GEOSS Asian Water Cycle Initiative

Country Activities

INDONESIA

Draft Implementation Plan

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Issues and needs : Introduction

- Archipelago country with population of 237.424.363 people in 17.500 island.
- Tropical rainforest with annual rainfall
  - Min = 1000 mm/year (Sumbawa)
  - Max = 13000 mm/year (Irian Jaya)
  - Ave = 2000 – 4000 mm/year (BMG)

Issues and needs : Related Hazard

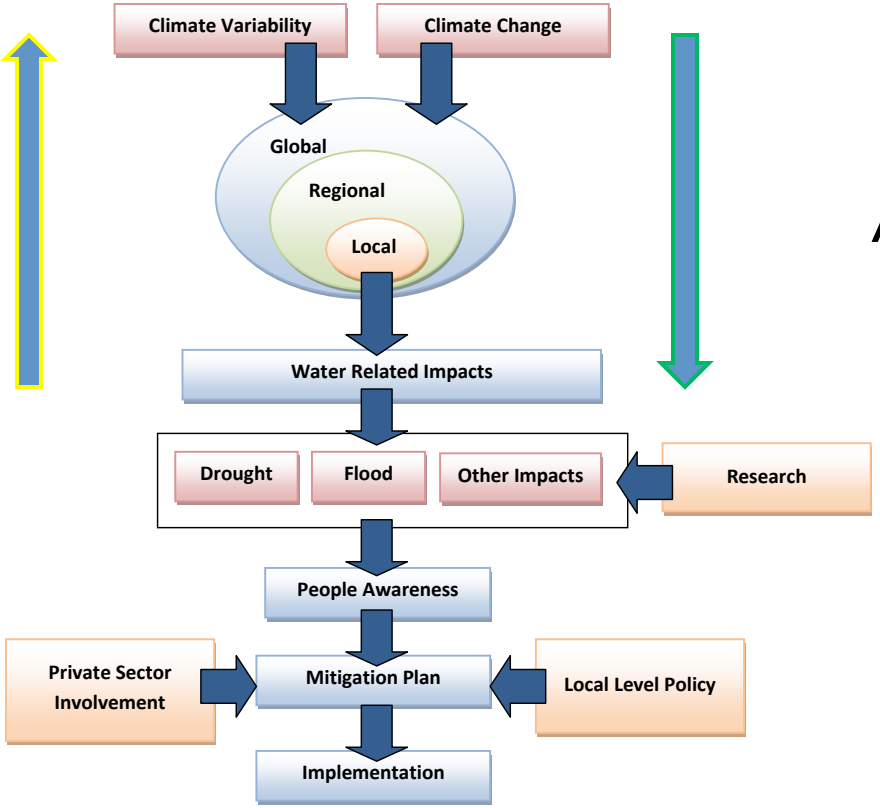
- **Flood** :
  - Excess Rainfall : Direct run off
  - Dambreak : Wave propagation
  - Rob : Higher tide (sea level rise).
- **Drought/water scarcity** :
  - Food insecurity
  - Deforestation/Forest fire (produce high carbon emission)
- **Identified Climate Change Influences**:
  - Higher in intensity and frequency
  - More unpredictable
  - Higher risk

Adaptation

- **Preparedness effort for risk reduction.**
- **Structural :**
  - Government and private.
  - Infrastrucures Development : Monitoring/EWS, Disaster Mitigation etc
- **Non Structural :**
  - Government, University, Private and NGO
  - Policy Development
  - Capacity Building :
    - Research : Reliability improvment for assesment and building code
    - Education/training : Resilient improvment of people in affected area
    - Network development : Data and tools sharing, Capacity Improvment of Human Resources

Frame work Approach

Country member



AWCI

Framework development based on simple approach

Types of Activity

- Network Development
- Development of Hydrological Data Base :
- Research for improving tool assessment :
  - Flood hydrograph
  - Rainfal-runoff model
  - Dambreak
- Education and Training
- Community services
- Pilot project study area :
  - Flood : Citarum river and its related area (Jabodetabek)
  - Drought : Kalimantan

Current Activities

- **Network Development**
  - Data Base Development : GOI (Government Of Indonesia, cq PU, BMKG, local govt, BAKOSURTANAL etc), LAPAN, AWCI-Tokyo Univ., K-Water, CKNet
  - Research : Hiroshima Univ., Tohoku Univ., Kouchi Univ.
  - Association : AWCI, GEOSS, HATHI, MHI
- **Education / Training**
  - Updating curricula of Master Study Program on Water Resources Engineering
  - Establishment of Water Resources Engineering for engineer/bachelor degree
  - Exchange program for faculty member and student : Erfurt Univ., Pitsburg Univ, Hiroshima Univ., Tohoku Univ., Kochi Univ
  - GOI : Ministry of Public works, Ministry of Environment and Local Government
- **Funding Support**
  - National : DGHE (Directorat General of Higher Education): providing research funding and higher-education scholarship for Indonesian students
  - International : USAID and ADPC (PROMISE : awareness against flood in Jakarta), Asahi Glass Foundation (Flood Early Warning System), JICA (Physical Model Laboratory)
  - Etc.

Current Activities

Current Partners

Collaborators ---------- Field	Local	National	Regional	Worldwide
Research	ITB (Research Group on Water Res, Atmospher Sci,GIS, Financ and Industrial Math and Center for Disaster Mitigation)	PJT II (Jatiluhur Reservoir in Citarum River)	Tohoku, Kochi, Tokyo Univ	
Operation	BBWS Citarum, NGO	BMKG, LAPAN, BAKOSURTANAL, Ministry of Public Work, Environment		
Administration	ITB, DPSDA	National board of Climate Change, Public Works, MInistry of Env.	AWCI	
Financial res.	ITB	DIKTI, RISTEK, NGO	ASAHI Glass Found., AWCI	USAID, ADB-K-Water
Human res.	Local Gov and NGO	Ministry of Public Work, Environment	Tokyo, Hiroshima Tohoku, Kochi	

Current Activities

Research activities play part in developing analysis method and warning system to support climate change adaptation.

- Rainfall Data Analysis in Citarum River Basin
  - Analyzing the importance of database to study historical climate behavior (rainfall, discharge, etc)
- Flood Control Study in Bandung Regency
  - Developing method to analyze flood control solution
- Urban Flood Inundation in Jakarta
  - Developing method to model flood inundation for warning system
- Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model
  - Developing method to analyze forest fire risk

RESEARCH: Rainfall Data Analysis in Citarum River Basin (1)

BACKGROUND

- **Flood disaster** often occurs during rainy season around the Citarum River which flows through Bandung Regency.
- **Lack of water supply** from Upper Citarum River Basin during dry season might disturb water supply for irrigation.
- These problems are associated with **climate change impacts** .
- The climate change adaptation effort have to deals with **common constraints** in Indonesia:
  - 1) lack of hydrological data;
  - 2) high discrepancy in hydrology/drainage computation result using the common computation method;
  - 3) unreliable design of drainage facilities, etc.
- This study emphasizes the importance of solving the constraints for Climate Change adaptation effort in the future.

