# Pre-Tracking Incoming Flood 2012 and Beyond by Satellite Imageries




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**Chairman, Executive Board**

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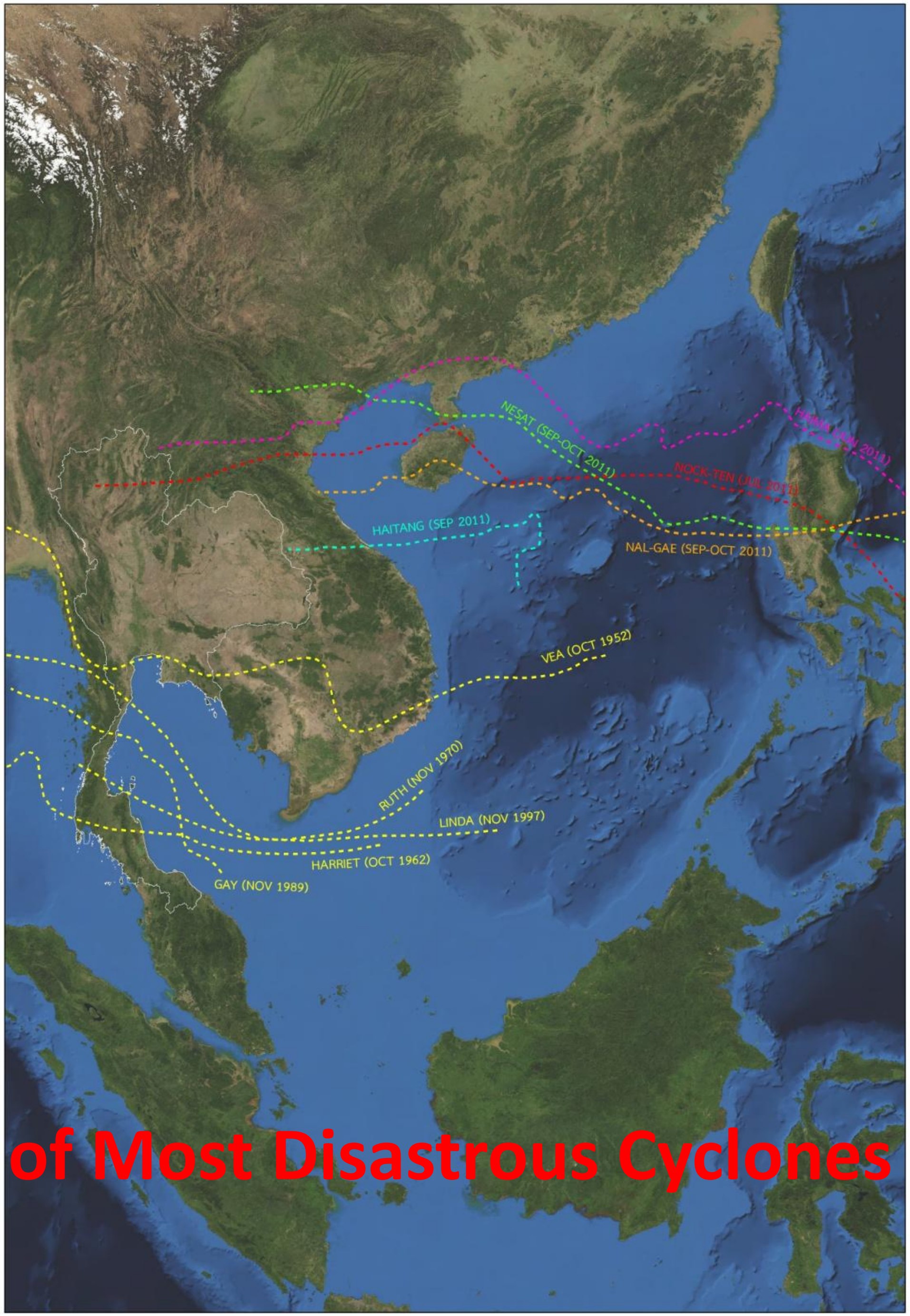
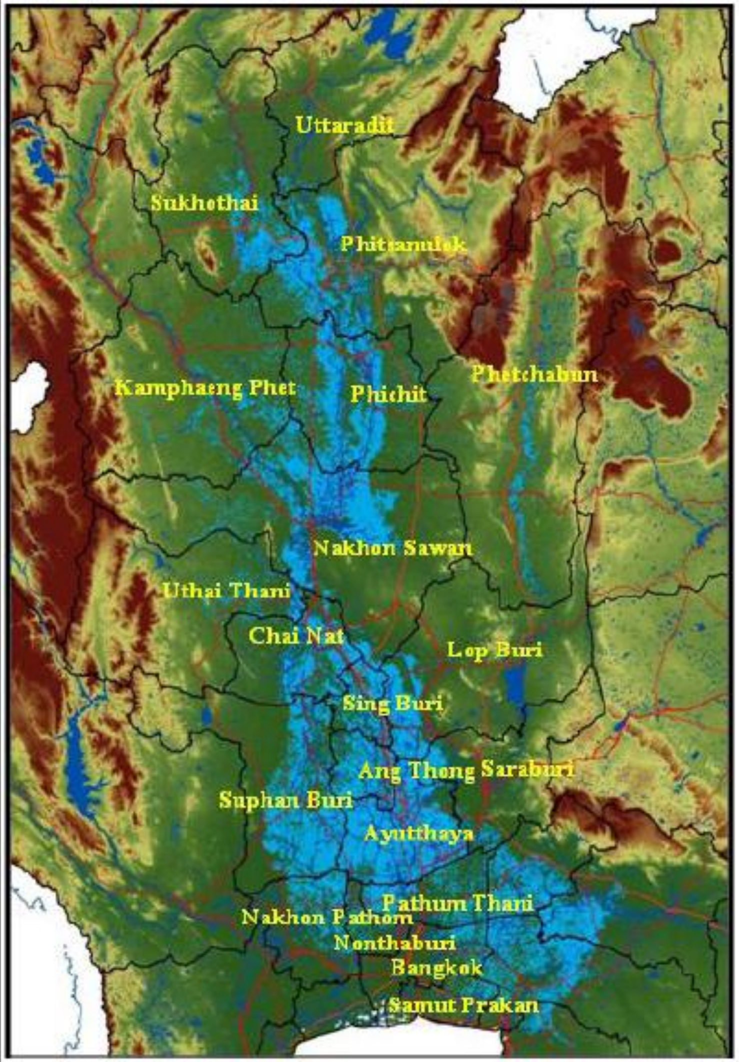
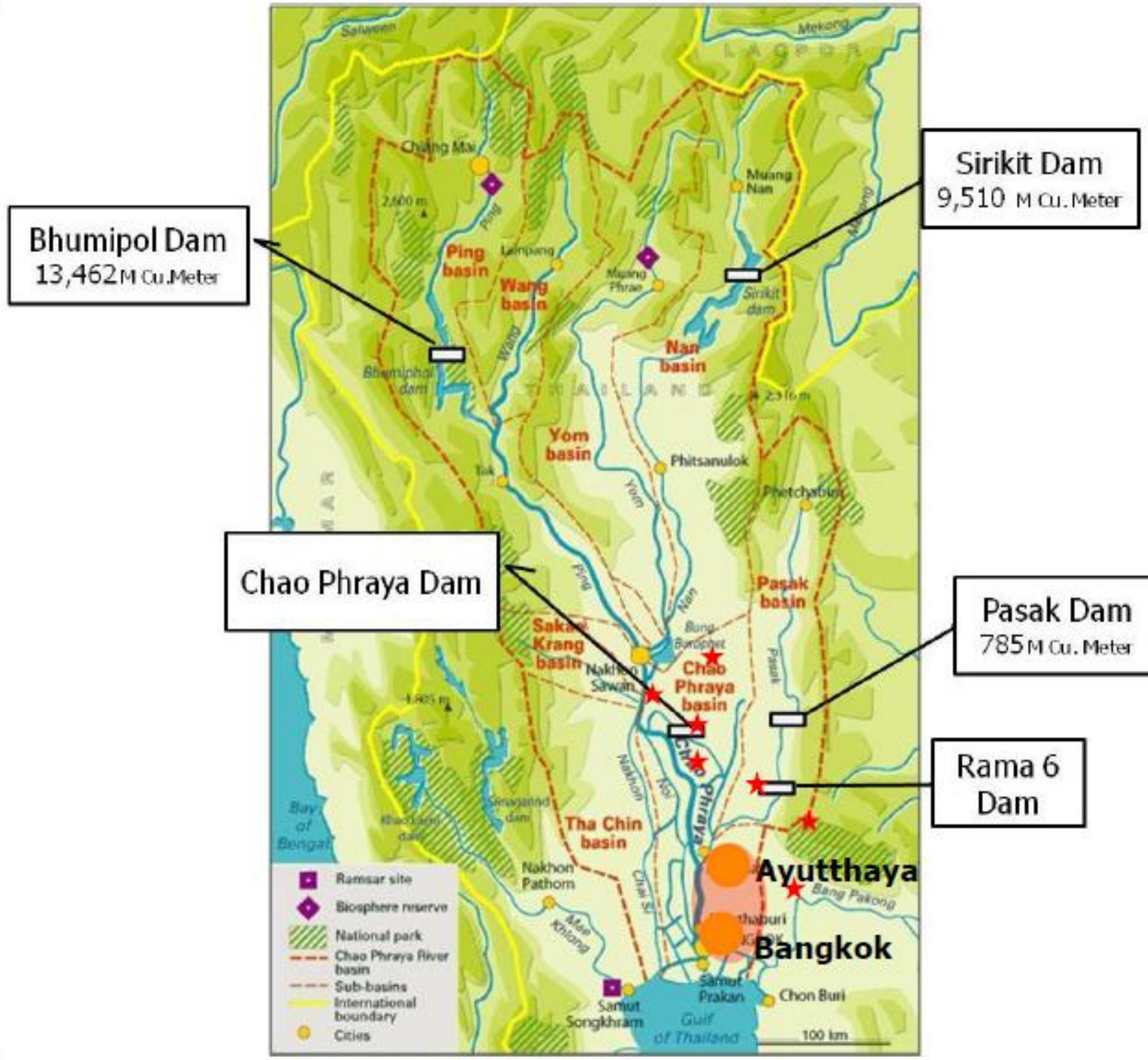


