2012 AIT-NUS-ITB-KU JOINT SYMPOSIUM ON HUMAN SECURITY ENGINEERING
Bangkok, Thailand, November 19-20, 2012

Sukhothai Flood Risk Management under changing climate

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Topics

- Introduction
- Study objectives and study area
- Flood area, damage VS discharge peak
- RRI simulation model and application results
- Future flood situations
- Flood risk management
- Conclusions and recommendation

Introduction-1

- disaster events around Asia, starting from Fukushima incident, in Japan, Indonesia earthquake, Bangkok Floods 2011 etc.

- The study of climate change revealed that Thai climate showed the change in cyclic characteristics and the seasonal pattern and extreme cases changed since then from the past records (Sucharit K., 2009).

Introduction-2

- Floods 2011 in Thailand caused a lot of casualties for local residents and also to the logistic of world supply chain. Since most of the Thai cities in the Central Plain located near the river side, the effect of extreme events both precipitation, sea water rise and land subsidence will give significant impacts to the urban flood management planning (Sucharit K., 2012; Itti, 2011; N. Phien-wej (2006)).
- The new way of infrastructure planning is needed to counter the present flood issue and also to cover future risk.

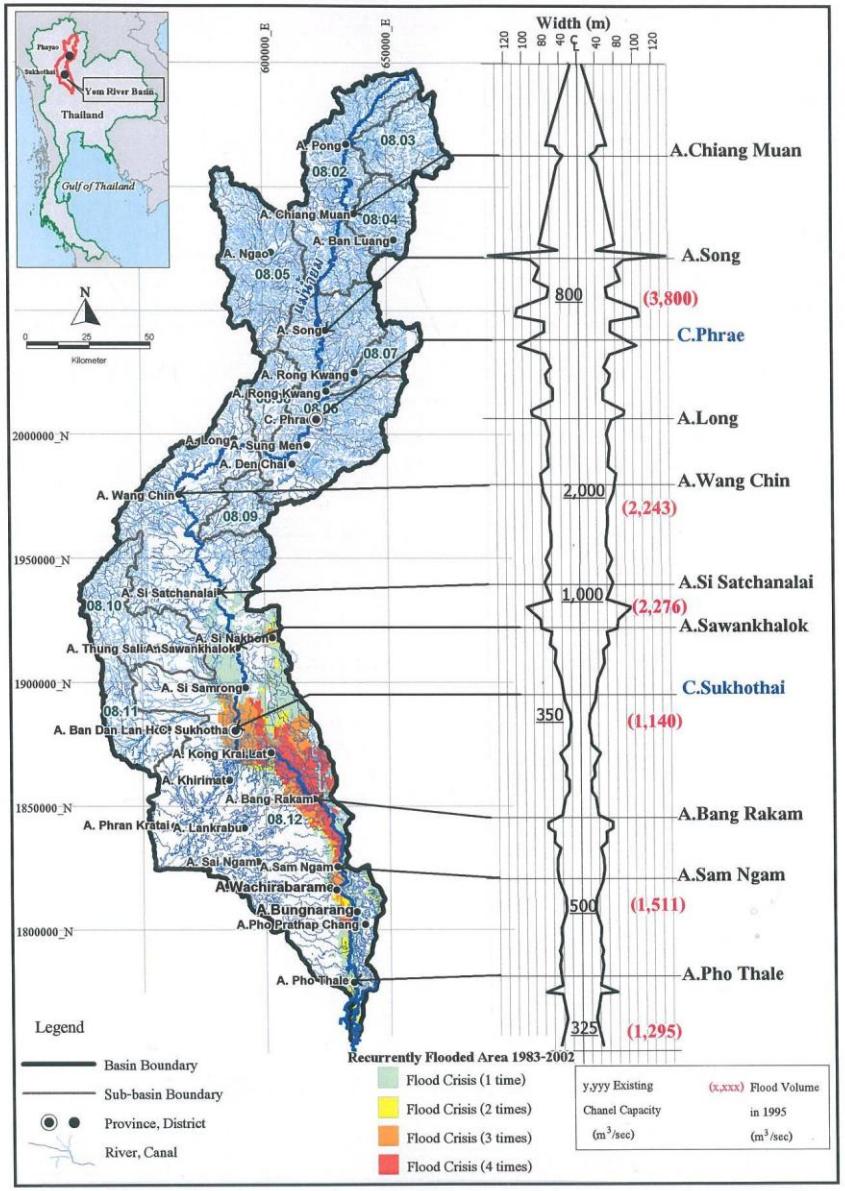
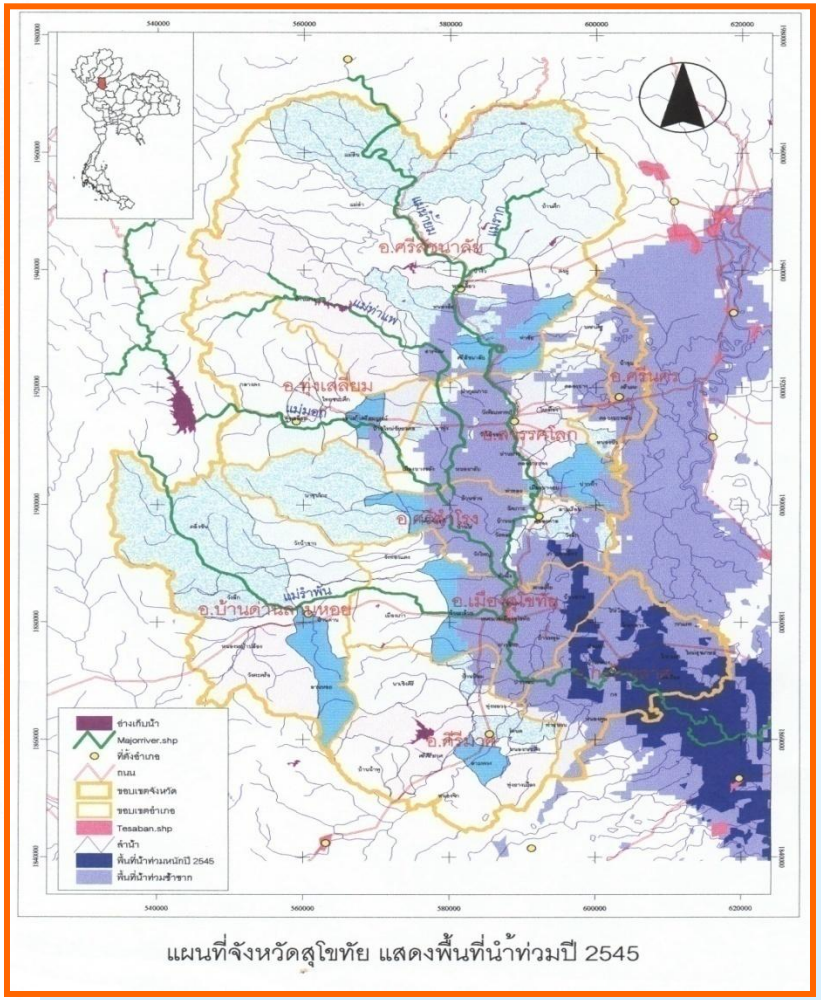