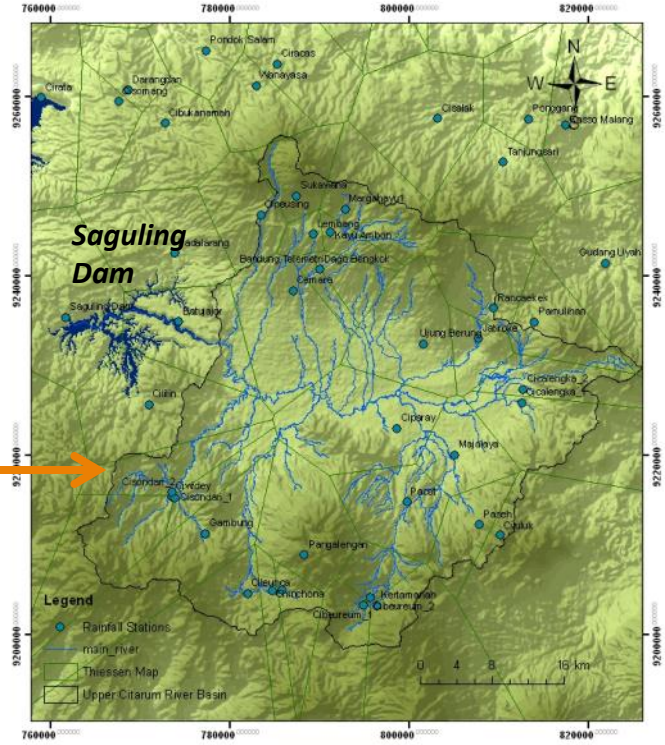
RESEARCH: Rainfall Data Analysis in Citarum River Basin (2)

INDONESIA

STUDY AREA

- **Citarum River Basin** is one of the strategic Basins in West Java, Indonesia.
- **Citarum River** flows from the mountainous area in Bandung, through the 3 cascade dams: Saguling, Cirata, and Jatiluhur, before finally flows to Java Sea.

Citarum River Basin



Upper Citarum River Basin

RESEARCH: Rainfall Data Analysis in Citarum River Basin (3)

Current Condition in Upper Citarum River Basin:

1) Flood in Upper Citarum River Basin

- Overflow of the Citarum River in Dayeuh Kolot Subdistrict is caused by high rainfall intensity and inadequate channel capacity.
- Inundation in Dayeuh Kolot Subdistrict is hard to be drained because of its lowland condition.
- This inundation would bring mud and damage properties.

Source: Natasaputra, 2010.

RESEARCH: Rainfall Data Analysis in Citarum River Basin (4)

Current Condition in Upper Citarum River Basin:

2) Upper Citarum River as Source of Water for Agriculture Area

- The average inflow to Saguling Reservoir in 2010 was 85.6m3/s, while inflow to Cirata and Jatiluhur Reservoirs were 161.2m3/s and 174.1m3/s, respectively.
- Upper Citarum River Basin is the main water supply contributor (49% inflow of Jatiluhur) for drinking water of Jakarta (capital city) and the most developed industrial area of Indonesia (Bekasi, Kerawang and Cikarang).

Source: PJT-II

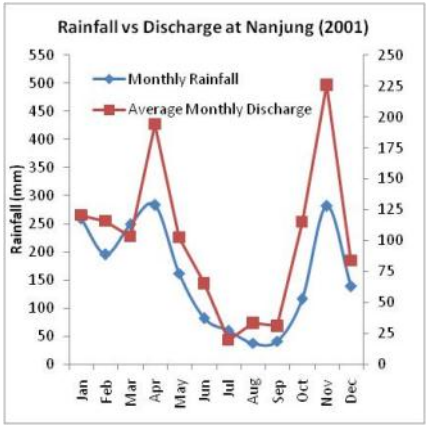
RESEARCH: Rainfall Data Analysis in Citarum River Basin (5)

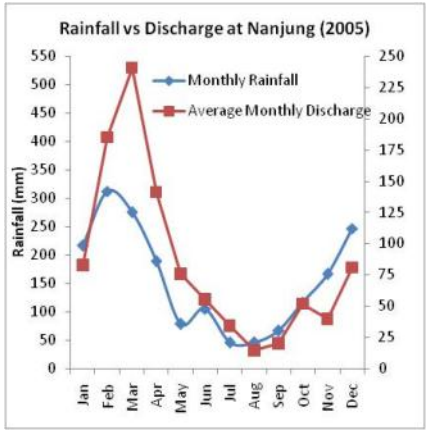
Current Condition in Upper Citarum River Basin:

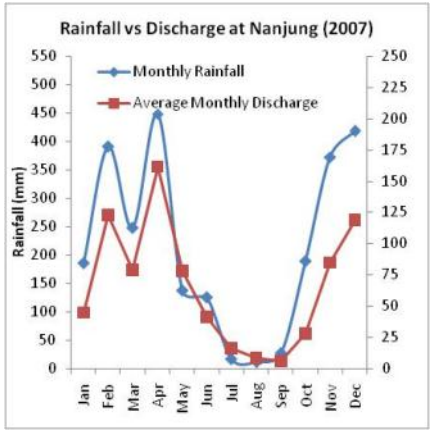
3) Rainfall Runoff Characteristic in Citarum River Basin

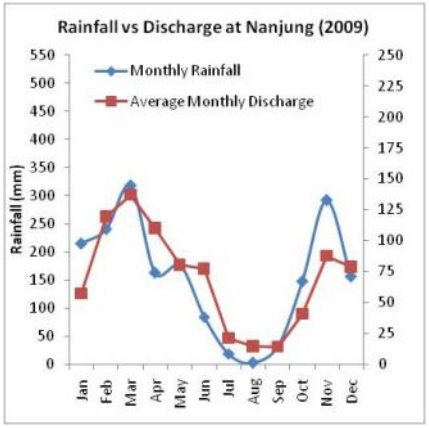
- Rainfall and discharge variability analysis in Upper Citarum River Basin (CRB) is done by comparing discharge stations data in Nanjung (near Saguling Dam inlet) with rainfall area in upper CRB.

- Monthly rainfall seems to have a strong correlation with monthly discharge which indicates the typical of runoff in developed area with high variation between wet and dry season, and relatively low base flow.







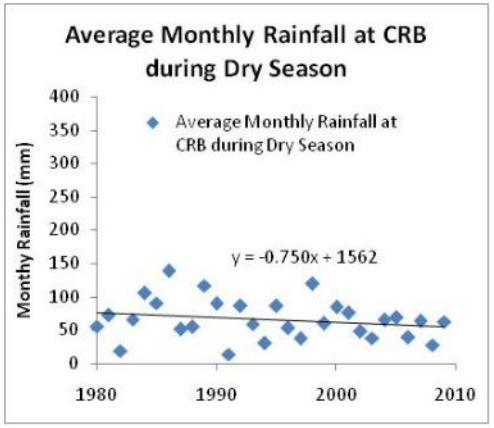


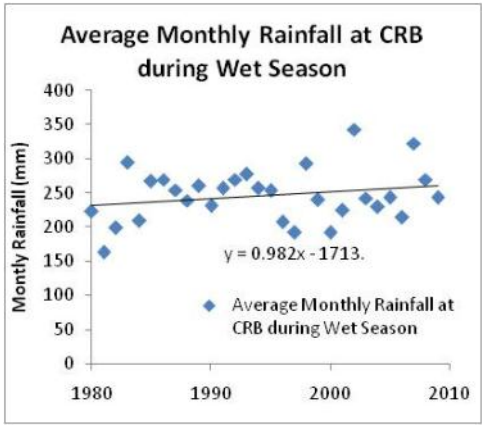
RESEARCH: Rainfall Data Analysis in Citarum River Basin (6)

