel Improvements
  - Flood Diversion/ Floodway
- Retention/ Retardation of Runoff
  - Reservoirs, Retarding Ponds
  - Rainfall Retention Facilities
  - Conservation of Upper Watershed thru Regulations on Development and Afforestation

**Non-structural Measures**
- Flood Plain Management
  - Land use regulation
  - Flood proofing of facilities
  - Flood insurance
- Flood warning and evacuation
  - Flood forecasting and warning system (FFWS)
  - Information and education campaign (IEC)
  - Flood hazard map
  - Flood fighting
  - Flood rescue & disaster relief
STRUCTURAL MEASURES

- Dam, reservoir
- Retarding areas
- Channel enlarging
- Bypass, floodway
- Embankment-dike

Non-structural Measures

- Reduce upstream runoff inflow

Non-structural Measures

- Upstream rain gauge network.
- Hydrological stations, Telemetering network.
- Flood monitoring and early warning system.
- Evacuation and mitigation operation

MOVE THE WATER AWAY FROM THE PEOPLE...!!

MOVE THE PEOPLE AWAY FROM THE WATER ...!!
Flood Forecasting and Warning is giving advance notice that a flood is imminent or is in progress at a certain location or in a certain river basin.

- Accuracy
- Timeliness

Flood Forecasting and warning can only be done if a river system or watershed is equipped with a monitoring facilities, i.e. rainfall and water level monitoring facilities and a good communication system.

Network of rainfall & water level stations for flood forecasting & warning system in the Pampanga river basin
Objectives of flood forecasting & warning system

- to forewarn the people living in the low-lying areas of the increase in water level of the river and the expected flood situation;

- to forewarn people living in the target area of the dam on the present and expected flood situation; and

- to alert the agencies concerned with flood control and/or flood fighting activities in the event of the occurrence of flood.
Rainfall observation of 15 mm in 1-hour duration

Rainfall observation is 60 to 80 mm for the past 3 hrs

Continuous rain of more than 80 mm for the past 3 hours and 3 hourly rainfall

THRESHOLD VALUES OF RAINFALL INTENSITY
### Criteria for the issuance of Flood Bulletins

### Assessment Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert Level (L4)</td>
<td>The water level at the gauging station when the channel reach/lake/swamp where the station is representing, is estimated to be 40% full on the average.</td>
</tr>
<tr>
<td>Alarm Level (L6)</td>
<td>The water level at the gauging station when the channel reach/lake/swamp where the station is representing, is estimated to be 60% full on the average.</td>
</tr>
<tr>
<td>Critical Level (L8)</td>
<td>The water level at the gauging station when a certain section of the channel reach/lake/swamp where the station is representing, is estimated to be 80% full.</td>
</tr>
</tbody>
</table>
Existing dissemination scheme for basin and dam bulletin

- NIA
- NPC
- DAM OFFICES
- PAGASA Main Operation Center - Flood Forecasting and Warning Section
- OCD / NDRRMC
- River FFWCs
- DPWH
- NWRB
- LOCAL DPWH OFFICES
- MEDIA
- CONCERNED PUBLIC
- FFWSDO FLOOD BULLETIN
- BASIN FLOOD BULLETIN
- CONCERNED PUBLIC

“tracking the sky...helping the country”
4. Evolution of FFWS and FFWSDO in the PH

- **Pampanga River Basin (PRB) FFWS**
- **Angat & Pantabangan FFWS**
- **Pasig-Marikina-Laguna Lake EFCOS (MMDA)**
- **Upgrading of Pampanga FFWS**
- **Upgrading of Agno FFWS / Enhancement of Pasig-Marikina**
- **Cagayan de Oro, Mandulog and Tagum-Libuganon FFWS**

**1972**
- Flood disaster in Bulacan

**1973-1978**
- Agno, Bicol & Cagayan River Basins FFWS

**1983**
- Flood disaster in Bulacan

**1986**
- Binga / Ambuklao & Magat FFWSDO

**1992**
- Design inflow of Angat - exceeded

**1993**
- San Roque FFWSDO

**2003**
- Flood due to Ondoy & Pepeng

**2004**
- JICA-TCP: Upgrading of FFWSDO

**2009**
- Flood due Pedring & Sendong

**2010-2012**
- GoJ: Upgrading of Bicol FFWS

**2011**
- Norad: Magat FFWS

**2012-2016**
- Upgrading of Bicol FFWS

**EO 2011** – Ipo telemetered FFWSDO - operational
**2012** – Caliraya FFWSDO will be operational

"tracking the sky...helping the country"
NETWORK of Existing PAGASA HYDROLOGICAL Stations (Telemetered major river basins and dams)

Major River Basins => 1,400 sq. km.