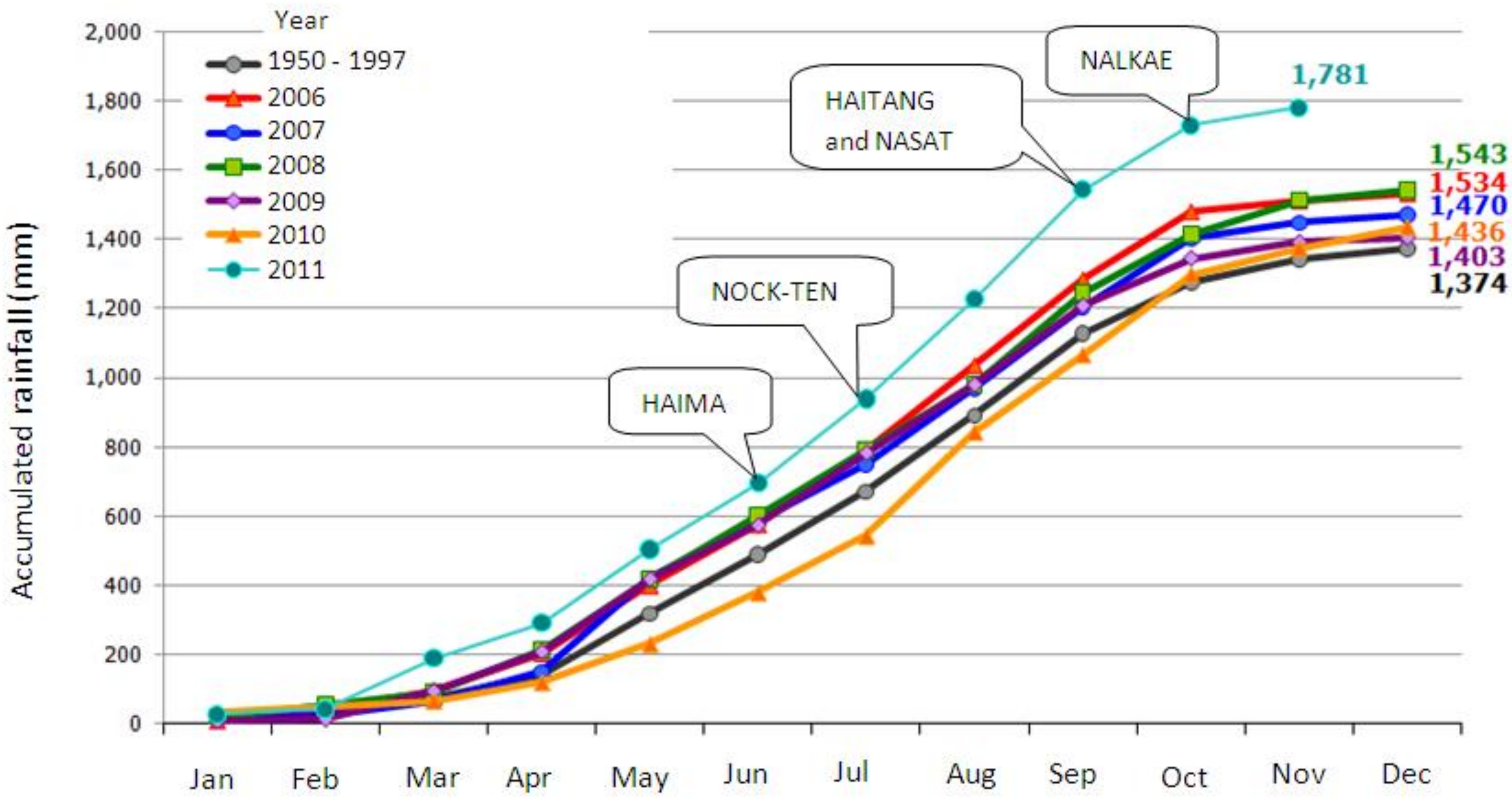

# Typical Tracks of Most Disastrous Cyclones over Thailand

# The Causes of 2011 Flood



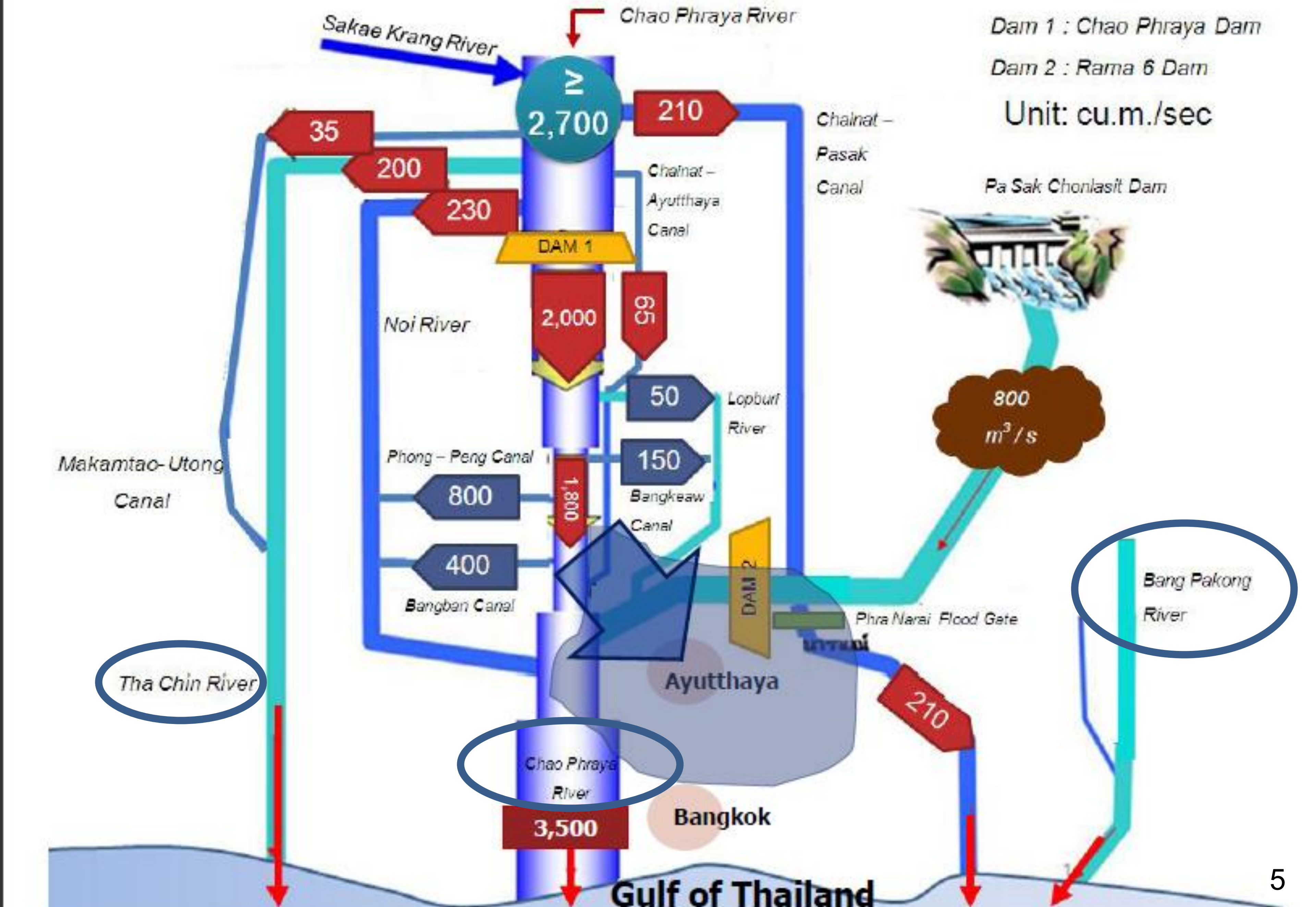



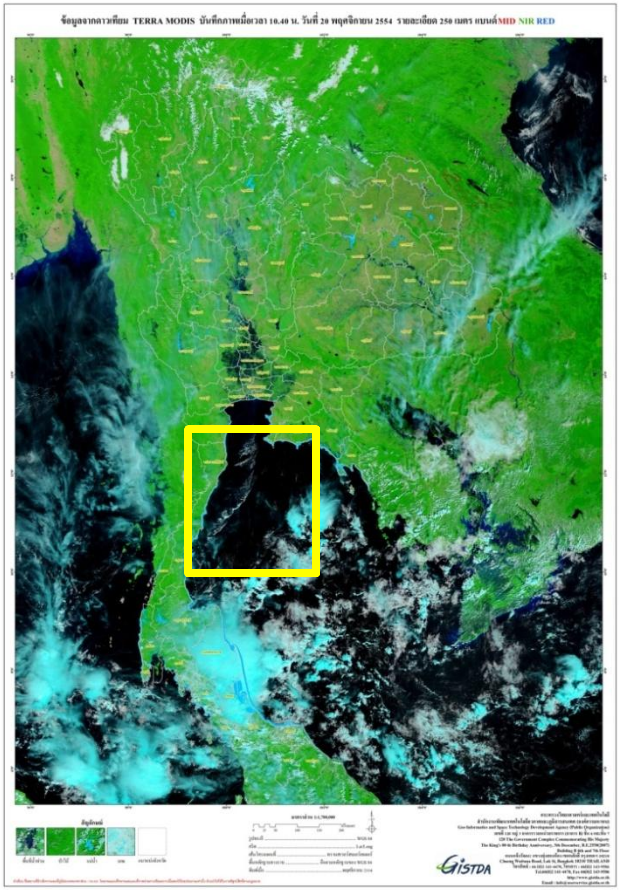
# Induced Rainfall

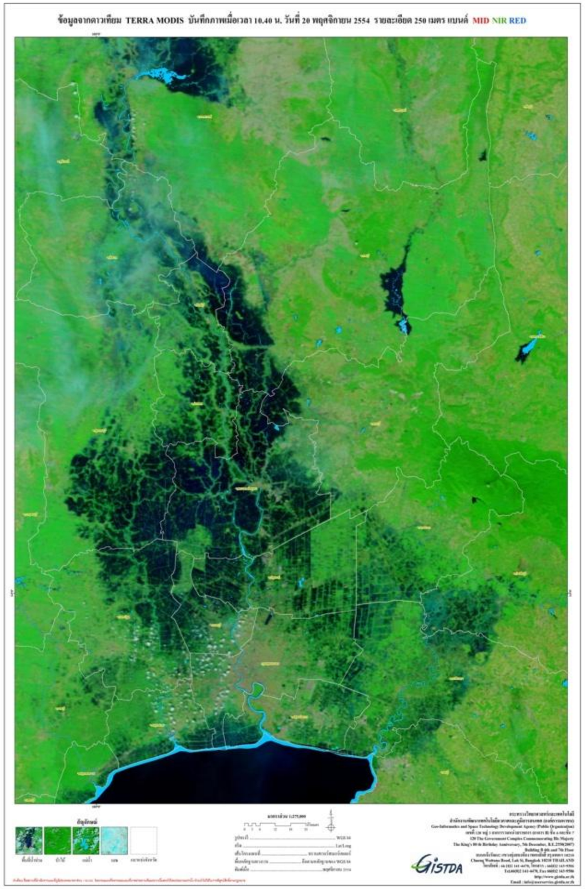