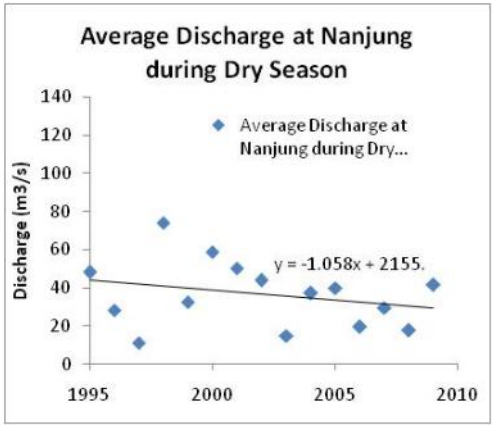
Current Condition in Upper Citarum River Basin:

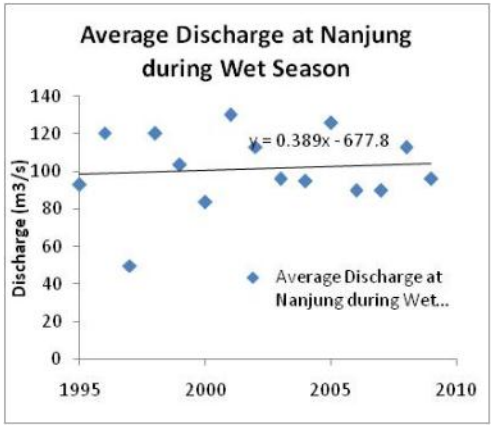
4) Seasonal Rainfall and Discharge Characteristic

- Average rainfall and discharge during wet season tends to increase.
- Average rainfall and discharge during dry season tends to decrease.









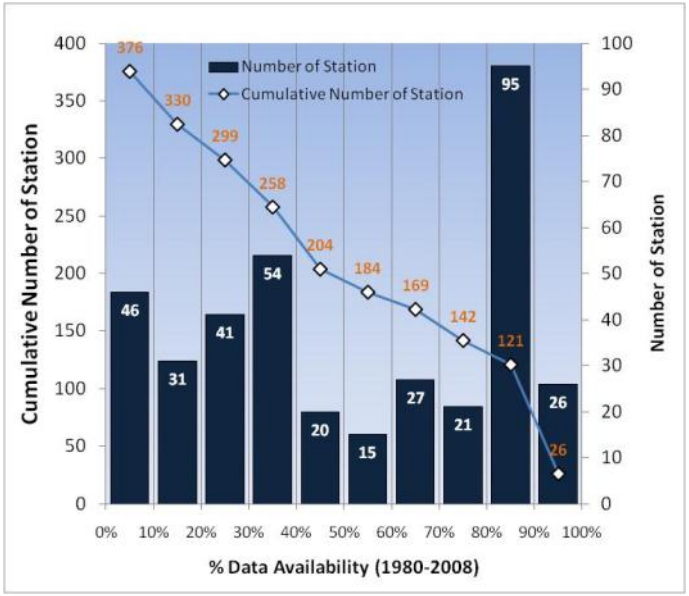
RESEARCH: Rainfall Data Analysis in Citarum River Basin (7)

Current Condition in Upper Citarum River Basin:

5) Hydrological Data Availability

- Analysis from 376 rainfall stations in Citarum River Basin from different data sources for the period of 1980-2008 shows that:

  - Only 26 stations (6.9% of the total rainfall stations) consist of very good data record with data availability more than 90%
  - 142 stations (37.8% of the total rainfall stations) consist of relatively good data records with data availability more 70%
  - 192 stations (51.2% of the total rainfall stations) consist of data records with data availability less than 50%

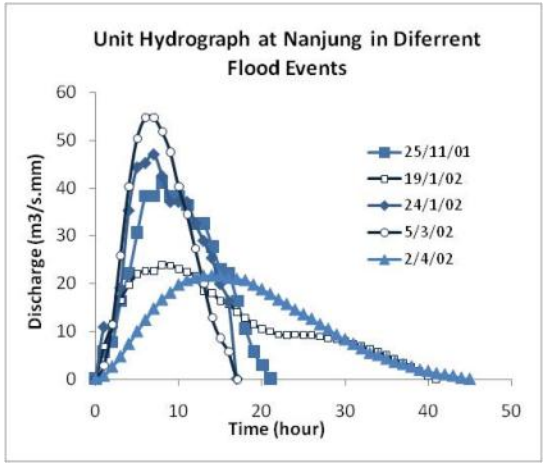


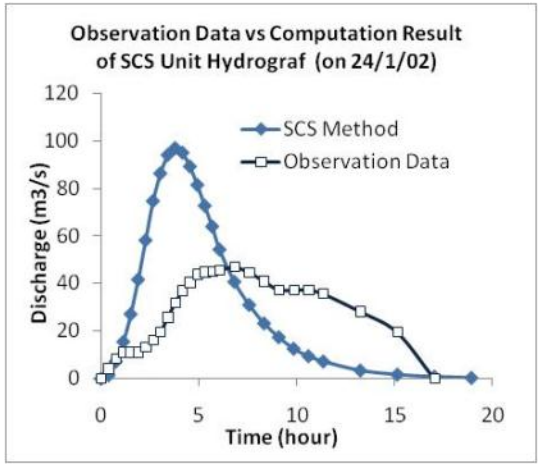
RESEARCH: Rainfall Data Analysis in Citarum River Basin (8)

Current Condition in Upper Citarum River Basin:

6) Hydrology Computation Method

- Most of hydrological computation/method for drainage/flood analysis used in Indonesia was derived in other countries, such as United States and Japan.
- Only few method were derived based on the actual local/regional conditions in Indonesia (might result in discrepancy between computation result and the actual field condition)
- Example of data plot of flood hydrograph based on case study of Nanjung





RESEARCH: Rainfall Data Analysis in Citarum River Basin (9)

Current Condition in Upper Citarum River Basin:

7) Inadequate Water Infrastructures

- Water infrastructure in the downstream of Jatiluhur previously was developed mainly to support irrigation system.
- Rapid land use change during the last decades has resulted in decrease of irrigation area and increase of urban/developed area.
- Irrigation water demand tends to decrease as affected by land use change, while irrigation infrastructures capacity is still in the same.
- This condition might result in the decreasing of water supply efficiency especially during dry season.

RESEARCH: Rainfall Data Analysis in Citarum River Basin (10)

Conclusions (1)

- Upper Citarum River Basin tends to have higher discharge in wet season and lower discharge in dry season in recent year compared to 10 to 15 years ago.
- Change in Upper Citarum River Basin condition is not only affected by anthropogenic factor (land cover change, urban area development), but also affected by changes in climate conditions.
- Plot of rainfall data also shows that average monthly rainfall data in wet season tends to increase, while average monthly rainfall data in dry season tends to decrease.