Figure 3.1-1 Flooded Area in Yom River Basin



แผนที่จังหวัดสุโขทัย แสดงพื้นที่น้ำท่วมปี 2545

Flood Problem in Yom River Basin

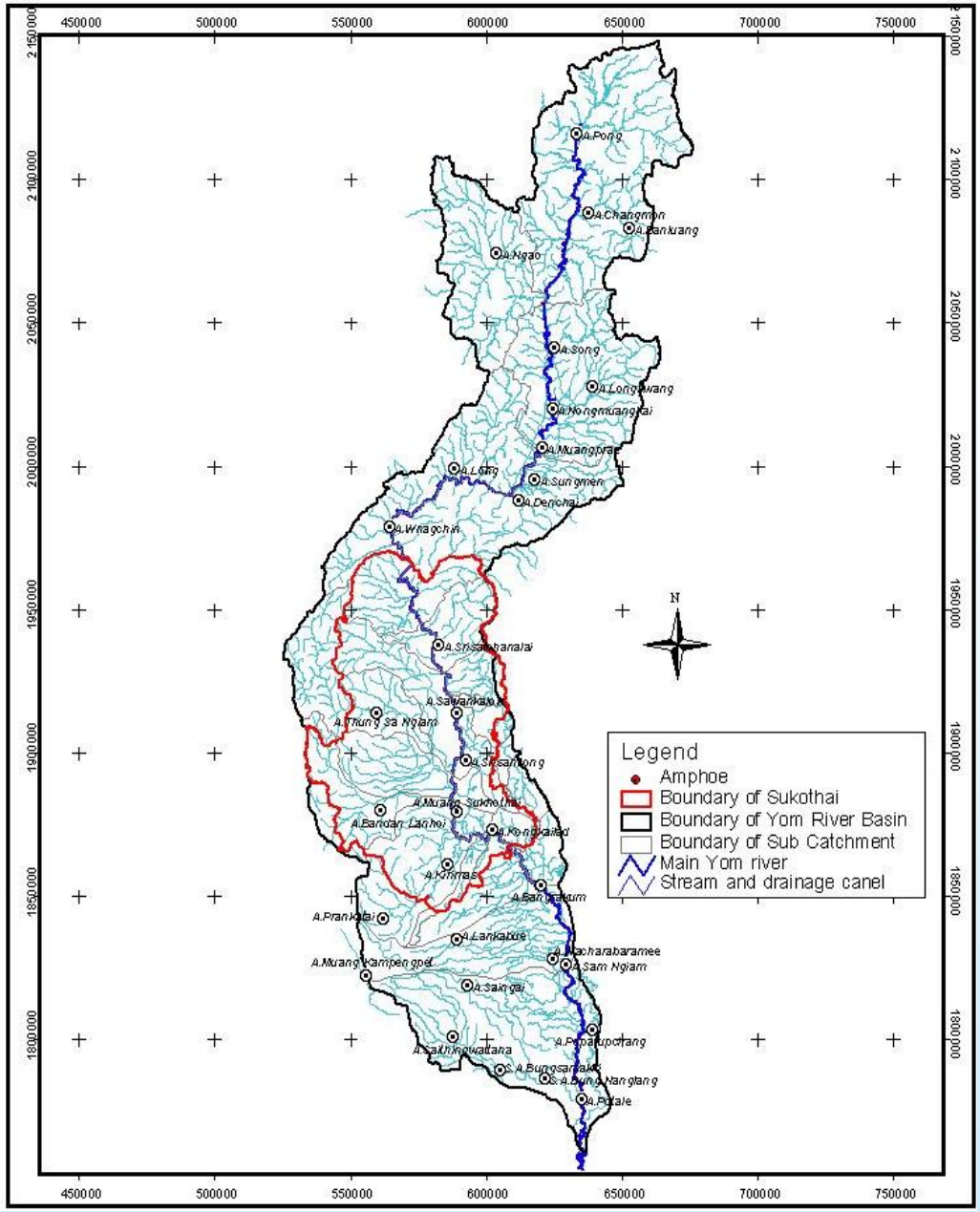
Source : RID

Study objectives

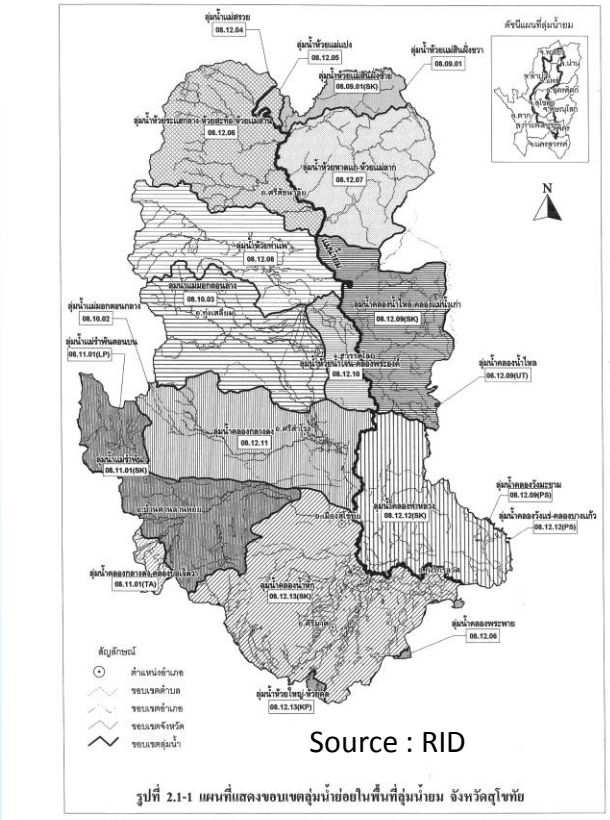
- Review the past flood records and their relationship of flood peak, flood area, flood damage.
- The hydrological analysis to see the difference of flood peak of present and near future in the probabilistic change
- The introduction of rainfall-runoff-inundation model to simulate and evaluate the floods in Sukhothai area
- Propose the adaptation measures under flood risk management concept

Study area

- Study area: Yom Basin focused on Sukhothai Province (Municipal area)
- Flood history (1977-2010) collected from concerned agencies including flood events , flood area and flood damages (as reported by the Department of Disaster Prevention and Mitigation).
- Near Future climate (2012-2025) based on MRI-GCM



Yom River Basin has the total catchment area of 23,616 km².