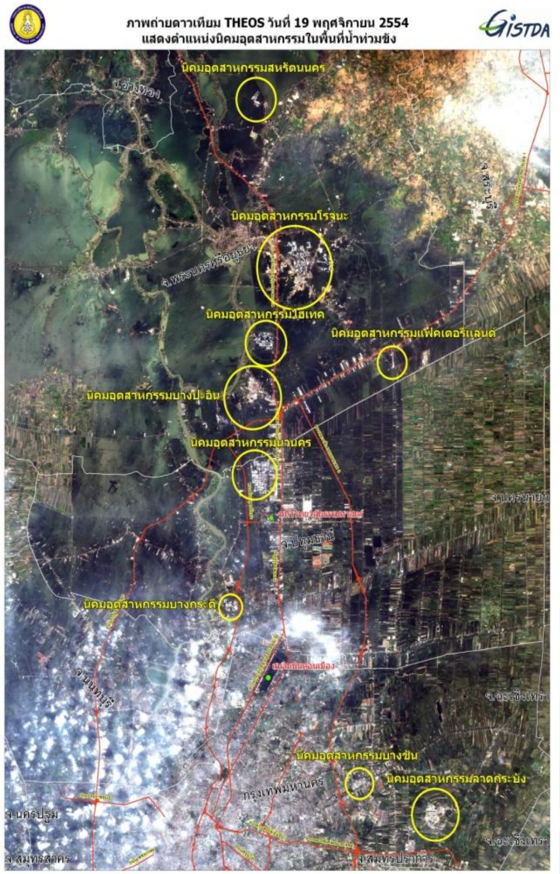

**Accumulated rainfall by major storm events in Thailand during 2011**

# The Causes of 2011 Flood



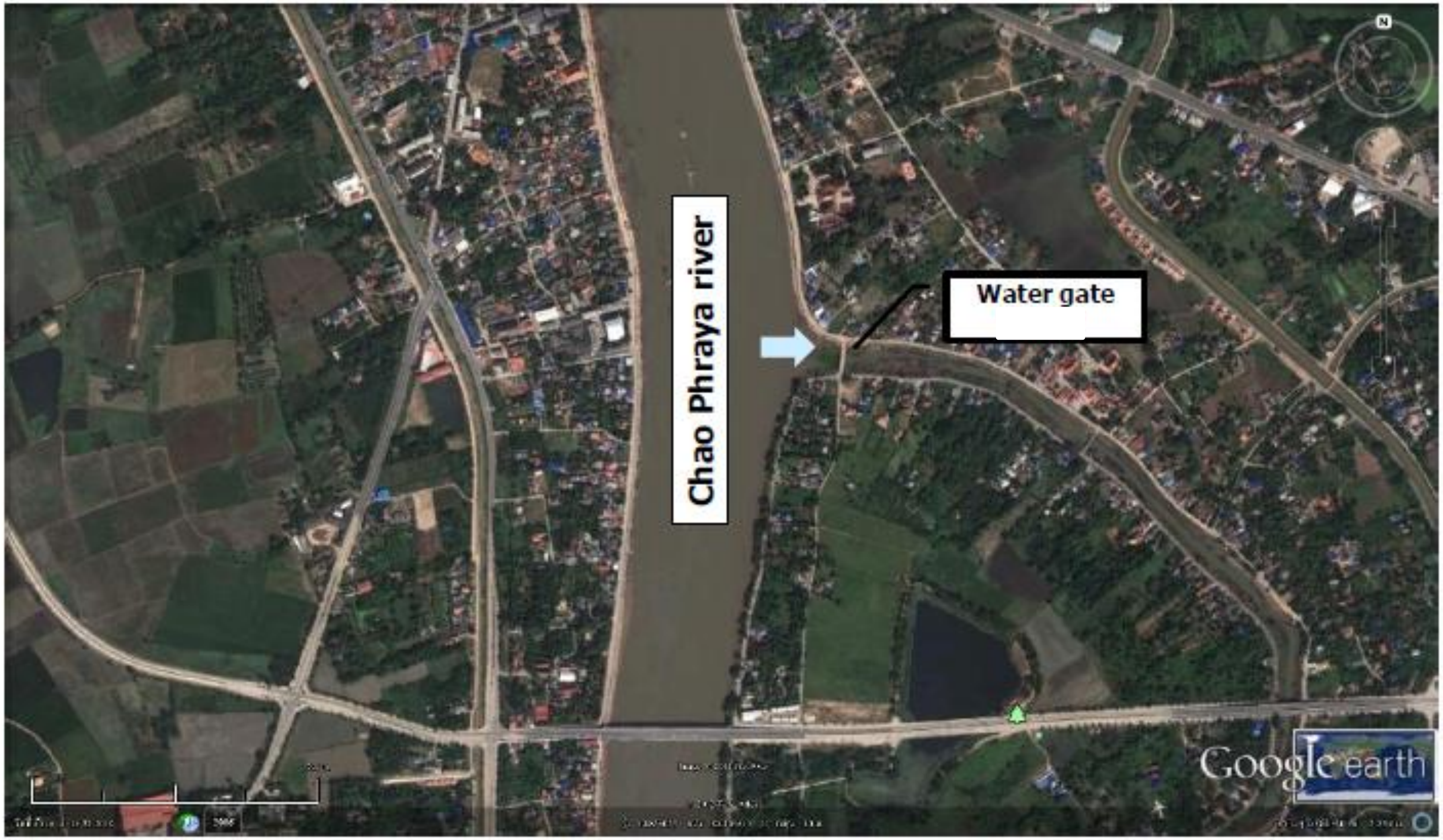


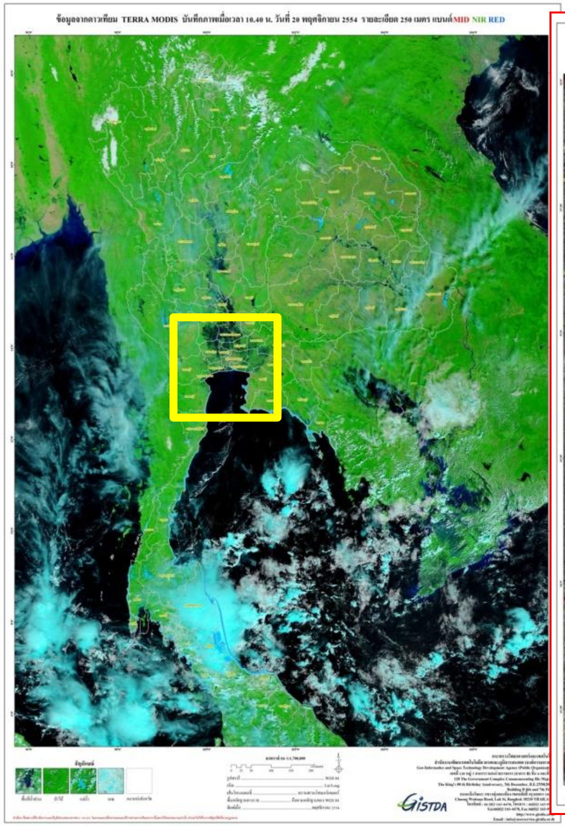



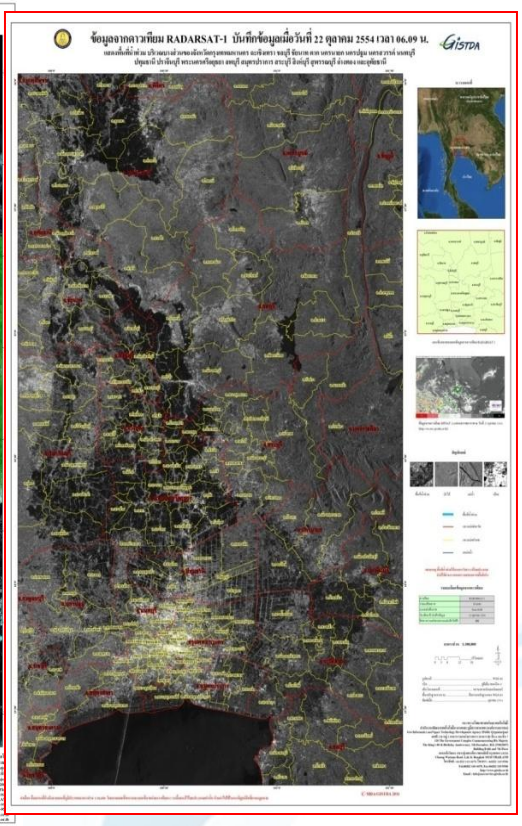



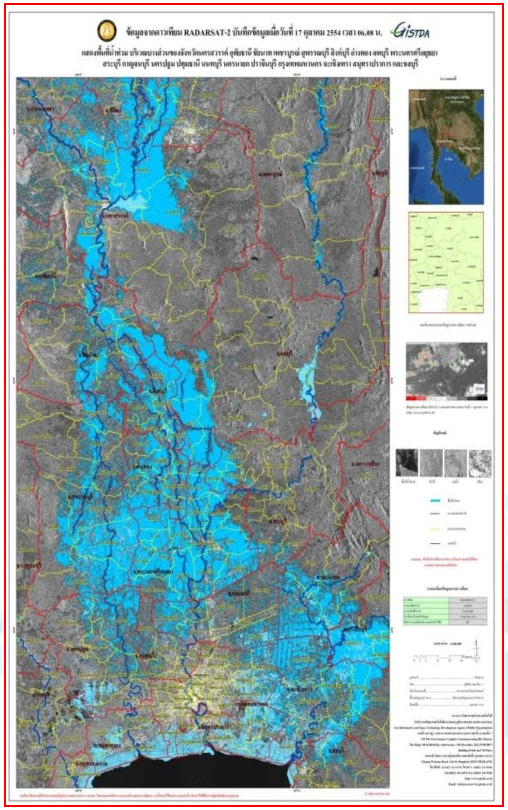