RESEARCH: Rainfall Data Analysis in Citarum River Basin (11)

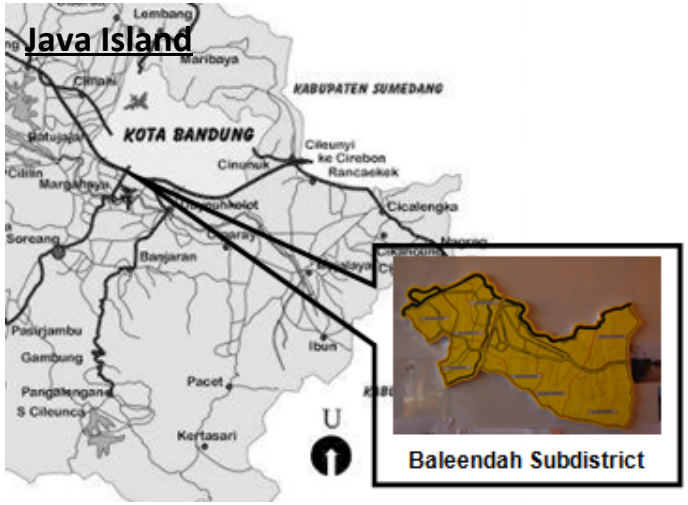
Conclusions (II)

- Lack of hydrological data availability and undeveloped hydrological computational method in Indonesia hint that the preparedness of Upper Citarum River Basin on Climate Change adaptation effort is still far from ideal conditions.
- Further improvement needs to be accomplished for future Climate Change adaptation effort in Upper Citarum River Basin, which might be caused by natural, anthropogenic, and combination between the two causes.
- The improvements are crucial in the sectors of data acquisition, data sharing, management, and the development of more reliable hydrological computation and modeling method.
- These improvements can be achieved by conducting activities and partnership with local and international organizations.

RESEARCH: Flood Control Study in Bandung Regency (1)

Background

- Citarum River, which flows through Bandung Regency, has been affected by climate change in the occurrence of heavy flood disaster in recent years.
- Heavy flood disaster in particular occurs in Baleendah Sub-district, a low area adjacent to Citarum River which is densely-populated.



- Previous solutions such as channel dredging and building dikes have become insufficient, which requires further study to find other alternatives.

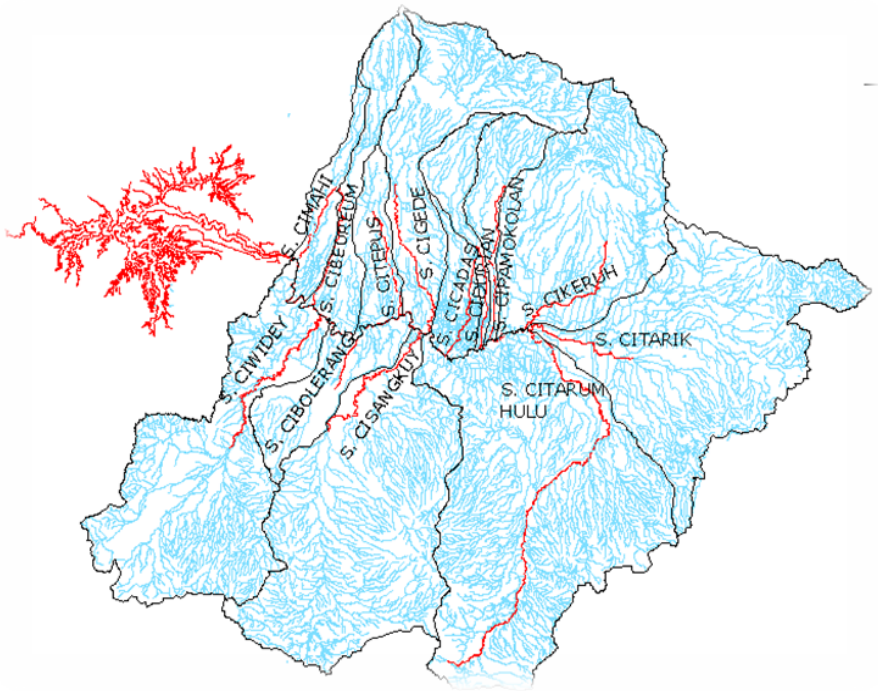
RESEARCH: Flood Control Study in Bandung Regency (2)

Objective

- This study aims in providing alternate solution to flood problem in Bandung Regency, by analyzing all 13 sub-basins of Citarum River which becomes the source of flooding.

- The result is expected to identify the sub-basin which mainly contributes the flood discharge of Citarum River.
- Flood control measurements can be prioritized on the problematic sub-basin to minimize flood discharge load to Citarum River.

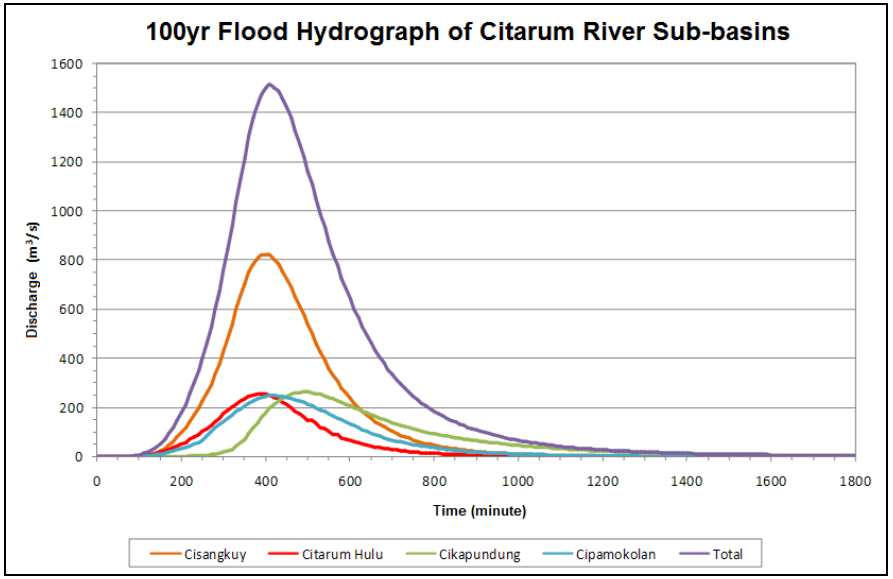
Upper Citarum River Sub-Basin Network



RESEARCH: Flood Control Study in Bandung Regency (3)

Flood Hydrograph Modeling

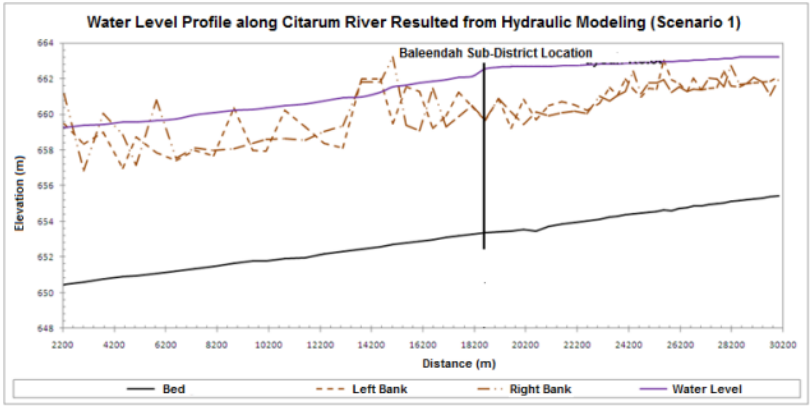
- 100 yrs flood hydrograph is obtained using basin modeling with HEC-1 for each sub-basin. Initial modeling includes 4 sub-basins which are Cisangkuy, Citarum Hulu, Cikapundung and Cipamokolan
- Input parameters include:
  - 100 yrs regional rainfall
  - Sub-basin characteristics: topography, land use and land cover as Digital Elevation Model (DEM) downloaded from Consultative Group on International Agricultural Research – The Consortium for Spatial Information (CGIAR-CSI) website.
  - Flood routing method (Muskingum Cunge which has been widely applied and mostly gives good/accurate results)

