Introduction of the research activities related to Thai Flood 2011 under the IMPAC-T project

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Outline

1. Urgent field survey of Thai flood 2011
2. Introduction of IMPAC-T
3. Urgent force project; Flood action of Chaophraya
Urgent field survey for Thai Flood 2011

Mr. Nakamura (IIS), who is the expert of river management
Urgent field survey

- Date; November 4 - 10, & December 2-6, in 2011
- Purpose; To clarify the factor of flood, the situation of disaster site, and flood fighting activity
- Area; middle - downstream basin of Chao Phraya River

Increase of water level

Flood fighting activities

(by Univ. of Tokyo)
Inundated the world heritage “Ayutthaya” on the Dec. 1, 2011
Damage of Thai flood 2011

• Personal suffering (by M. of Interior, at Jan. 8, 2012)
  ➔ cause 813 deaths, and 3 missing

• Economic damage (by World Bank)
  ➔ about 1.36 trillion Baht (≈45 billion US$, cause down in about 1.1% of real GDP growth rate in 2011

• Damaged crop field (by M. of Agriculture & Cooperatives)
  ➔ 20,403 km² (≈4% of Thailand, 12.5% of C. P.)
Rain in 2011

◆ Total precipitation in May through October in 2011 was 143% of the mean value in the past.

◆ The annual precipitation in Chao Phraya river basin, Thailand:
→ in La Nina years: 1061 mm
→ in Normal years: 987 mm

※ TMD Observation Data
- Daily precipitation data of May - Oct., 2011 (From GTS)
- 1982-2002 of daily precipitation data (From GAME-T Data Center)

(Komori et al., 2012)
Rainfall at Huay Bong, Mae Chaem

Much rain in 3 times
March-May
July-August
October

Almost normal rain
June & September

Typhoon affected
• If we knew the heavy rainfall in May, July, and September in 2011 beforehand, we could have prepared a little better, but:

• Flood forecasting depends on weather forecast
  – Hourly to daily rainfall for flashflood
  – Monthly to seasonal rainfall for Chao Phraya

• Predictions in seasonal rainfall and typhoon landfalls are still challenging.
  – El Nino and La Nina could be predicted more than a year advance. However, not all La Nina cause severe floods in Thailand.
Even the rainfall is 143% of normal, why the huge flood happen?

- Evapotranspiration (ET) is approximately 70% of annual rainfall in normal year.
- ET does not change very much year by year.
- In flood years, increment of rainfall mainly causes increase in river runoff.

\[
\begin{align*}
\text{Rain} & \quad \text{ET} \quad \text{Runoff} \\
100 & \quad 70 \quad 30 \\
\downarrow & \\
143 & \quad 70 \quad 73
\end{align*}
\]

\[243 (=\frac{73}{30})\% \text{ of Normal Runoff}\]
River discharge at Nakhon Sawan

at C2 (Nakhon Sawan)
during from 1956 to 1999 (44 yrs), & 2011 in Rainy season (Jun - Oct)

Total discharge; Top 5

<table>
<thead>
<tr>
<th>Year</th>
<th>(10^2 m^3)</th>
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<tbody>
<tr>
<td>1</td>
<td>2011</td>
</tr>
<tr>
<td>2</td>
<td>1970</td>
</tr>
<tr>
<td>3</td>
<td>1961</td>
</tr>
<tr>
<td>4</td>
<td>1975</td>
</tr>
<tr>
<td>5</td>
<td>1995</td>
</tr>
</tbody>
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(Nakamura et al., 2012)
- Flood occurred over discharge capacity.
- Discharge capacity decrease in downstream.

Discharge capacity of Chao Phraya River (Source: RID)
Discharge capacity of C. P.