# Flood Mapping from Optical Satellites

# The Causes of 2011 Flood



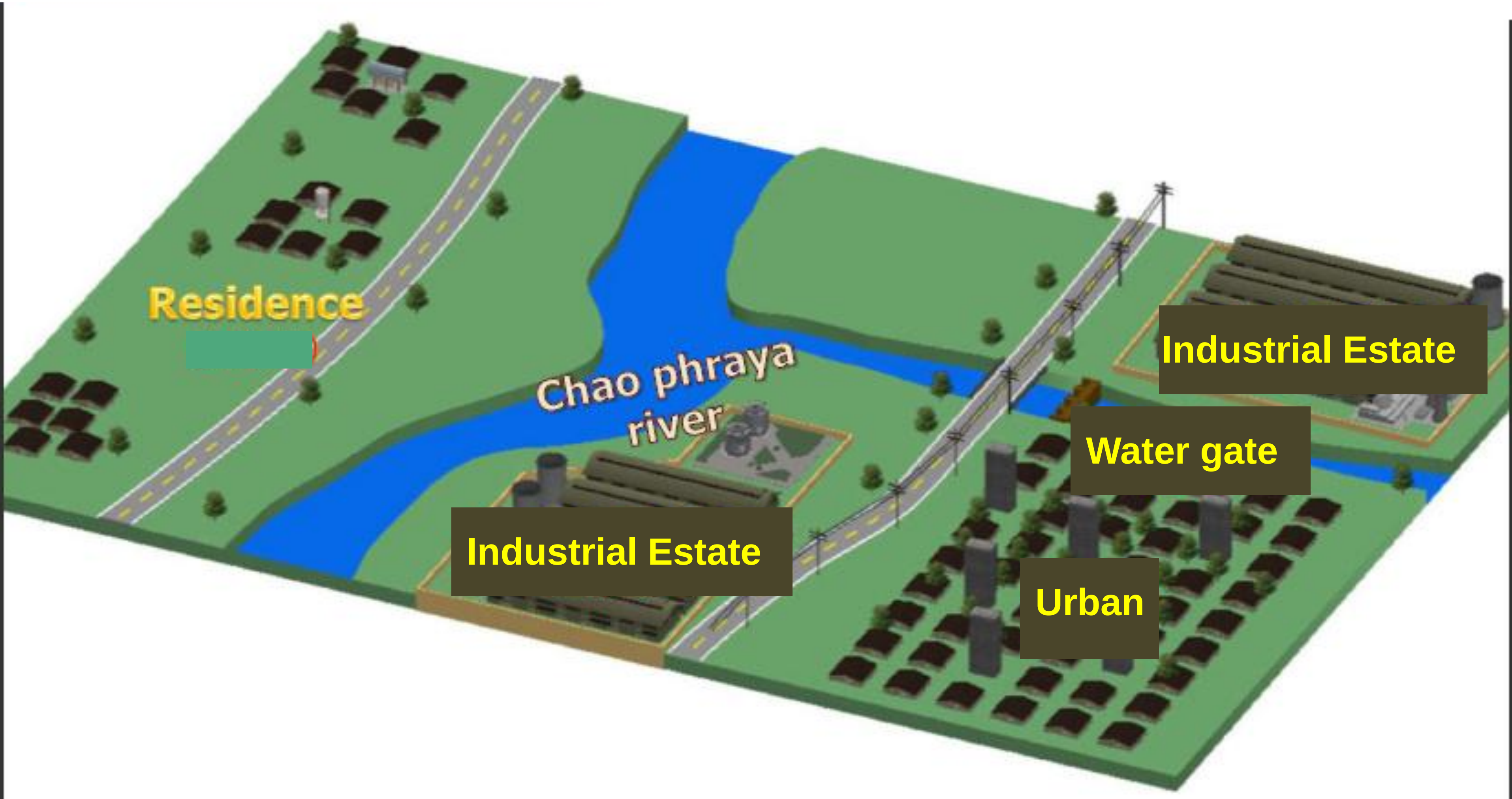


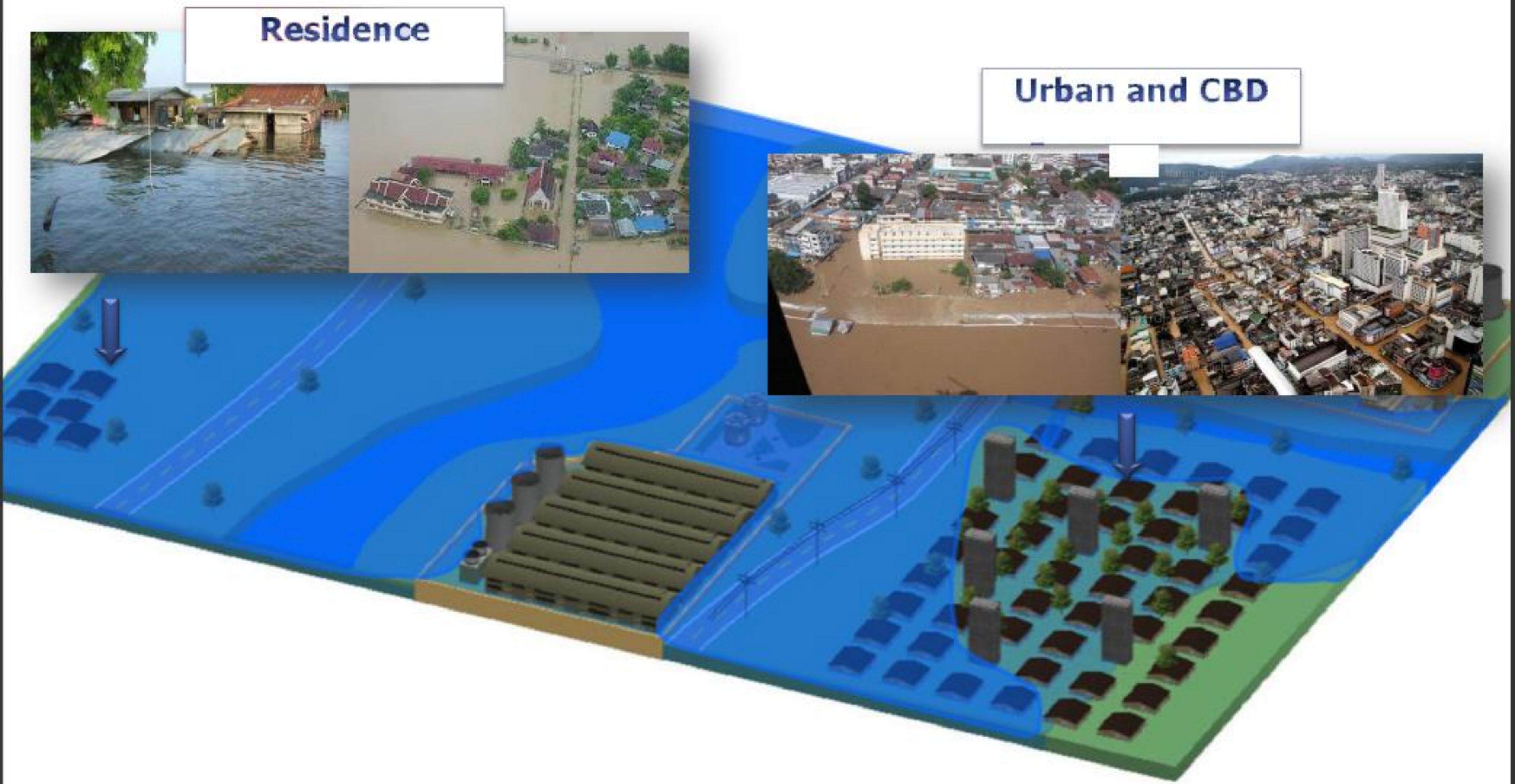




# Flood maps based on SAR satellite data

# The Causes of 2011 Flood

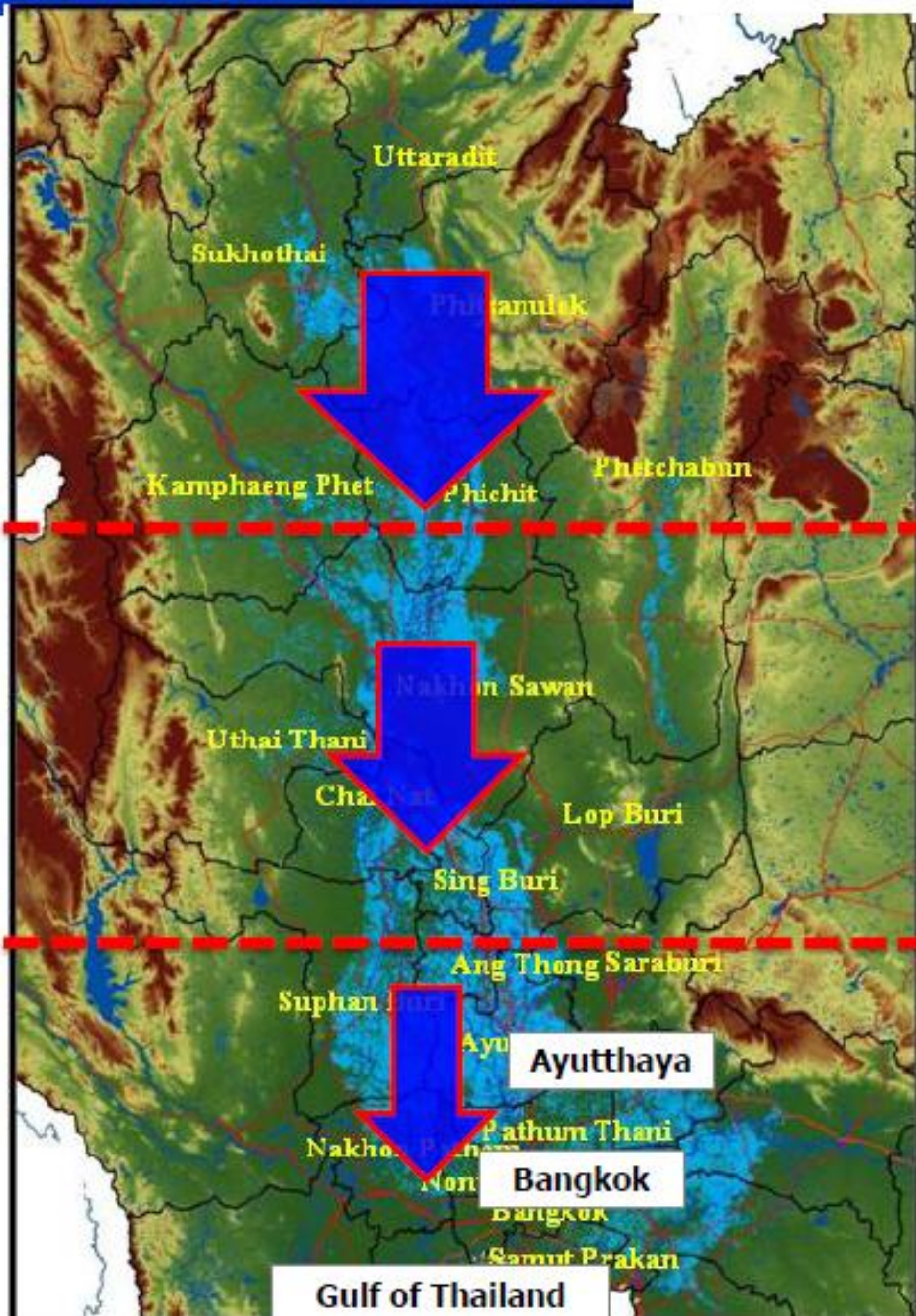



# Flood simulation in 2011




# Flood simulation in 2011

# Flood Prevention Strategy




**Up Stream**
**Forestation**
**Dam Management**

**Mid Stream**
**Water collection**
**Water Retention Areas**

**Strengthening Infrastructures**

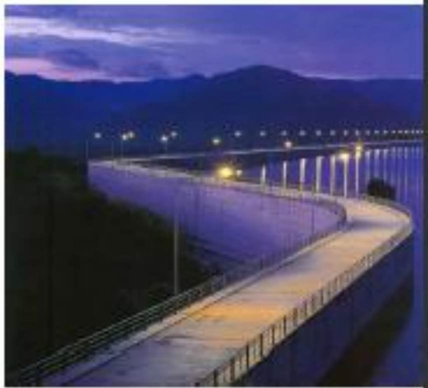
**Down Stream**
**Increasing Speed/Volume**