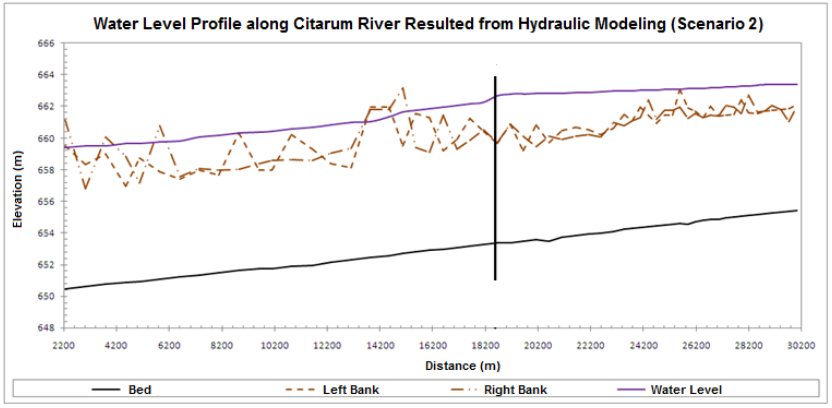


RESEARCH: Flood Control Study in Bandung Regency (4)

Hydraulic Modeling

- 1D flow modeling with HEC-RAS is done to identify overflow potential along Citarum River when it is flowed with flood hydrograph from the four studied sub-basins.
- There are 2 modeling scenarios:
  1) Simultaneous rainfall occurance on all four sub-basins. In this scenario all flood hydrographs are inputted at the same time.
  2) Extreme condition in which the peak discharge of four flood hydrographs simultaneously enter Citarum River.





RESEARCH: Flood Control Study in Bandung Regency (5)

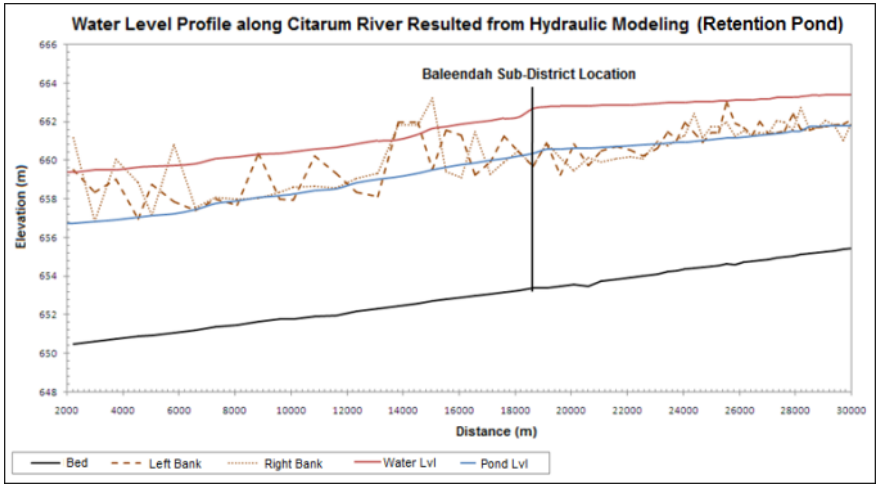
Flood Control Analysis

- The results of modeled hydrograph (of initial 4 sub-basins modeling) show that Cisangkuy gives the highest flood discharge contribution to Citarum River.
- Flood control analysis to reduce discharge contribution of Cisangkuy Sub-basin is planned as retention pond.
- Considerations for choosing retention pond:
  - Capable of temporarily storing flood discharge from the sub-basin to delay it entering Citarum River.
  - Capable of controlling hydrograph outflow to Citarum River to avoid simultaneous peak time of all hydrograph.

RESEARCH: Flood Control Study in Bandung Regency (6)

Flood Control Result

- Required retention pond dimension is obtained with HEC-HMS modeling which produces flood hydrograph of Cisangkuy Sub-basin that has lower value than the initial result (without retention pond).
- The reduced Cisangkuy flood hydrograph is modeled again in HEC-RAS. The result shows flood HWL reduction in Citarum River, in which overflow still occurs but in minor state.



RESEARCH: Urban Flood Inundation in Jakarta (1)

Background

- Urban flood has been an enormous problem for many cities in the world.
- Appropriate model for urban flood prediction is necessary in order to support decision maker in urban planning.
- Flood in urban area has different characteristic compare to flood in rural area.
- Developed model should consider physical based process in order to represent natural phenomena of urban flood

RESEARCH: Urban Flood Inundation in Jakarta (2)

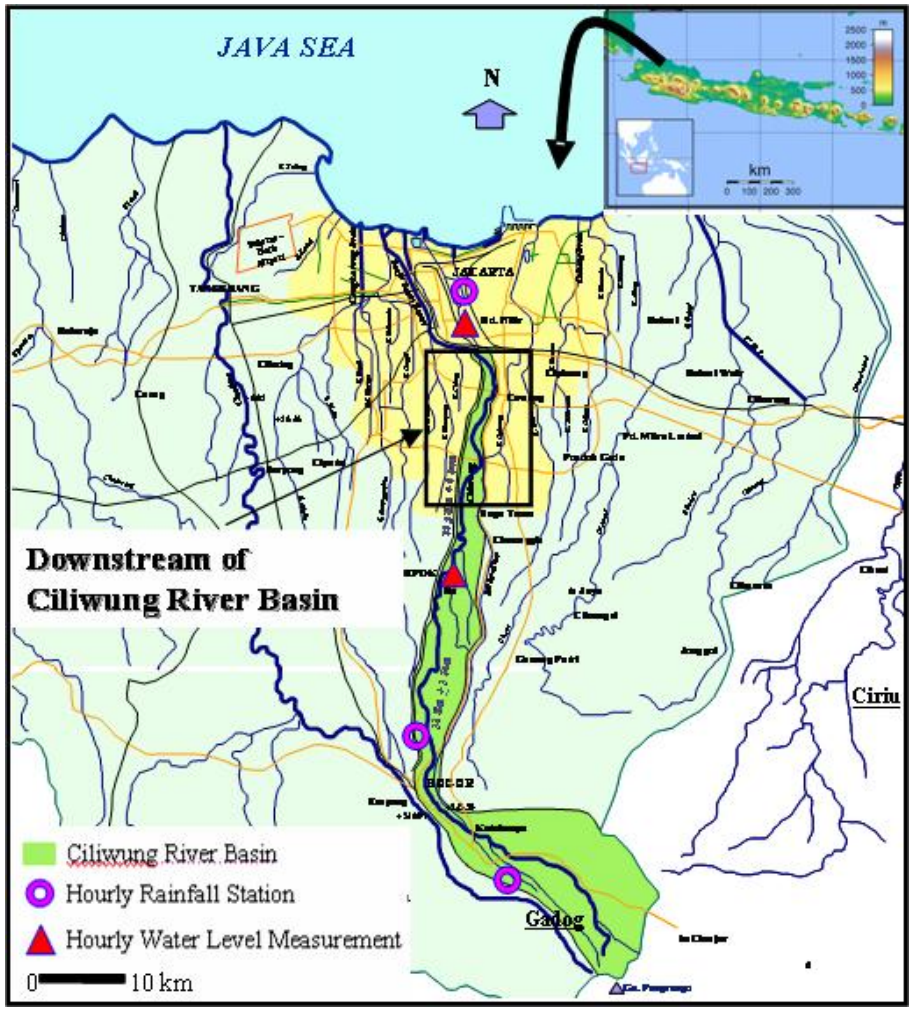
INDONESIA

Objective

- To develop integrated urban flood model with rainfall-runoff process in dense building area considering physical based process.