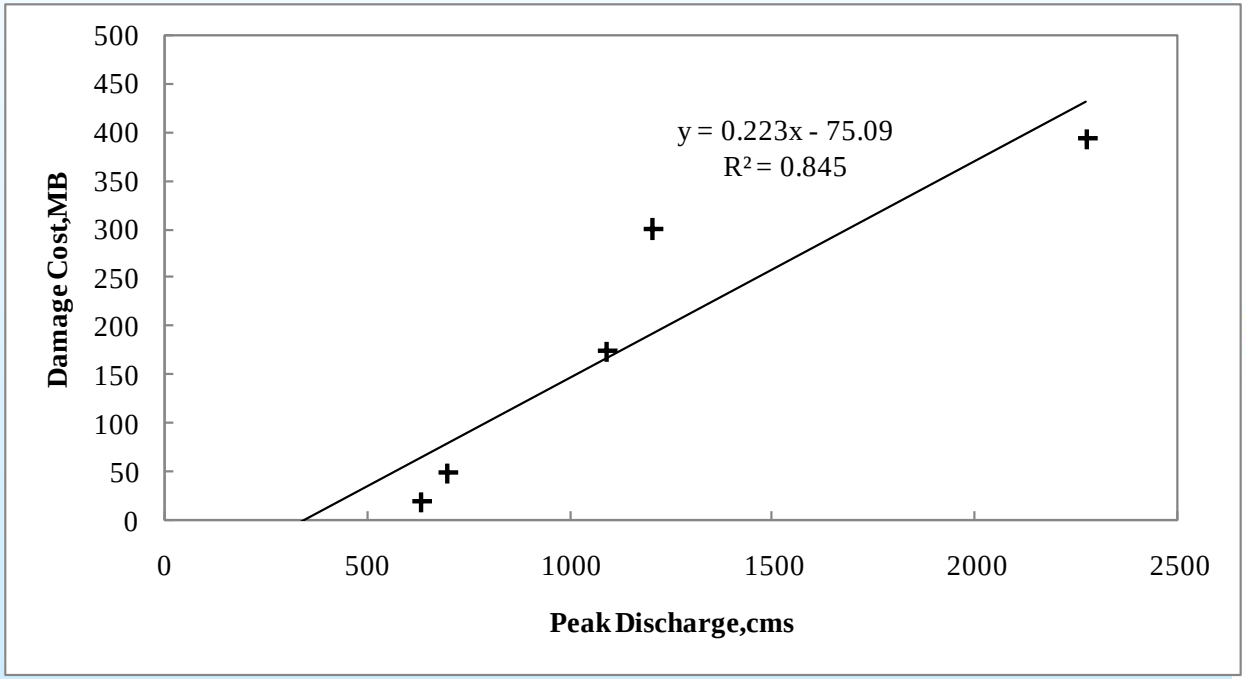


The coverage area of Sukhothai province is about 6,596 Km²

Yom River Sub-Basin in Sukhothai Province Boundary

damage VS discharge peak

- Relationship between Sukhothai flood damage cost and peak discharge at Y14.



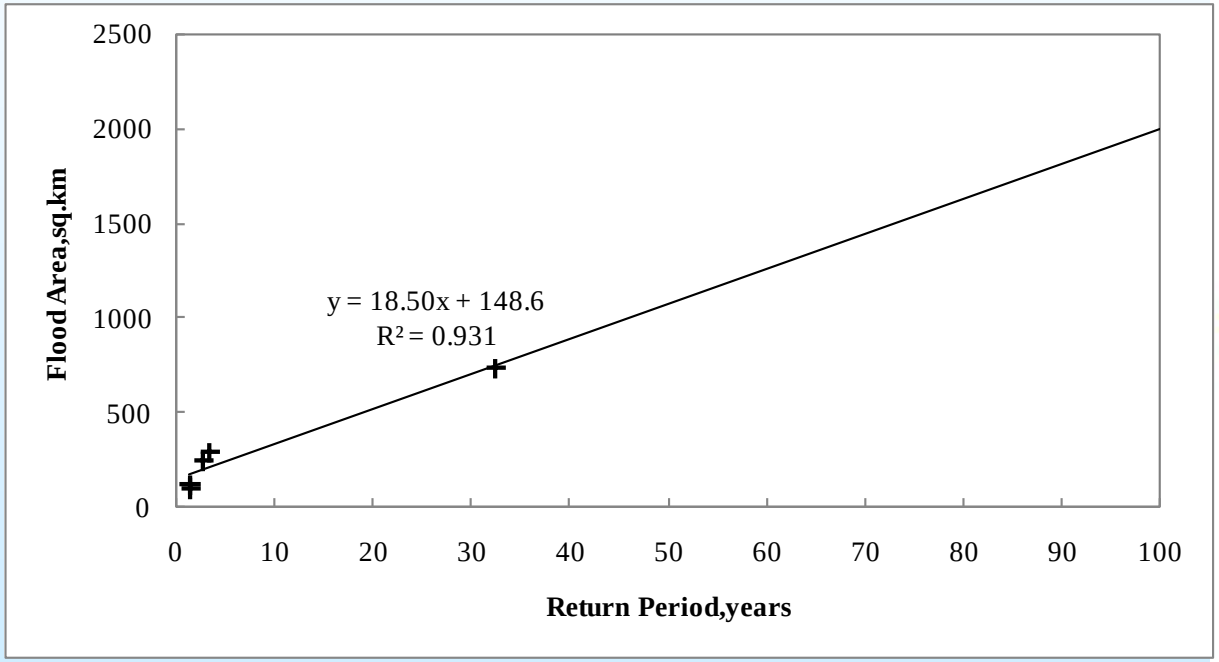
Flood area, damage VS discharge peak

From flood past records in Sukhothai Province (1977-2010)

Year	Peak Flood cms	Flood Area sq.km	Damage cost MB	Tr years
1995	2,271.50	741.20	394.32	32.41
1997	692.80	126.13	49.71	1.48
1998	629.30	95.66	19.73	1.38
1999	1,088.70	251.94	174.73	2.72
2002	1,200.90	293.40	300.02	3.34