Accumulated exceedance discharge
(10² m³)
(day number when the Q is over capacity)

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</thead>
<tbody>
<tr>
<td>1961</td>
<td>95</td>
<td>74</td>
<td>76</td>
<td>70</td>
<td>119</td>
</tr>
<tr>
<td>(78)</td>
<td>(77)</td>
<td>(64)</td>
<td>(69)</td>
<td>(96)</td>
<td></td>
</tr>
</tbody>
</table>

(Nakamura et al., 2012)
Then, what happened?
Corruption of water gate

(in Sep., by RID)

(1) 9/22-10/28 (25m)
(2) 9/24-约2週間 (1.300m)
(3) 9/18-不明 (1,000m)
(4) 9/22-不明 (20m)
(5) 9/22-不明 (40m)
(6) Ban Chom Srirat 水門
   9/13-10/12 (40m)
(7) 9/14-約2週間 (20m)
(8) 9/17-約2週間 (40m)
(9) Phra Ngam水門
   9/15-不明 (40m)
(10) Tanuing水路の水門
    9/14-不明 (15m)

No. 破堤日-締切日または締切にかかった期間（破堤幅）

(in Dec., by Univ. of Tokyo)

IMPAC-T project
- 8 levee crevasses on the left bank from the middle to the end of Sept.

→ ①, ⑥ took 1 month to fix the levee

- Most of levee crevasses locate on a curve (water colliding front)

**Video** Inundation situation

**Point of levee crevasse between Nokhon Sawan and Ayutthaya (Source: RID)**
Estimation of flood volume btw. Nakhon Sawan & Ayutthaya

River discharge of each RID stations

Flood volume from Nakhon Sawan to Chao Phraya Dam is *1.8 billion m³.
Flood volume from Chao Phraya Dam to Ang Thong is 3.9 billion m³.

* Flood volume is calculated by removing the discharge capacities of Ta-chin river and Noi river (650 m³/s).

Indicating nearly identical waveform until the beginning of Sept.

→About more than 5 billion m³ water inflow to floodplain on the left bank. This means 1/4 of the total flood volume.
We surveyed many other elements of flood, for example, water quality, flood fighting, reservoir operation, retarding basin, etc…

but I skip today
Please see our website or paper.
Introduction of IMPAC-T
What's IMPAC-T?

IMPAC-T: “Integrated study on Hydro-Meteorological Prediction and Adaptation to Climate Change in Thailand”

One of SATREPS

For the Earth, For the Next Generation

Kasetsart Univ.

TMD, RID

KMUTT, PCD, DNP,

Chula. U., Naresuan U.,

DWR, BRRAA, MUT

U. of Tokyo, Kyoto U.,

Tohoku U., NIES,

Hokkaido U., NIAES,

Tokyo Institute of Tech.,

Fukushima U.

http://impac-t.kugi.kyoto-u.ac.jp/
Climate Change is the major security issue for human beings for both developing and developed counties.

Human Activity is one of the major factors threatening the sustainable development of the world particularly by the demographic & economic growths in Asia.

Earth observation considering climate change

Validation & Analysis

Social-ecological-system model for Hydrological cycles and Water Resources Assessments

Water related information integration system

Early warning system on the risks of water-related disasters by integrating observations and model

Developing National Strategic Plan in Water Sectors for Adaptation Measures under CC.

Decision-making support system (DMSS) for adaptation in water-related areas under climate change

Web Services

IMPAC-T project
Joint research groups

**Target**
Decision-making support system (DMSS) for adaptation in water-related areas under climate change

- **Impact assessment and adaptation to CC**
  - Soil moisture - land slide
  - Coastal erosion
  - Mapping of flood hazard & GWP by watershed analysis
  - H08

- **Water resources/circulation modeling**
  - Land flux
  - Rain observed by satellite
  - Telemetering

- **Earth observation considering climate change**
  - Atmos. model
  - Quantitative radar rain estimates
  - Monsoon variability and anthropogenic impact

- **Water related information integration system**
  - Semi-real time index related water disaster (flood, land slide etc.)
  - Semi-real time rain map
  - Short/mid term forecast of water demand
  - Visualize the information related water circulation
  - Estimation of water demand/circulation under CC
Design of IMPAC-T server system

- Basins A and B
- IMPAC-T Stations
- Data Archive Server
- Integrated Server
- Application Server
- Satellite
- Historical
- Radar
- Flux obs.
- etc...