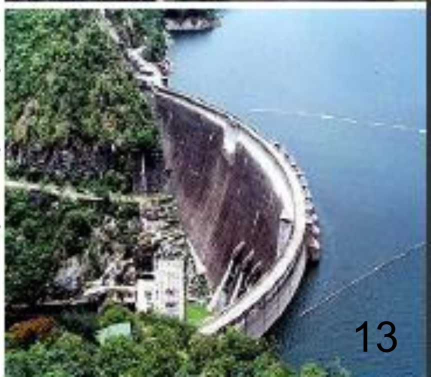
**Area Protection**

# Increasing Flood Retention Capacity in all Major Dams

**Rule Curve (max = 64% & min = 45%)**

| Dam | Capacity (M. Cu. M.) | Y2011 (64%) | Y2012 (45%) | |
|---|---|---|---|---|
| | | Capacity left (M. Cu. M.) | Capacity left (M. Cu. M.) | More Capacity left (M. Cu. M.) |
| Bhumipol | 13,462 | 4,846 | 7,404 | 2,558 |
| Sirikit | 9,510 | 3,423 | 5,230 | 1,807 |
| Kiew Lom | 112 | 40 | 61 | 21 |
| Kiew Kormha | 170 | 60 | 93 | 33 |
| Pasak | 785 | 282 | 431 | 149 |
| **Total** | **24,039** | **8,651** | **13,219** | **4,568** |





# Pre-tracking and Preparing for the Incoming and Future Floods:

A Strategic Committee for Water Resource Management : covering flood management, cascading from upstream to intermediate and downstream of river basins. Satellite imagery and geo-informatics to support all the implementation in an integral manner as follows:

**1. Establishment of National Water Resource Data Center and Improvement of Forecasting and Warning Systems:** Under this plan, GISTDA will improve its capacity by receiving more RADAR satellites and improve data acquisition and production capacity with higher accuracy in flood forecasting using high-resolution Digital Elevation Model (DEM).

# Pre-tracking and Preparing for the Incoming and Future Floods:

**2. Forest and upstream ecosystem restoration:** To increase the capacity of infiltration and water retention in upstream areas. Satellite images such as THAICHOTE (THEOS) and Landsat are to monitor the progress of restoration.

**3. Systematic Management of Dams and Reservoir**: To be monitored on its wetted parameters by satellite images.

# Pre-tracking and Preparing for the Incoming and Future Floods:

**4. For Intermediate Zone: New construction of flood mitigation infrastructure such as floodway and flood diversion channel:**

Geo-informatics and satellite images are used to map across upstream, intermediate and downstream in relation to overland flows to determine best possible locations for flood ways, canal routing ways and additional release gates.

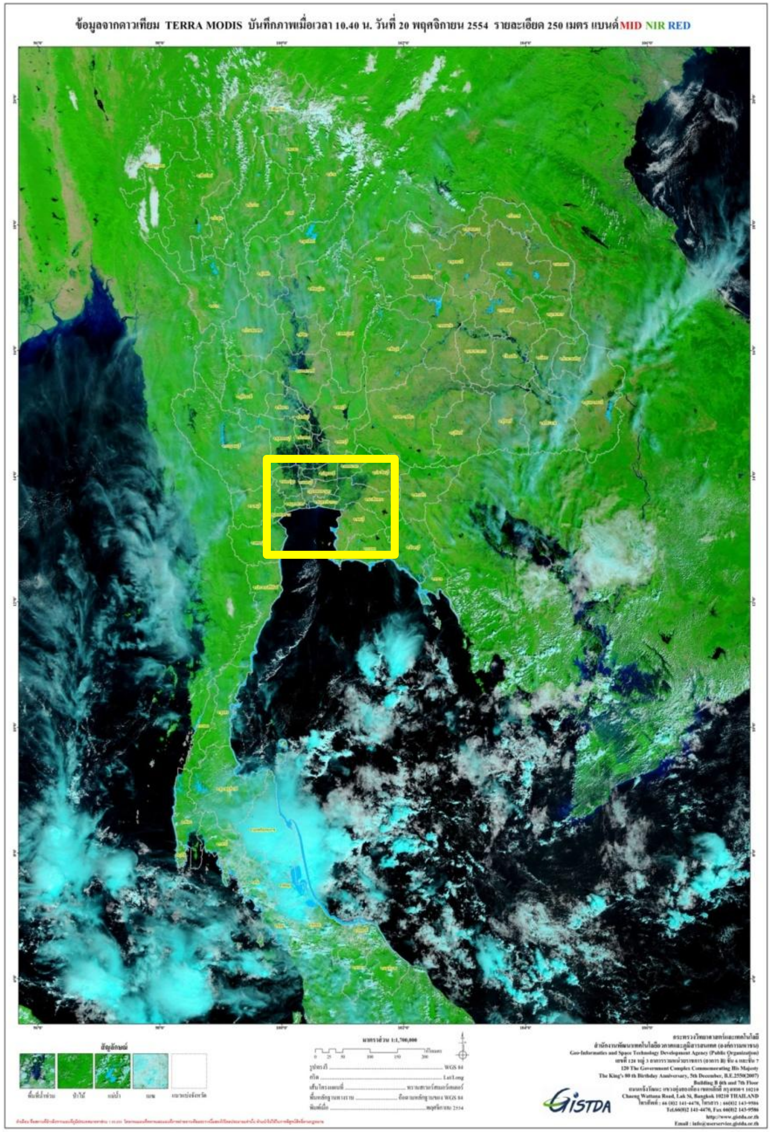
# Pre-tracking and Preparing for the Incoming and Future Floods:

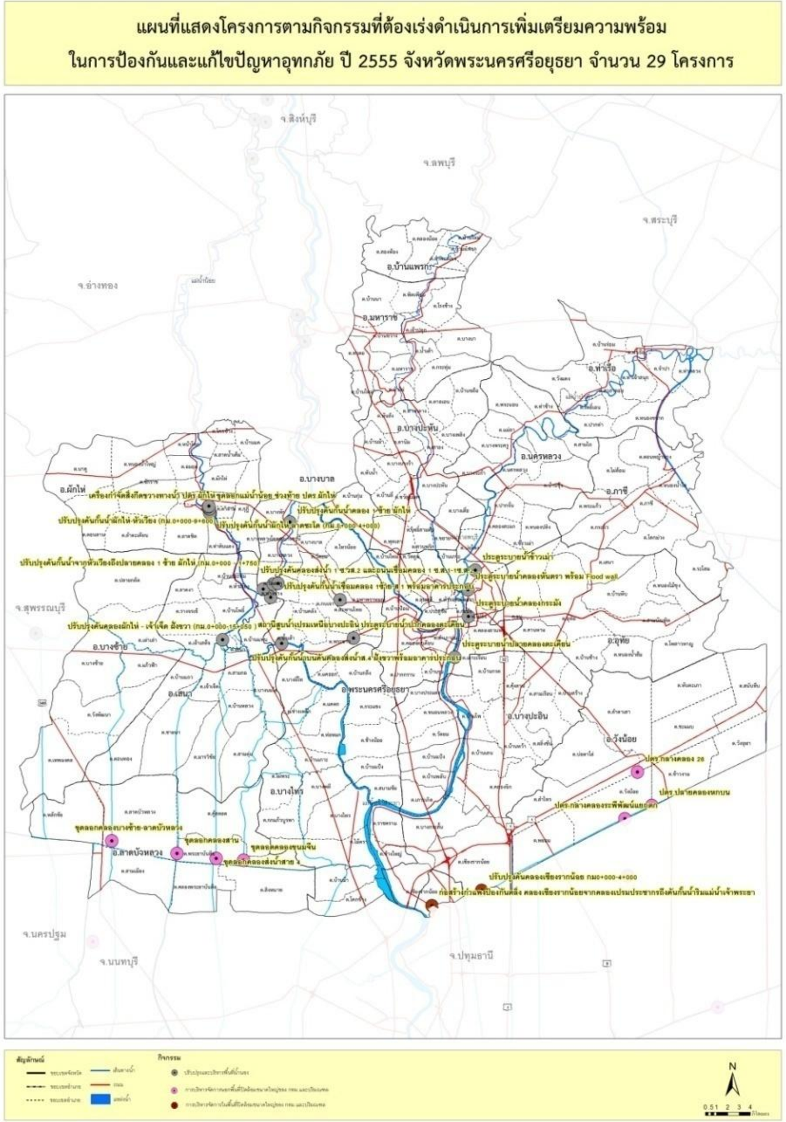
**5. For Downstream Zone: Improvement of Water Management structures**: Improve existing water management structures such as water gates, pumping stations and dykes are to be implemented. Geo-Informatics based project information system is to provide coherent views to verify that all the projects will serve the purpose of mitigating the impact of possible incoming flood.