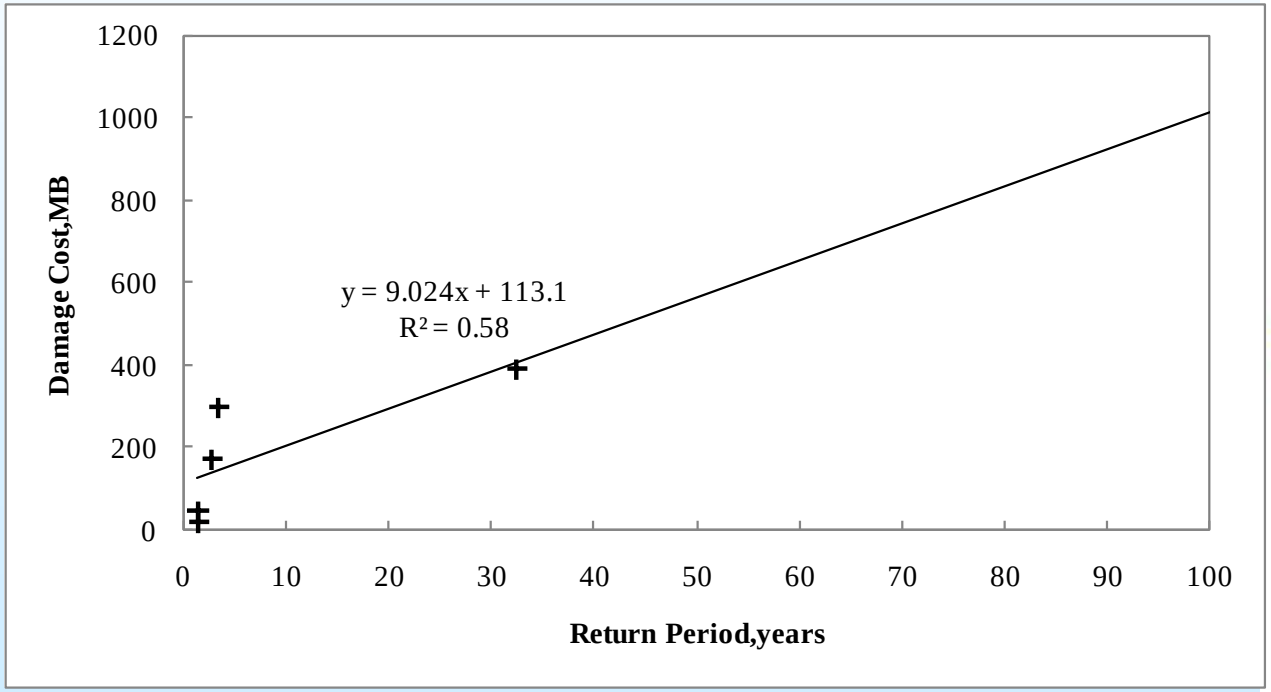
Flood area with return period

- Relationship between flood area and return period.



Flood damage in return period

- Relationship between flood damage cost with return period.



Peak discharge in near future

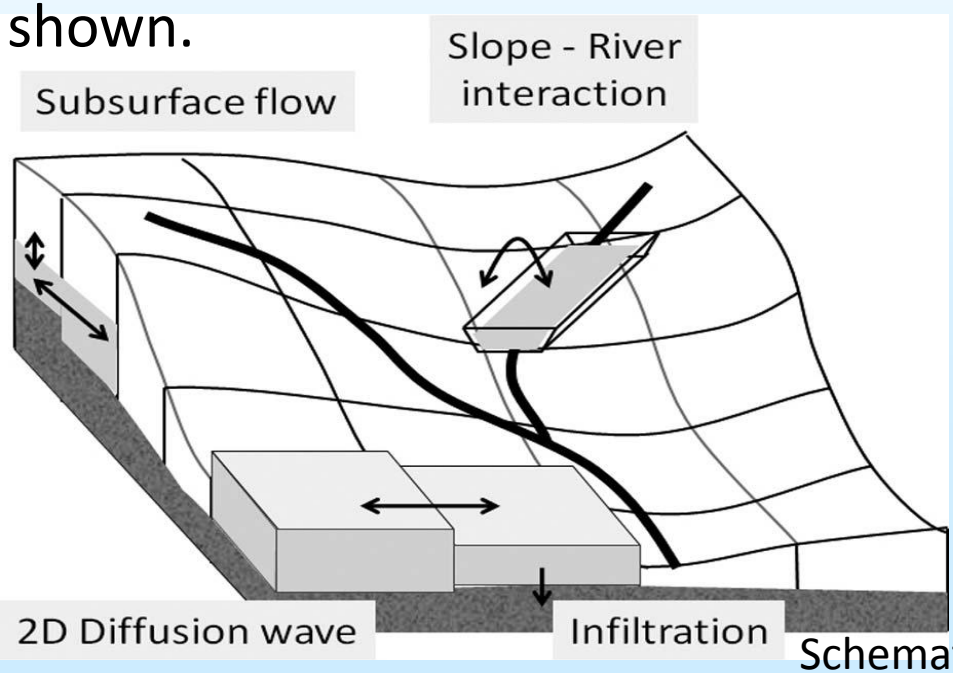
Station	Maximum discharge in 2006 (CMS)	Maximum discharge in 2019 (CMS)	Difference (%)	Maximum discharge in 2022 (CMS)	Difference (%)
Y.14	2,044	2,471	17.28	2,567	20.37
Y.6	2,171	2,592	16.24	2,648	18.01
Y.3A	1,568	1,908	17.82	1,974	20.62
Y.4	555	665	16.54	749	25.90

Remarks : based on bias corrected MRI-GCM(near future) and HEC-RAS one dimensional hydraulic simulation

Simulation model and the results

- The model, used for flood projection in this study, is a two dimension rainfall-runoff-inundation (RRI) model

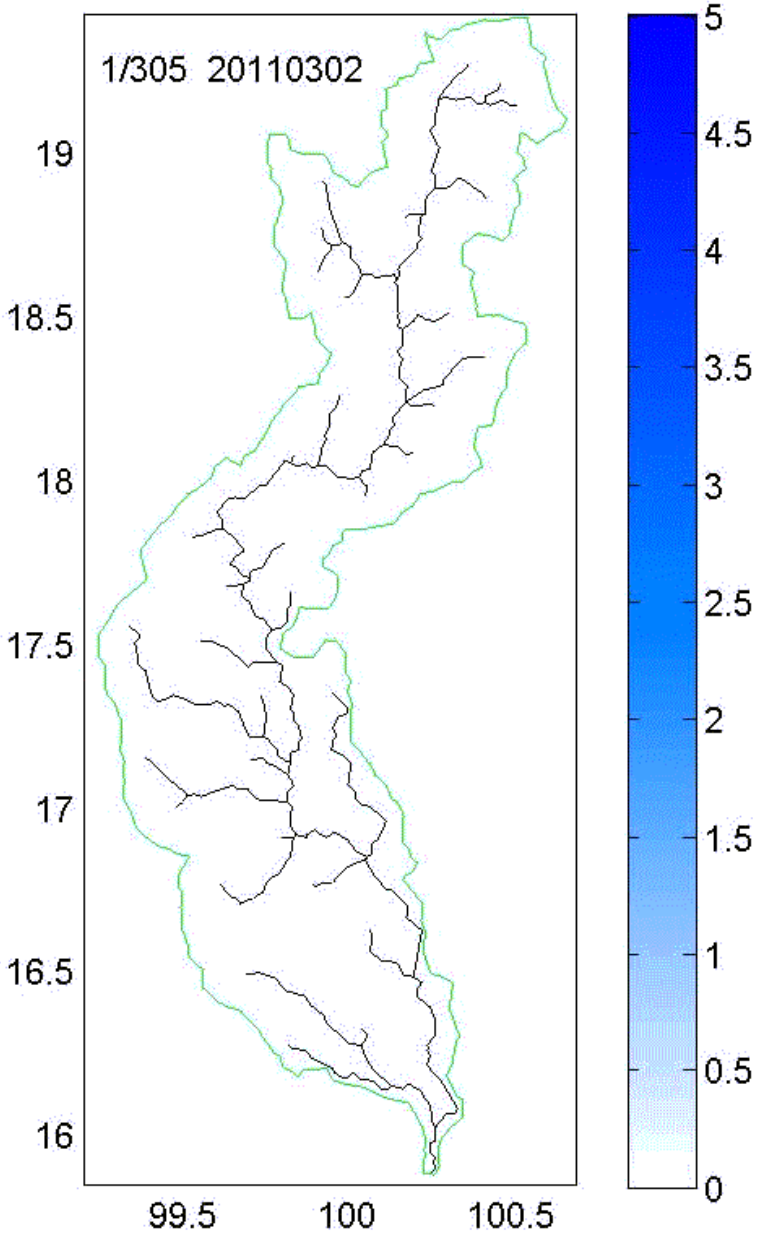
- The model deals with slopes and river channels separately as shown.