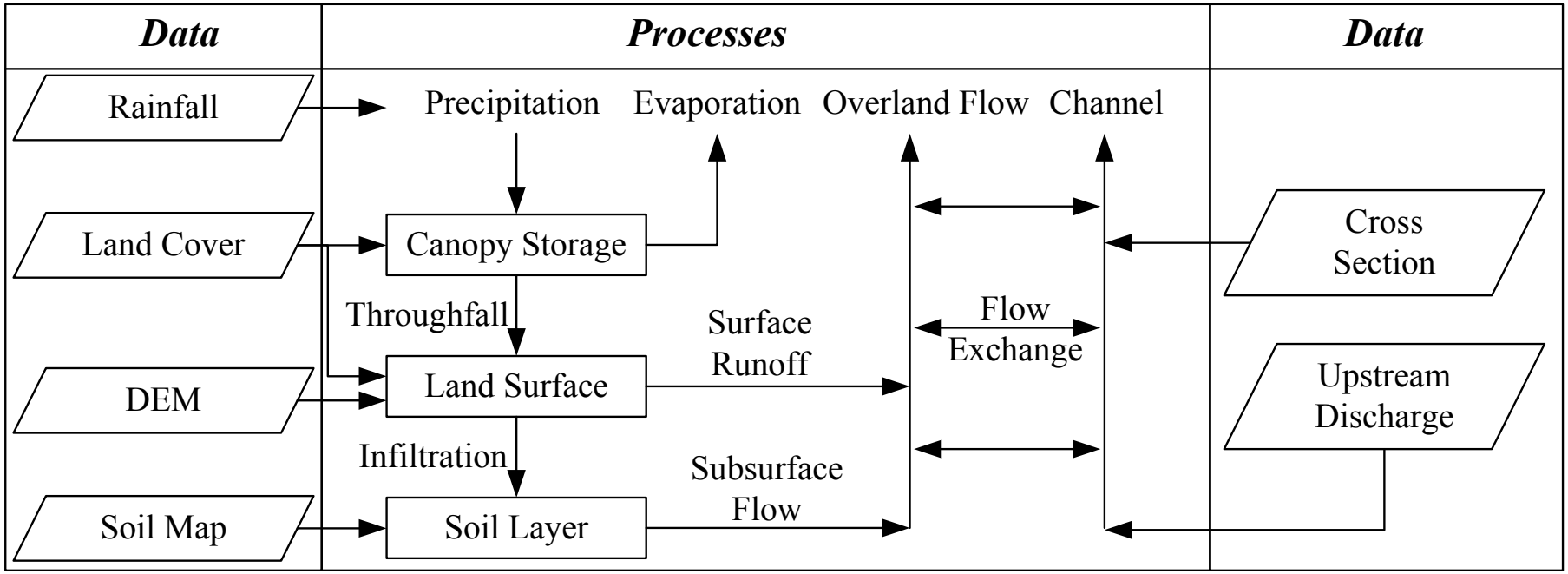
Study Area

- Downstream part of the Ciliwung River basin in Jakarta, West Java, Indonesia.
- 38 km2 of catchment area and 20 km of river length.
- Located around central activities in area with high density of building.



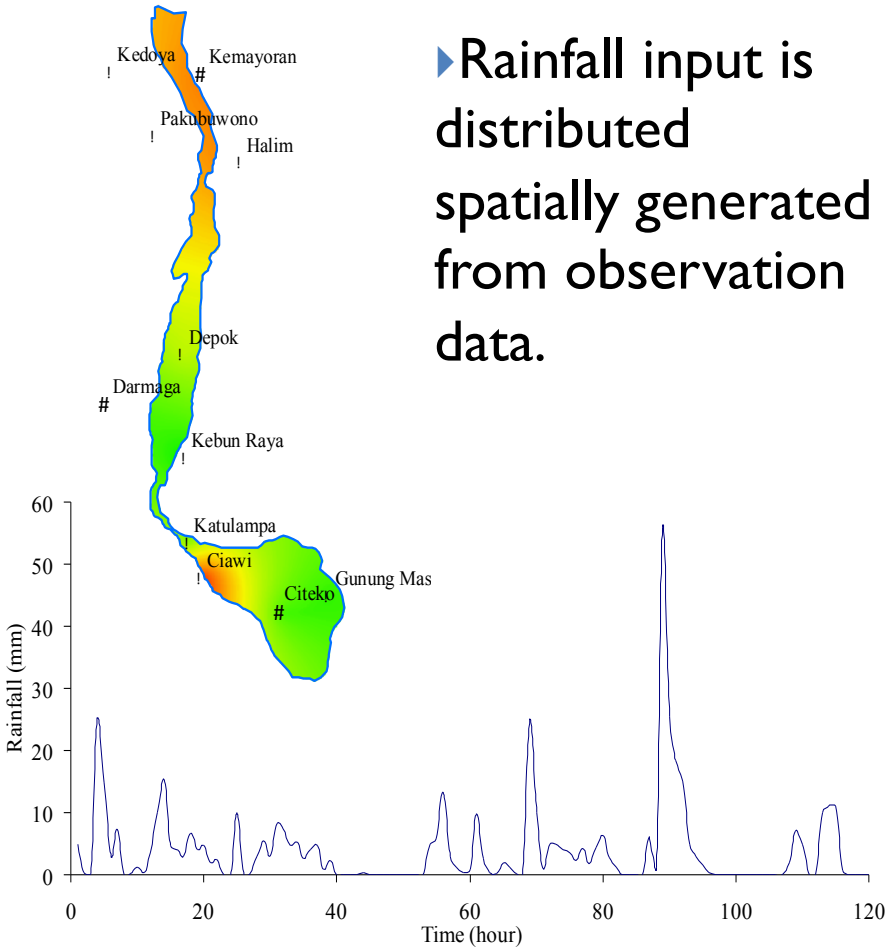
RESEARCH: Urban Flood Inundation in Jakarta (3)

Model Development



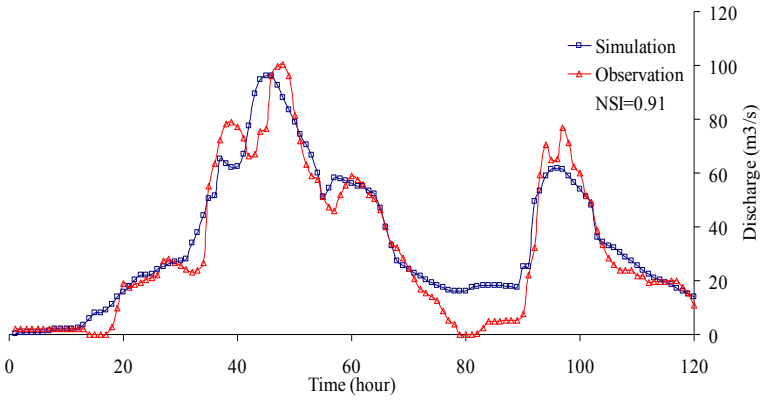
RESEARCH: Urban Flood Inundation in Jakarta (4)

Model Scenario



- Rainfall input is distributed spatially generated from observation data.