# Pre-tracking and Preparing for the Incoming and Future Floods:

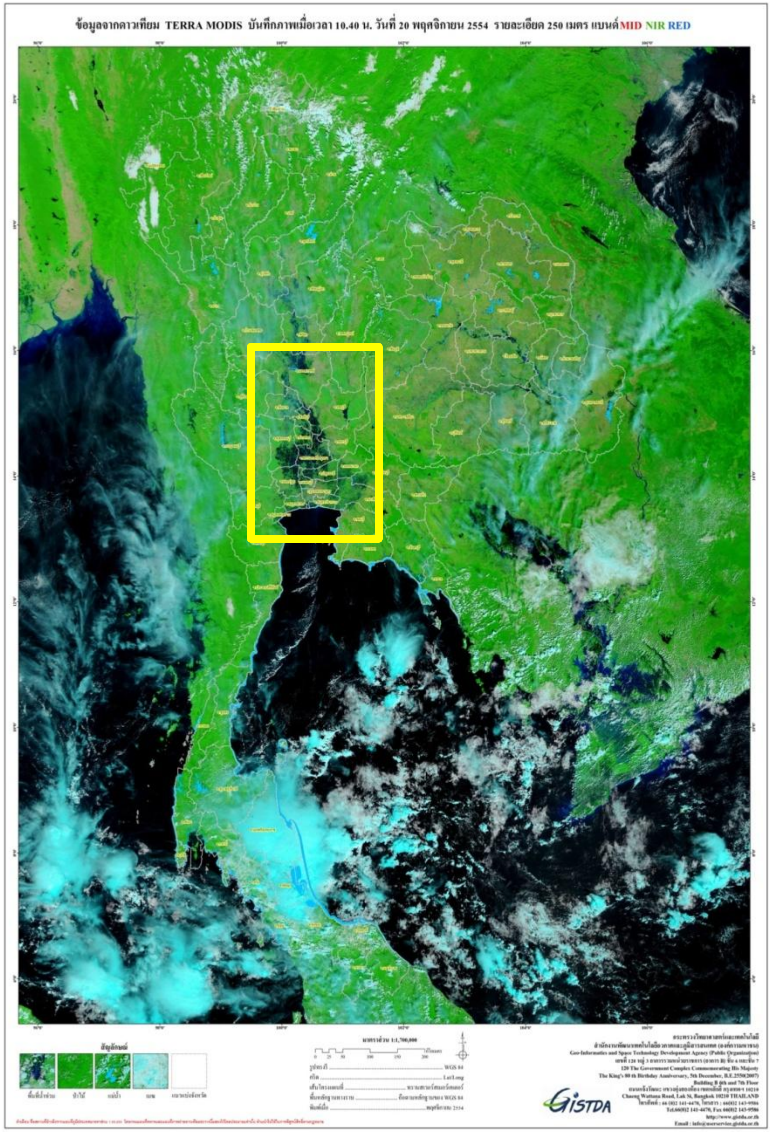
**6. Spatial Retention area:** Inundation areas are derived and stored as GIS layers. Analysis in GIS system shows the frequency of flood in different areas. The areas with high frequency of flood are considered as potential temporary retention areas during flood season in order to reduce the amount of water flowing downstream.

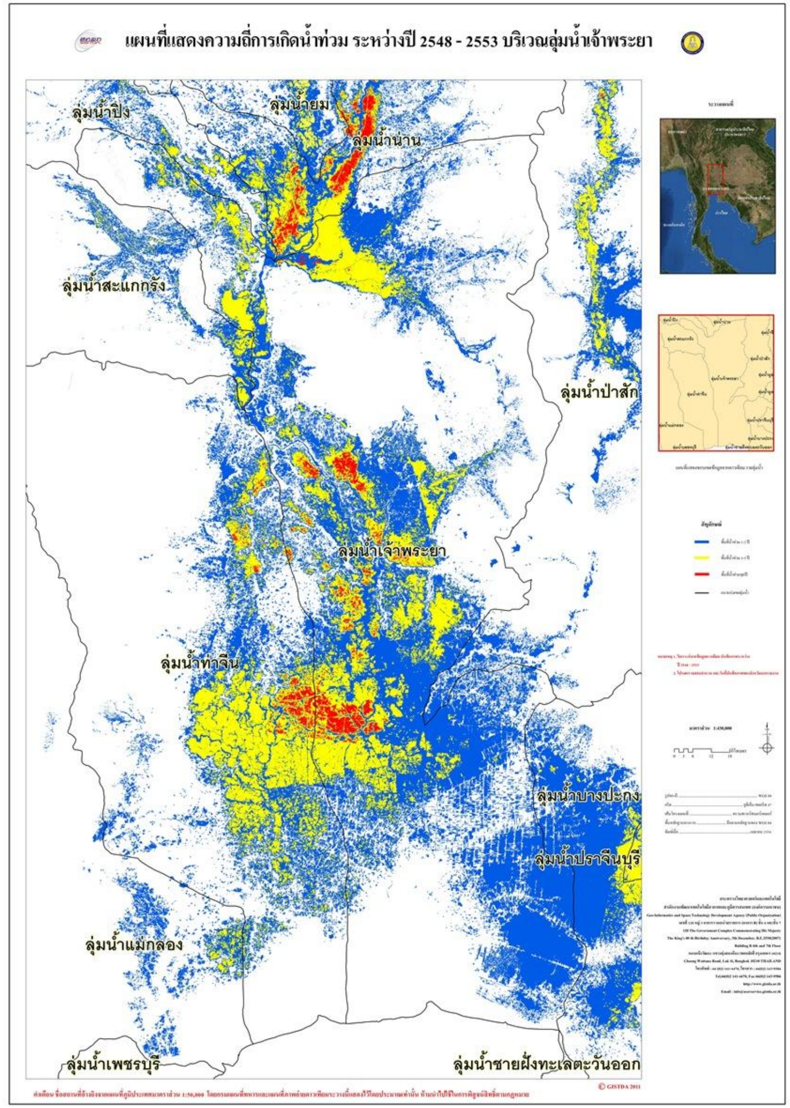
**7. Emergency Response Planning:** High resolution satellite imagery along with GIS system is utilized for emergency response planning at local administrative level such as planning for suitable temporary shelter and evacuation purposes.




## Examples of map of projects to be implemented in Ayuthaya Province to prevent and mitigate potential floods




## Map of flood frequency based on satellite image, forming a basis to identify potential retention areas

# GIS-Terrain Based Simulation
# Cooperation GISTDA-JAXA-University of Tokyo

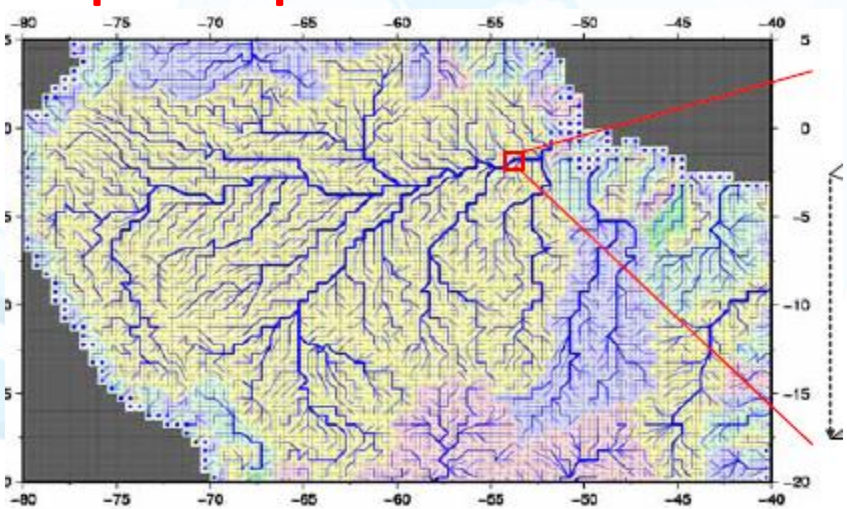
- Distributed river routing model using River Network Map

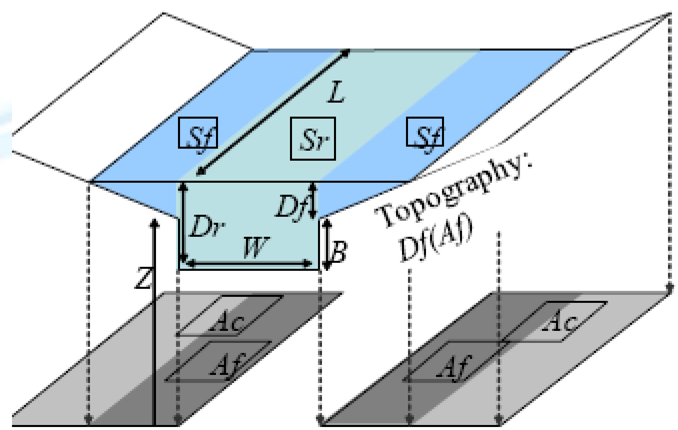
Input: Land Surface Runoff, Output: Water storage

River discharge, Water level, Inundated area

-River and floodplain storage with sub-grid topographic parameters

> Explicit representation of water stage in a single grid-box (25 km size)




(Yamazaki 2011)