Schematic diagram of the rainfall–runoff–inundation (RRI) model (Sayama et al., 2012).

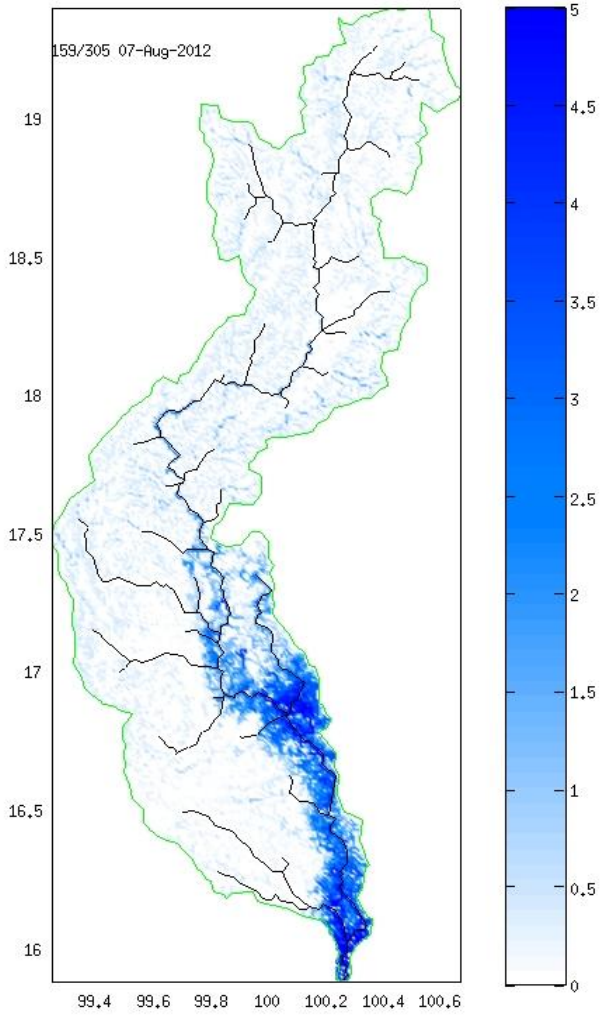
Simulation model and the results

- Simulation results



Simulation model and the results

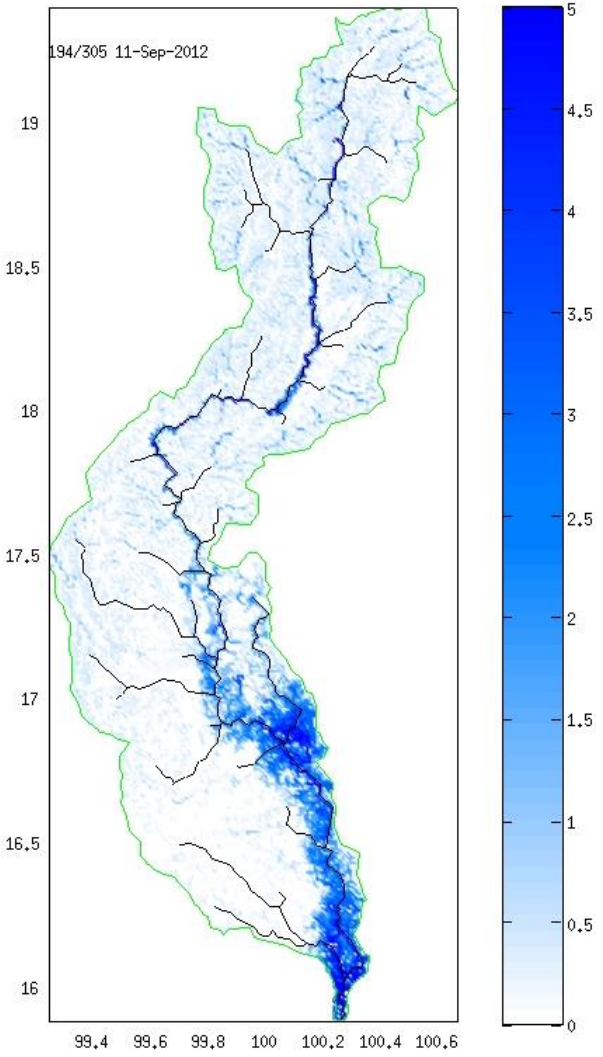
Simulated results compared with satellite image