Obs. stations
Receivers

+ include mirror system

TMD

KU

USER

Satellite
Historical
Radar
Flux obs.
etc...

jica
ST
IMPAC-T project
Urgent force project; Flood action for Chao Phraya
• Operation of reservoir in 2012 will reported by RID in January
• Rehabilitation of infrastructure; about 17 billion B
  – 12.6 Billion B in 2012, 4.5 billion B in 2013
• Construction of data pool, forecasting, warning
  – Data Pool; NSTDA, Royal Survey Dept., JICA, & Chulalongkorn U
  – Improvement of weather forecast; RID
  – Early warning system; National Disaster Warning Center
• Emergency response system; M. Interior, M. Natural Resources & Environment, M. Defense
• Identification & compensation system for retarding basin; M. Agriculture & Cooperatives, M. Interior
• Restructuring of ministry related water management; lead by the Office of the Council of State
Urgent Force Project; Flood action of Chaophraya

1. Urgent rehabilitation / improvement
2. Reconstruction assistant
3. Revision of master plan

Revision of master plan (M/P)

1. Update of dataset
2. Prehension of flood situation in 2011
3. Assessment of operation of M/P, and flood force in the past
4. Meteorological field in 2011 flood, reflection of climate change into M/P
5. Reconfirmation of development project in river basin
6. Readjustment of flood simulation
7. Readjustment of flood force and M/P

Original target IMPAC-T project

1. Capacity development of observation in hydro-meteorology
2. Development of water cycle/resource modeling
3. Development of water related risk assessment

IMPAC-T can and should promote the research activities and support updating the master plan of the Chaophraya river.
Our mission for the urgent force project

• Request of JICA
  – Simulation of the upstream of Chao Phraya including the operation of reservoirs
    • Finally, reproduction of flood in 2011 + operation of reservoir
    • First, reproduction of discharge during 1981 – 2004 + operation of reservoir

• Contents what I introduce here
  – Method of simulation
  – Future plan
Method of simulation

Comparison the rainfall btw. forcing (K10) and observation

Sensibility experiment of parameter in H08 modeling
(4 hydrological parameter; SD, tau, gamma, Cd)

Water balance in basin & river discharge at Nakhon Sawan

To decide the appropriate combination of parameter by match in annual river discharge & monthly hydrograph

Simulation of river discharge without reservoir in 24 yrs
Naturalized simulation (exclude any water intake from river)

Simulation of river discharge with reservoir in 24 yrs
Reservoir simulation (using simple operation rule of reservoir)

IMPAC-T project
Future task

• Reproduction in 1981-2004
  – To define what’s the appropriate parameter
  – We received the discharge data of 32 stations in upstream by Nakhon Sawan from RID, so we continue to evaluate and consider the parameters.
  – To improve the model of reservoir operation

• Reproduction in 2011
  – It was clarified the availability to do from the consideration in detail.
  – We will conduct the test run as soon as possible.
• From the field survey of Thai flood 2011, we learn that the flood in Chaophraya cause huge damage in not only local but also globe.
• Original viewpoint of IMPAC-T might focus to the flush flood or land slide.
• We should consider the research related to the flood in lower Chaophraya, because the frequency of extreme event will increase under the climate change.
• For the updating of master plan in Chaophraya and the decision making, the IMPAC-T continue to conduct the research activities related to the flood in not only mountainous but lowland area.
• For the final target of IMPAC-T, we will have a communication with the society. Especially, we should consider how to make the appropriate interface to connect the decision maker.
Thank you for your attention