Monitored telemetered major river basins (5+3)

Monitored dams (6)

Major river basins (18)
REHABILITATED PAMPANGA RIVER BASIN FLOOD FORECASTING AND WARNING SYSTEM
Rehabilitated Agno River Basin Flood Forecasting and Warning System

AGNO RIVER BASIN

LOCATION MAP

Flood Forecasting and Warning Section (FTWS), Hydrometeorology Division, PAGASA-DOST
Cagayan River Basin Flood Forecasting and Warning System (CRBFFWS)

- Cagayan River Basin Flood Forecasting and Warning Center (CRBFFWC)
- Five (5) rainfall and water level gauging stations (Pangal, Maris Dam, Gamu, Tumauini and Buntun)
- Repeater Station
Bicol river basin FFWS

Drainage area: 3771 sq. km.
FFWS established: 1983

Upgrading of the Bicol River Basin - component in the project “Improvement of Capabilities to cope with Natural Disasters caused by Climate Change”, Non-Project Grant Aid (NPGA) Program of the Government of Japan.

Project Implementation: 2015
Flood Forecasting & Warning System for Dam Operation

FFWSDO - Inter-agency undertaking: PAGASA, NPC, NIA, OCD, DPWH, NWRB, MWSS

Protocols:
1. Flood Operation Rule
2. Dam Discharge Warning
3. Flood Forecasting & Warning
Pasig Marikina River FFWS Monitoring Equipment 1/2
### Status of Water Level of PMRB

as of 5:40 AM September 19, 2014

#### Water Level Map

<table>
<thead>
<tr>
<th>Station</th>
<th>WL (EL.m)</th>
<th>Alert (EL.m)</th>
<th>Alarm (EL.m)</th>
<th>Critical (EL.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montalban</td>
<td>-</td>
<td>22.40</td>
<td>25.00</td>
<td>23.60</td>
</tr>
<tr>
<td>Burgos</td>
<td>28.36</td>
<td>27.40</td>
<td>27.00</td>
<td>28.40</td>
</tr>
<tr>
<td>San Mateo-1</td>
<td>20.39</td>
<td>18.00</td>
<td>19.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Nangka</td>
<td>-</td>
<td>16.50</td>
<td>17.10</td>
<td>17.70</td>
</tr>
<tr>
<td>Mindanao</td>
<td>33.93</td>
<td>33.00</td>
<td>24.00</td>
<td>35.00</td>
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<tr>
<td>Tumanan Bridge</td>
<td>17.91</td>
<td>17.26</td>
<td>18.26</td>
<td>19.26</td>
</tr>
<tr>
<td>Sto Nino</td>
<td>16.83</td>
<td>15.60</td>
<td>16.00</td>
<td>17.00</td>
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<tr>
<td>Marcos Highway</td>
<td>16.33</td>
<td>14.50</td>
<td>15.50</td>
<td>16.50</td>
</tr>
<tr>
<td>Rosario JS</td>
<td>14.02</td>
<td>12.00</td>
<td>14.00</td>
<td>15.00</td>
</tr>
<tr>
<td>San Juan School</td>
<td>-</td>
<td>11.00</td>
<td>11.50</td>
<td>12.00</td>
</tr>
<tr>
<td>Fort Santiago</td>
<td>-</td>
<td>11.00</td>
<td>11.50</td>
<td>12.00</td>
</tr>
<tr>
<td>Pandacan</td>
<td>-</td>
<td>11.00</td>
<td>11.50</td>
<td>12.00</td>
</tr>
<tr>
<td>Rosario LS</td>
<td>12.06</td>
<td>13.00</td>
<td>13.50</td>
<td>14.00</td>
</tr>
<tr>
<td>Napindan-2</td>
<td>12.00</td>
<td>14.00</td>
<td>14.50</td>
<td>15.00</td>
</tr>
<tr>
<td>Napindan-1</td>
<td>11.05</td>
<td>13.50</td>
<td>14.00</td>
<td>14.50</td>
</tr>
</tbody>
</table>

#### Station Color

- PAGASA Major Station
- PAGASA Station
- MMDA Major Station
- MMDA Station
- PAGASA-UNDF Station
Cagayan de Oro & Mandulog river basins FFWS

Operational FFWS (2015) - established with funding under the TWIN PHOENIX Project (AusAID/ UNDP) and GoP.
Future Projects:
River basins FFWS under NPGA (GoJ)

Davao FFWS
Buayan-Malungun FFWS
Tagaloan FFWS

The Non-Project Grant Agreement (NPGA-GoJ) will provide 36 monitoring instruments (3 AWS, ARGs and WLGs) – to be implemented in 2015, while installation will be undertaken by the GoP.