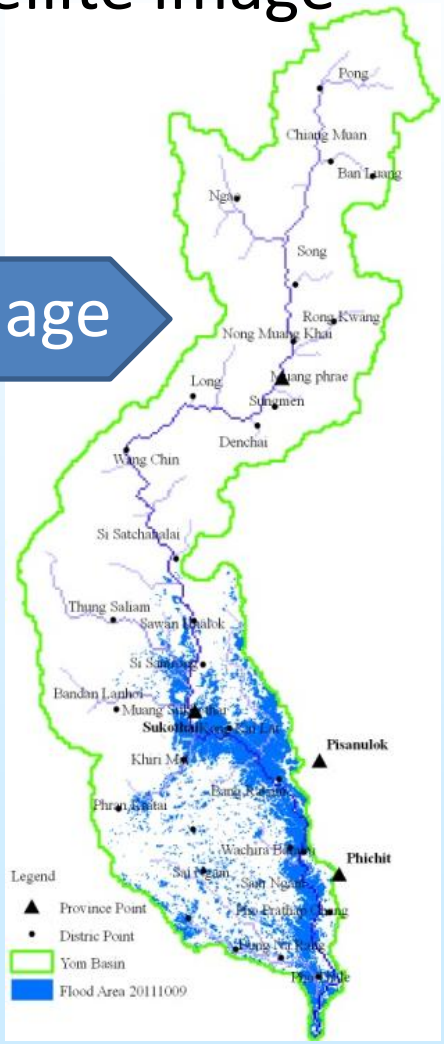
satellite image

Simulation model and the results

Simulated results compared with satellite image

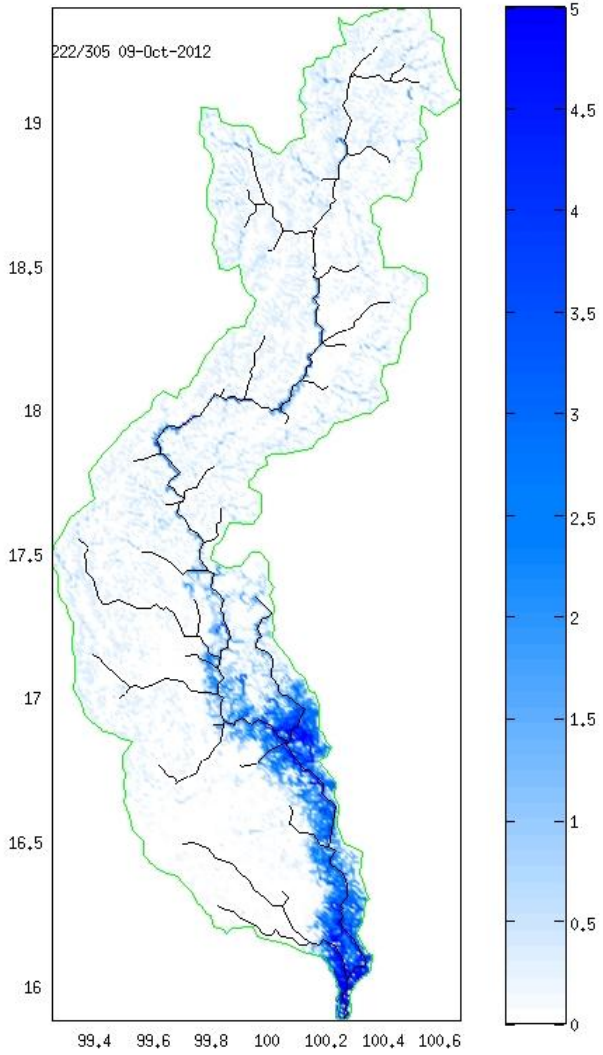


satellite image

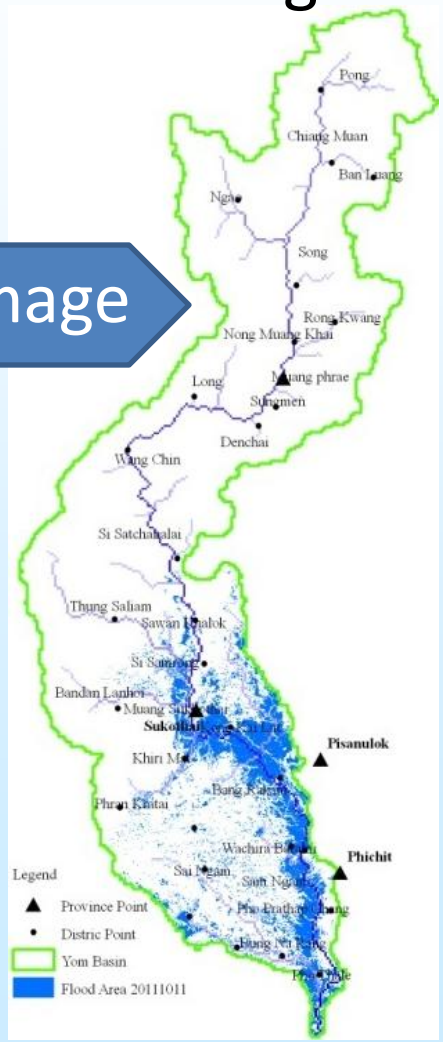


Simulation model and the results

Simulated results compared with satellite image