# The relation between storage, stage and inundated area is described by the sub-grid topographic parameter

Prognostic Variable : S

Diagnostic Variable : Others

## Without Flooding

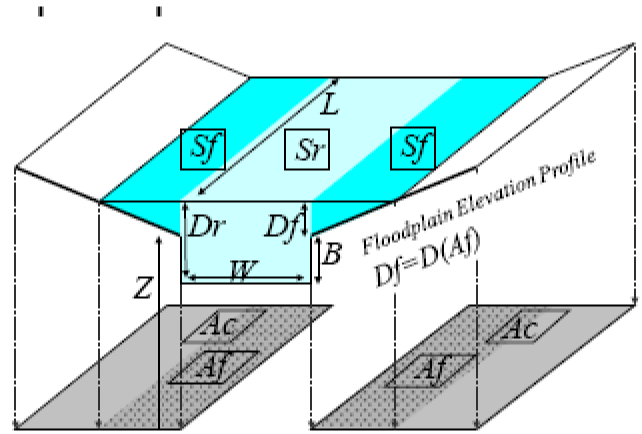
$$S_r = S$$
$$D_r = \frac{S_r}{WL}$$
$$S_f = 0$$
$$D_f = 0$$
$$A_f = 0.$$

Only consider rectangular river channel

## With Flooding

$$S_r = S - S_f$$
$$D_r = \frac{S_r}{WL}$$
$$S_f = \int_0^{A_f} (D_f - D(A))dA$$
$$D_f = D_r - B$$
$$A_f = D^{-1}(D_f).$$

These are solvable when Floodplain Elevation Profile, Df = D (Af), is an increasing function




| Symbol | Name | Unit |
|---|---|---|
| | parameters | |
| L | Channel Length | m |
| W | Channel Width | m |
| B | Bank Height | m |
| Z | Surface Altitude | m |
| Ac | Unit Catchment Area | $m^2$ |
| | variables | |
| S | Total Water Storage (Sr+Sf) | $m^3$ |
| Sr | River Channel Water Storage | $m^3$ |
| Sf | Floodplain Water Storage | $m^3$ |
| Dr | River Water Depth | m |
| Af | Flooded Area | $m^2$ |
| Q | Discharge | $m^3s^{-1}$ |

**(Yamazaki, 2011)**

## Calculate water exchange between the downstream grid. Velocity estimated by the Diffusive Wave, Water Storage in next time step is predicted by the Continuity equation

St. Venant equation for 1-D unsteady flow is approximated to the diffusive wave Equation (Acceleration terms are negligible in case of the natural flow in large rivers)

$$\frac{1}{g}\frac{\partial v}{\partial t} + \frac{v}{g}\frac{\partial v}{\partial x} + \frac{\partial h}{\partial x} + i_0 - i_f = 0$$

Kinematic

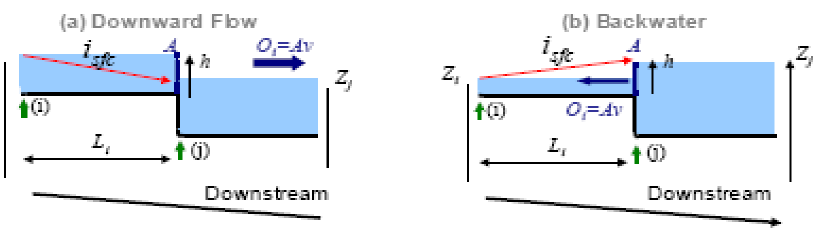
Diffusive

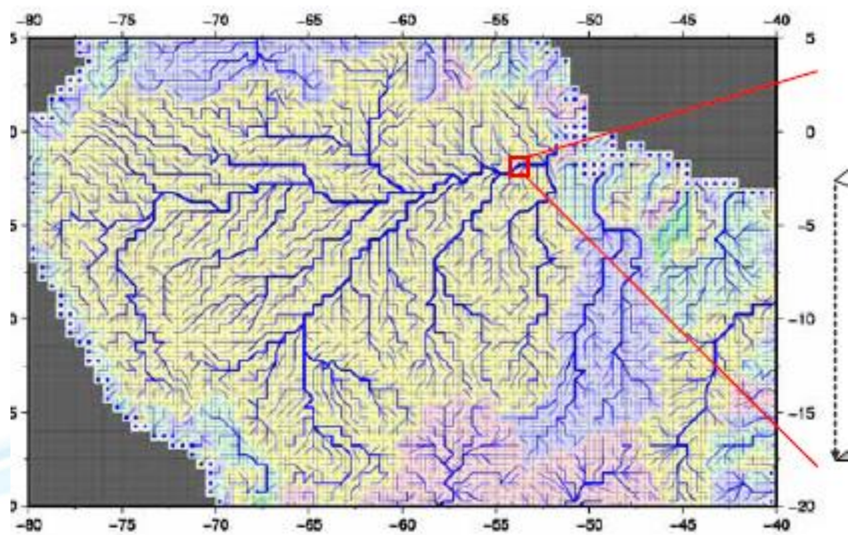
Dynamic

Inertial term, $\delta v/\delta t$ is implemented in the actual calculation, because it makes the simulation stable [Bates et al, 2010]

$$S_i^{t+\Delta t} = S_i^t + \sum\nolimits_k^{\text{upstream}} Q_k^t \Delta t - Q_i^t \Delta t + A_{c_i} R_i^t \Delta t$$

Continuative Equation

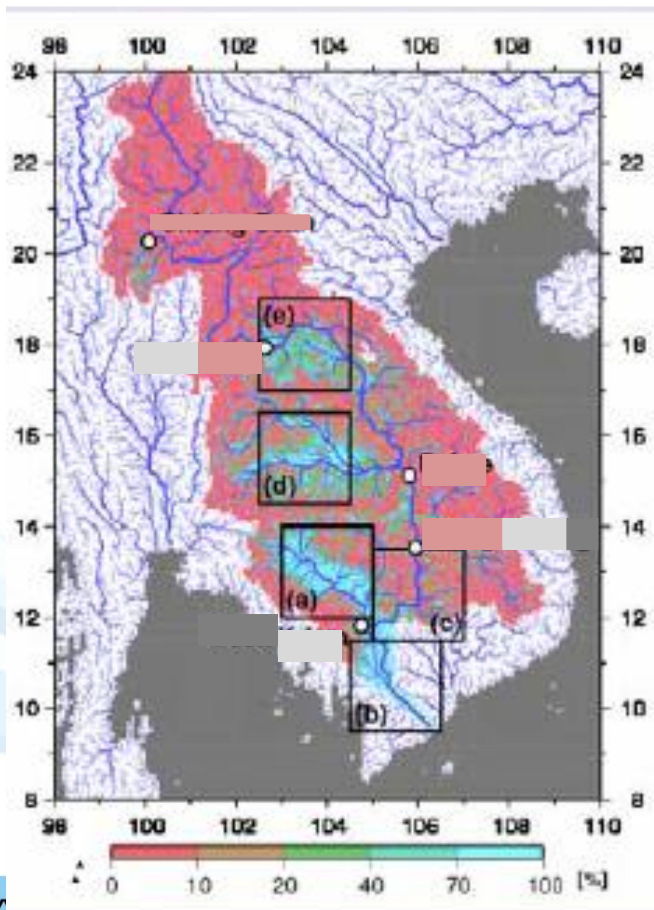


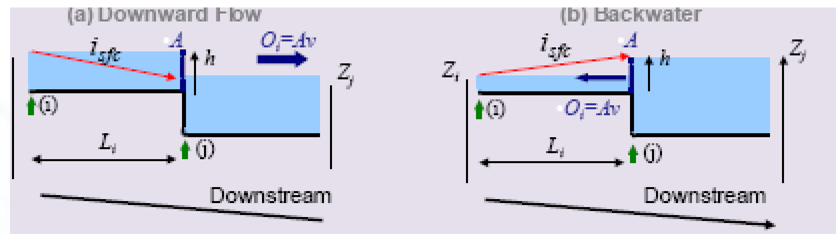



(Yamazaki, 2011)

The pressure term , $\delta h/\delta x$, is considered
So that the black water effect is represented in the model

River discharge is calculated along the prescribed river network using a diffusive wave equation, so that backwater effect is considered. Total Water storage of each grid-box at next time step is predicted by a mass conservative equation




$$\frac{1}{g}\frac{\partial v}{\partial t}+\frac{v}{g}\frac{\partial v}{\partial x}+\frac{\partial h}{\partial x}+i_0-i_f=0 \qquad i_f = n^2 v^2 h^{-\frac{4}{3}}$$

Kinematic

Diffusive

Dynamic

Manning's roughness

St. Venant Momentum Equation

$$S_i(t+\Delta t)=S_i(t)+\sum_j^{upstream} Q_j\Delta t - Q_i\Delta t + A_i R_i \Delta t$$

Mass conservation equation

**(Yamazaki, 2011)**