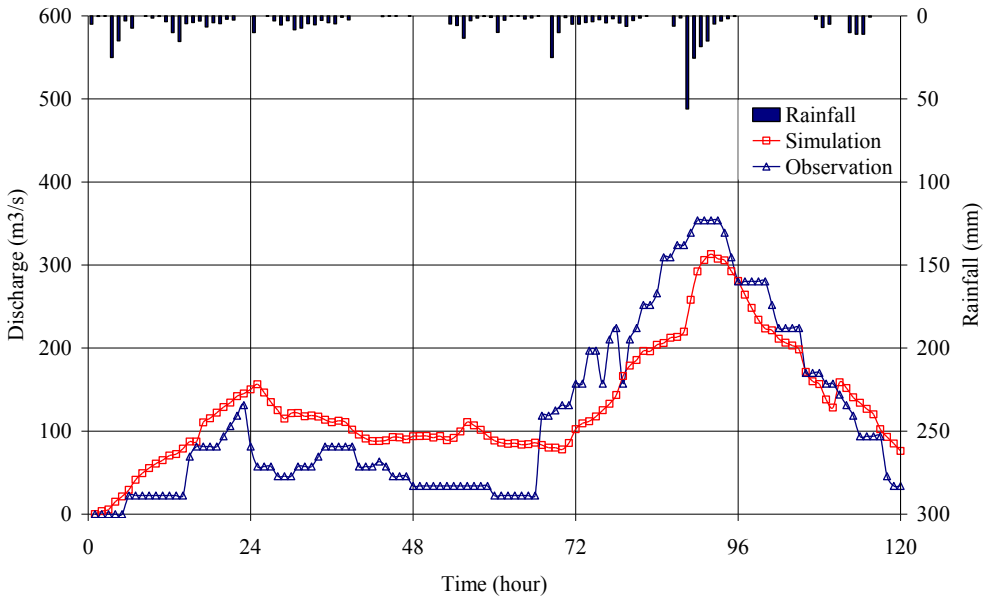
- Discharge input is generated from upstream model output which has been verified with observed data.

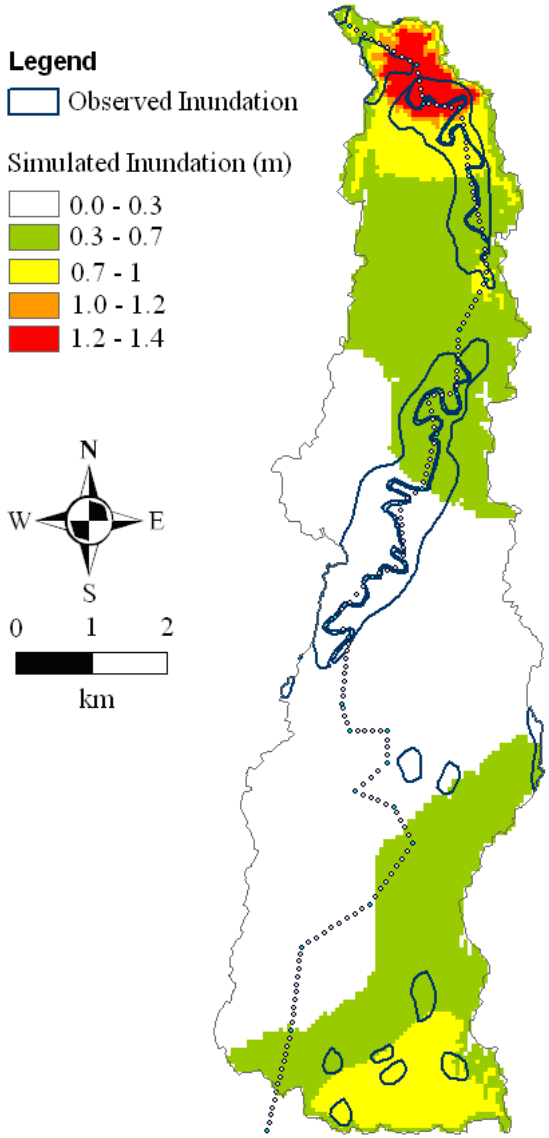


RESEARCH: Urban Flood Inundation in Jakarta (5)

Model Result

- Good agreement is shown by comparison to observed data with high value of Nash Sutcliffe Index of 0.75.





Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model (1)