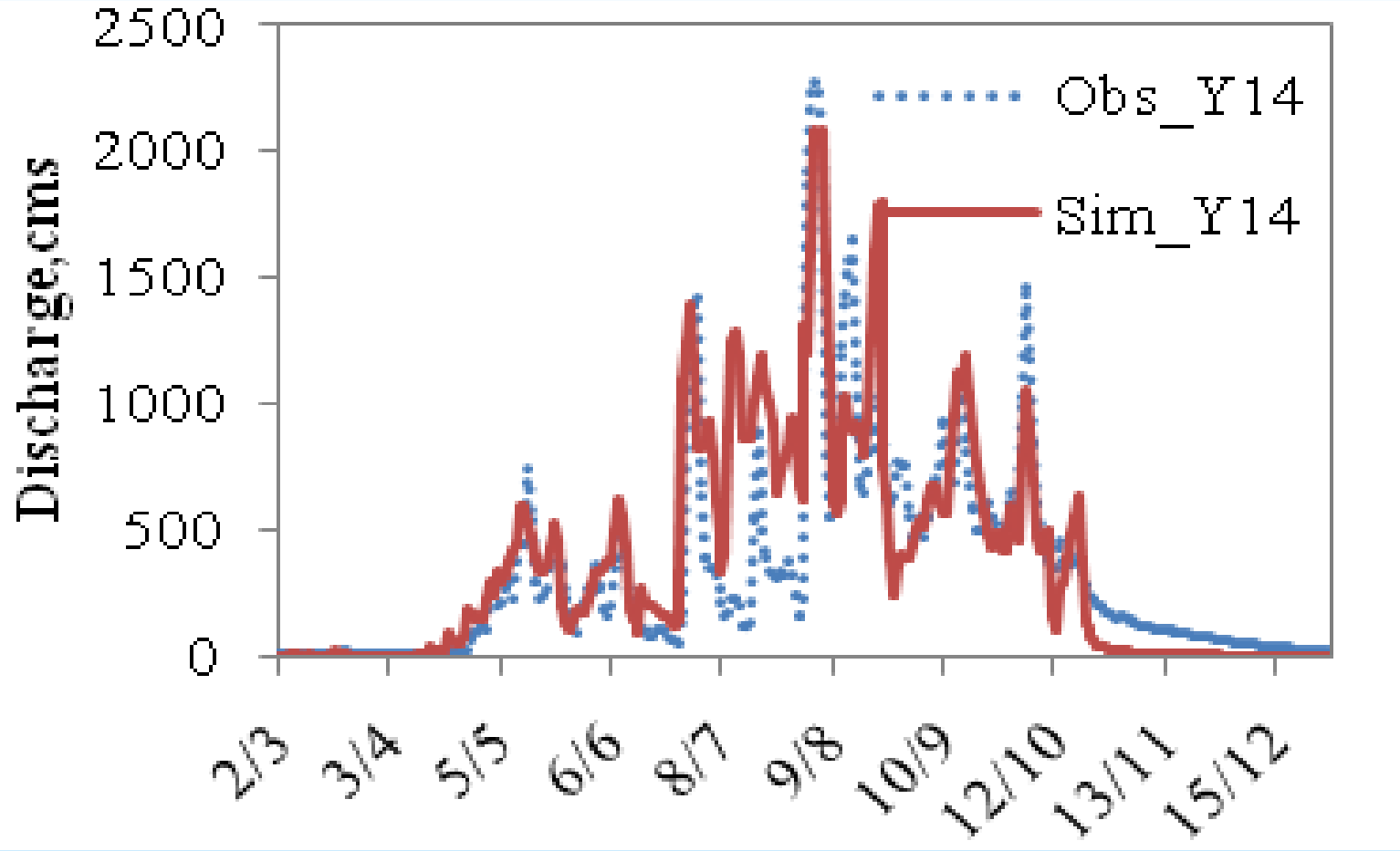


satellite image



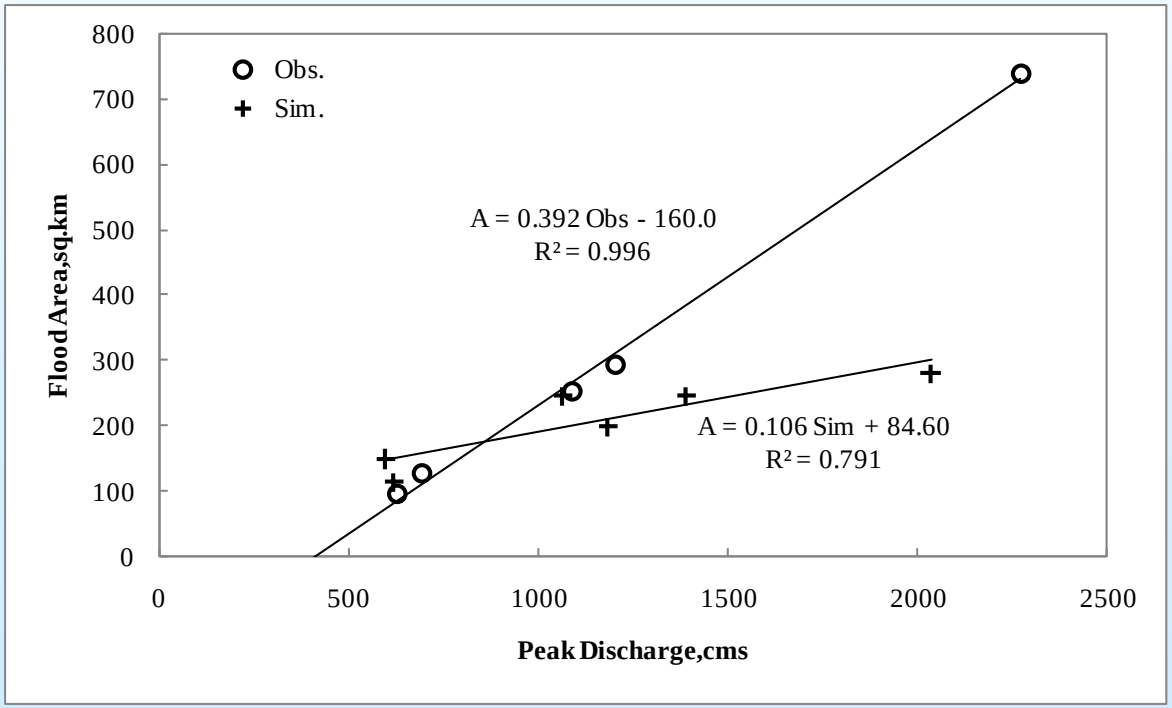
Simulation model and the results

- RRI calibration results at Y14.



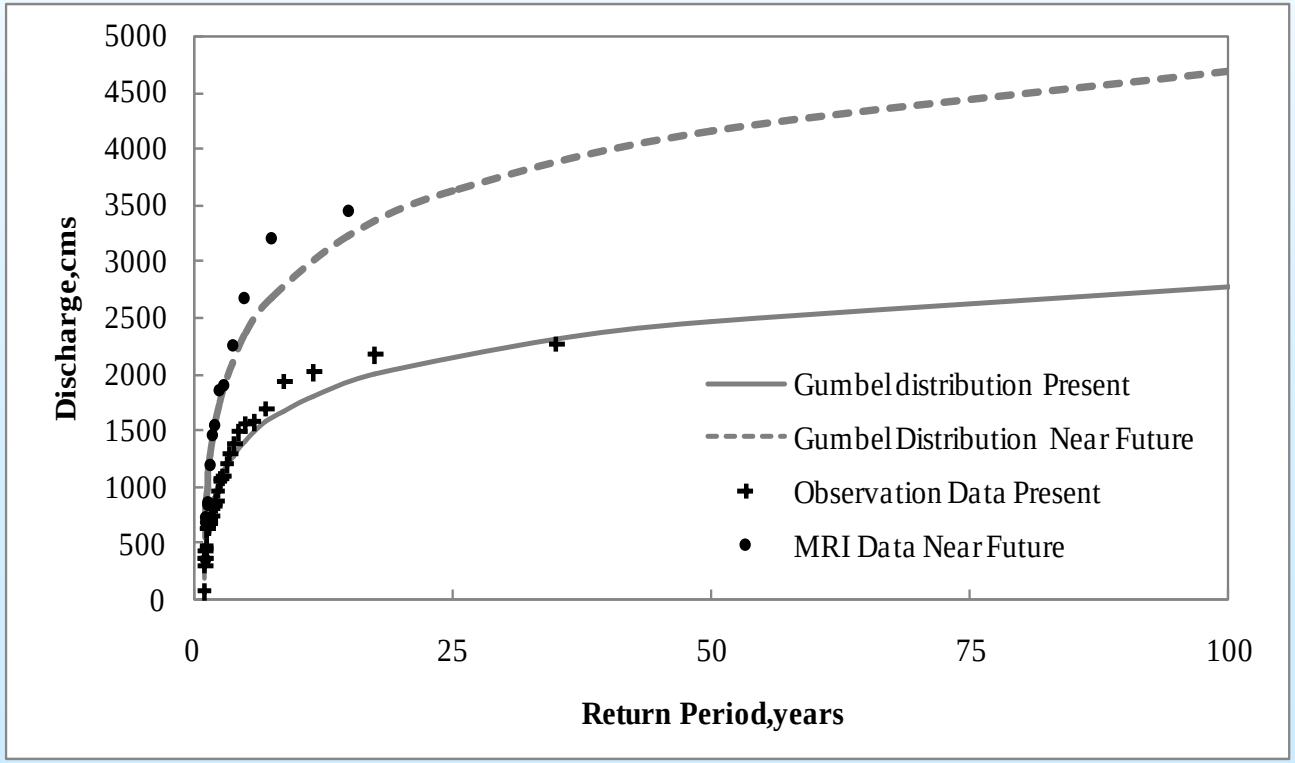
Flood area, damage VS discharge peak

- Flood area with peak discharge (at Y14) compared between observed and simulated.