Equipments are all ready for installation (2015).
Major river basins in the Visayas

FFWS (2014) – will be established with funding under the Government of India thru RIMES
Ilog Hilabangan River Basin (Visayas)

FFWS will be established with funding under PAGASA budget (GoP).

- NTP was served to the winning bidder for the installation of the monitoring equipment within the basin.
Other river basins in Mindanao

- Cotabato FFWS
- Agusan FFWS
KOICA 3

Proposed project: Automation of Flood Early Warning System for Disaster Mitigation in Greater Metro Manila

Project cost: USD7,102,767.40

FFWS for Pasig Marikina River and Tullahan river

NCR PAGASA Flood Information Command Control Center display and data archiving system
### Telemetered CBF EWS for Laguna, Cavite, Rizal, and Bulacan

**Data Center Monitor**

#### Data Panel - Laguna

<table>
<thead>
<tr>
<th>Rain Gauge Station</th>
<th>Date &amp; Time</th>
<th>10-Min</th>
<th>1-Hr</th>
<th>24-Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG_CUEVA</td>
<td>2016-01-27 08:21:11</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>RG_KATAYPUANAN</td>
<td>2016-01-27 08:21:31</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>RG_KAPATALAN</td>
<td>2016-01-27 08:21:51</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>RG_MATALINGTING</td>
<td>2016-01-27 08:22:11</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Water-Level Station</th>
<th>Date &amp; Time</th>
<th>WLmsl</th>
<th>ALERT</th>
<th>ALARM</th>
<th>CRITICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WL_POBLACION</td>
<td>2016-01-27 08:20:11</td>
<td>5.07</td>
<td>8.7</td>
<td>9.5</td>
<td>9.95</td>
</tr>
<tr>
<td>WL_CORALAN</td>
<td>2016-01-27 08:20:31</td>
<td>16.94</td>
<td>18.85</td>
<td>20</td>
<td>21.15</td>
</tr>
<tr>
<td>WL_NUMERO</td>
<td>2016-01-27 08:20:51</td>
<td>30.49</td>
<td>31.9</td>
<td>32.5</td>
<td>33.15</td>
</tr>
<tr>
<td>WL_LLAVAK</td>
<td>2016-01-27 08:22:31</td>
<td>2.15</td>
<td>3.65</td>
<td>4.45</td>
<td>5.2</td>
</tr>
<tr>
<td>WL_KATAYPUANAN</td>
<td>2016-01-27 08:21:31</td>
<td>42.95</td>
<td>42.6</td>
<td>42.9</td>
<td>43.2</td>
</tr>
</tbody>
</table>
Communication scheme for CBFEWS

Warning Phase
1 - READY
2 - Get SET
3 - GO

Communication of Warning
1 - MDCC
2 - BDCC
3 - Local Volunteers

Evacuation Center

Legend:
? Information starts here in case of large-scale system (Ex. typhoon and monsoon).
? Information starts here in case of local/ small-scale system (Ex. Thunderstorm and ITCZ).

Disaster Operation Center (DOC)
Provincial Hall

PAGASA
PAGASA- Field Station

Bandillo Megaphone w/siren
Church Bells

Batingaw Sitio/Purok Leaders

RR Observers

Water Level Observers

River Observation
1 – Color
2 – Speed of Flow
3 – Sound
4 – Presence of Debris

Weather Update / Info
Data / Flood Advisory / Warning

Flood info

Target Community

Evacuation Center

"tracking the sky...helping the country"
OTHERS...

- Implementation of other foreign projects (JICA, JICA-LLDA, KOICA, AusAID, NZAP, UNDP, ADB, WFP, GIZ, non-government organizations (NGOs), etc.)
- Application of remote sensing data
- Flood hazard mapping to risk mapping
- Recruitment of young engineers
- Continuous training of technical personnel

Risk Analysis Project (RAP): UNDP/AusAID/GA
THANK FOR YOUR ATTENTION!

www.pagasa.dost.gov.ph

Main Operation Center-Flood Forecasting and Warning Section (MOC-FFWS)

Hydrometeorology Division

02.929.40.65/02.928.27.54/02.920.40.52/02.926.6970 or you can e-mail us at hmd.ffws@gmail.com

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