Future flood situations

- Near future situations (2012-2025) of floods in the study area were simulated from MRI-GCM, bias corrected to fit with past data, and the peak flood at Y14 was simulated and analysed statistically compared with the past records from daily flow (during 1977-2010)



Return period and annual peak discharge at Y.14 for present and near future.

Present/Future flood situations

- the impact from the climate change induced increase of peak discharge in the station Y14 and the flood area and flood damage (using the previous flood-peak discharge relationships)

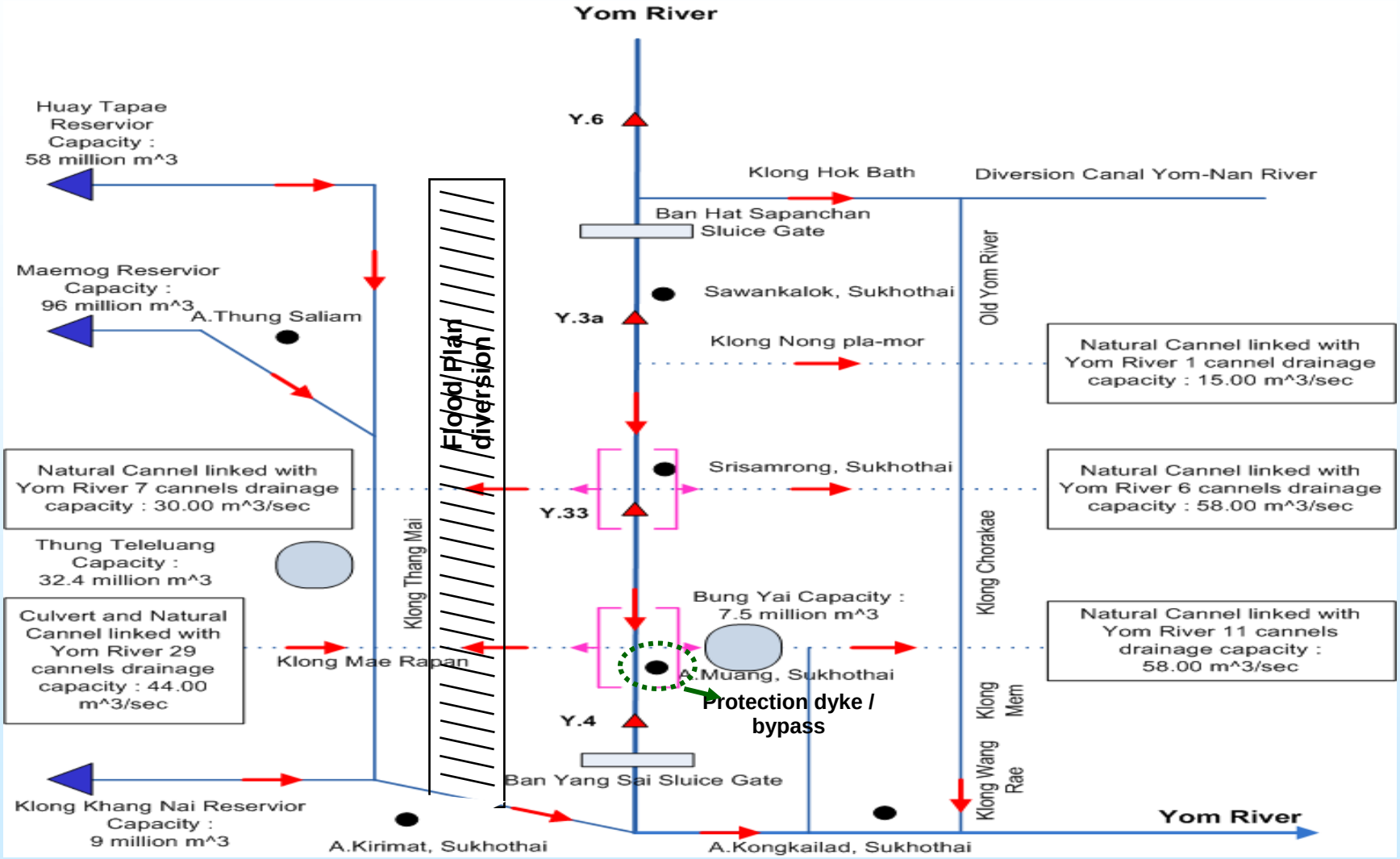
Return period	Flood Area, sq.km			Damage cost, MB		
years	P	N	% Diff.	P	N	% Diff.
2	195.18	420.45	115.41	126.97	255.12	100.93
5	391.10	755.82	93.25	238.42	445.90	87.02
10	520.82	977.86	87.75	312.21	572.21	83.28
25	684.72	1,258.40	83.78	405.45	731.81	80.49
50	806.30	1,466.53	81.88	474.62	850.21	79.13
100	926.99	1,673.12	80.49	543.28	967.73	78.13

The flood area and damage in the near future will increase about 80- 120 % compared with the present period.

Flood risk management

- Based on return period on flood area and damages under past and future scenarios
- Appropriate measures can be evaluated and proposed (additional to existing measures), i.e.,
  - Hard measures in the municipal area (dyke, pumping station)
  - Flood plain management in the rural area (flood retention, flood way, flood diversion)
  - Flood warning system to concerned parties

The existing flood mitigation measures in Sukhothai Province and future proposal



Conclusions-1

- Past historical information were gathered from the concerned agencies and the relationships of flood peak-flood area-flood damages were formulated in the probabilistic base.
- The RRI model was used to simulate the flood situations in the study area for more precise spatial distribution after calibration.
- Near future MRI-GCM climate data were used to project the future flood situations in the study area and it is found that future flood will increase by 80-120 %.

Conclusions-2

- New technology like RRI simulation in the study can help to better the planning for flood risk management
- The simulated flood information can also be used for risk management discussion among parties concerned to seek for acceptable solution for flood infrastructure planning including future flood

Recommendations

- The flood hazard approach is recommended to find flood adaptation measures in the future for both urban and rural in the study area in the optimum and acceptable manners under risk management concept in the future.
- Satellite information linking with hydraulic simulation can help better the flood warning system in the future.

Acknowledgement

- The authors would like to express sincere thanks to the authorities concerned, e.g.,
  - Royal Irrigation Department
  - Electricity Generating Authority
  - Sukhothai Municipal
  - Thai Meteorological Department etc.

  for their data and comment provision.

This research is funded by Chulalongkorn University under climate change research cluster.

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The existing flood mitigation measures in Sukhothai Province and future proposal