INDONESIA

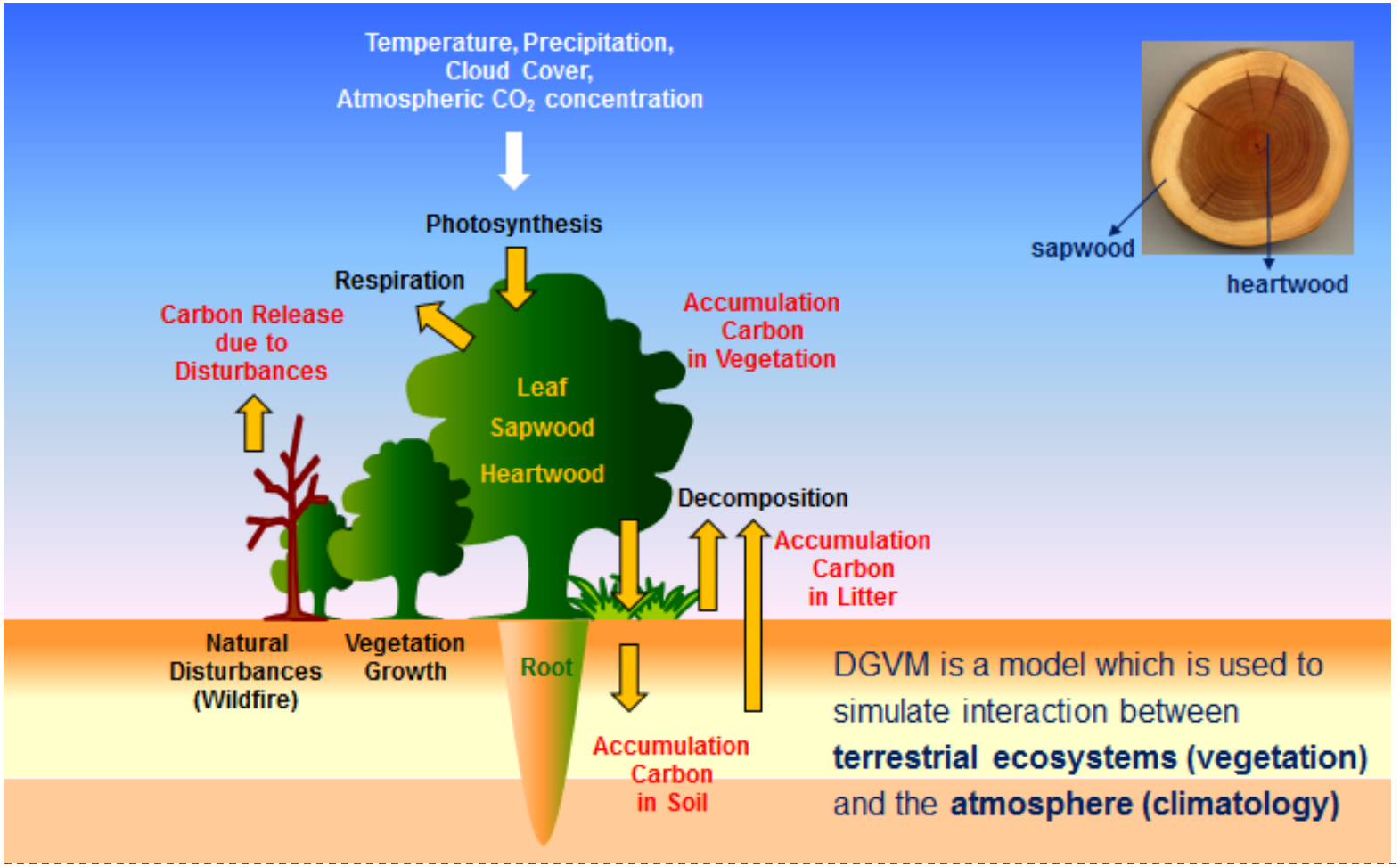
Background

- During 1997/1998 forest fire, from about 8.1 million ha area affected by fire in Kalimantan, 1.1 million ha (13.5%) was in peat and swamp forest (Tacconi et al, 2007).
- Total carbon released to atmosphere during 1997/1998 forest fire in Indonesia was estimated between 0.81 to 2.57 GtC, 78% resulted from peat combustion (Page et al., 2002)
- **Climate change might lead to the increase of drought intensity** which result in lower water table in peatland, and intensifies peat decomposition, removing 40% to 86% soil organic carbon in the next 100 years (Ise et al, 2008)
- In this study, the **effect of climate change to drought and variation of soil water level** was simulated by using LPJ- DGVM to estimate the occurrence of forest fire in Kalimantan.

Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model (2)

INDONESIA

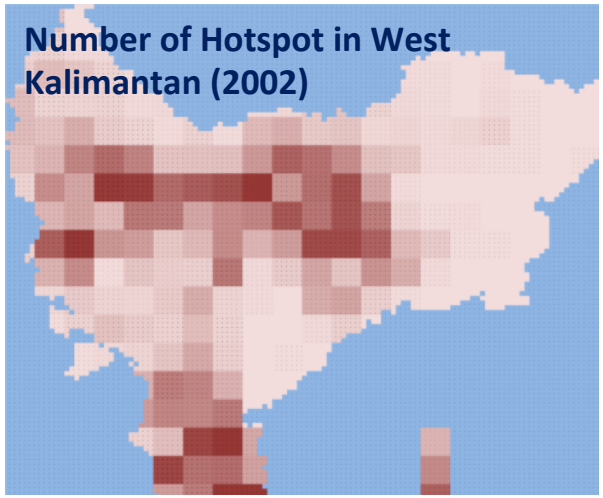
Objective and Methodology

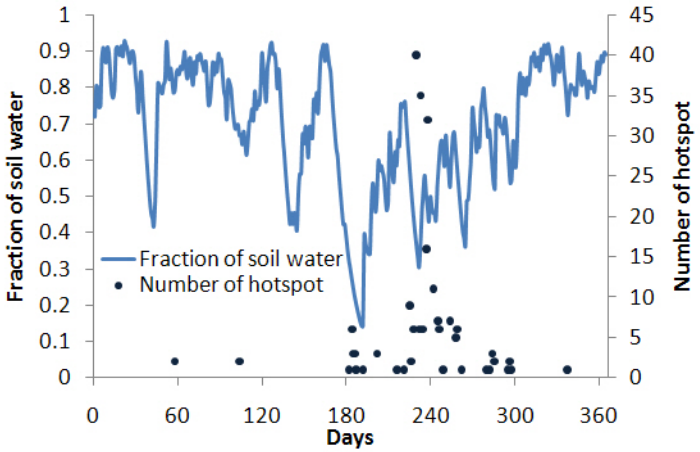


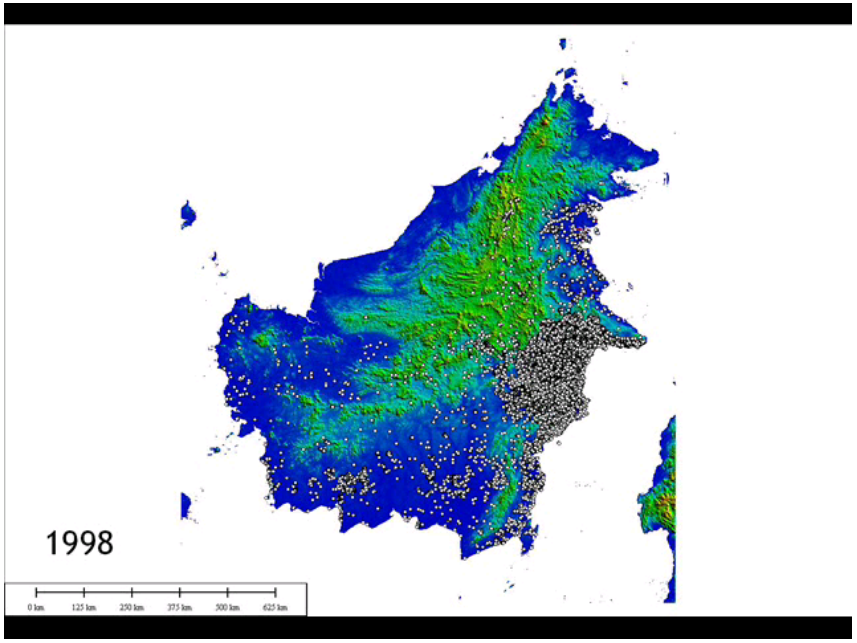
Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model (3)

INDONESIA

Spatial Distribution of Fire (Hotspot) in Kalimantan







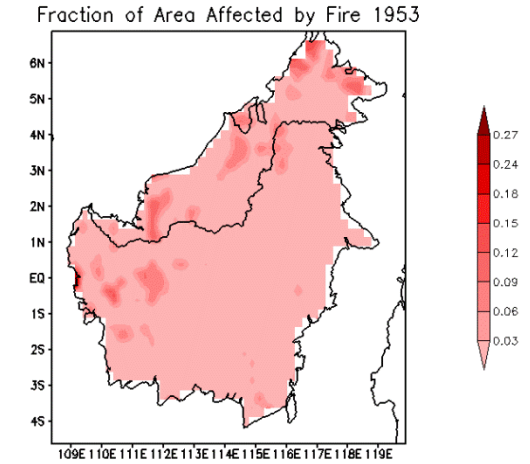
Hotspot in Kalimantan over Years

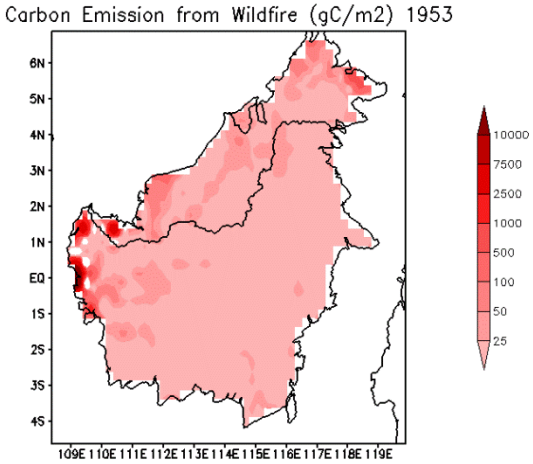
- Number of hotspot is highly increase after certain level of soil water content
- The relation between number of hotspots and soil water can be used to predict fire probability index

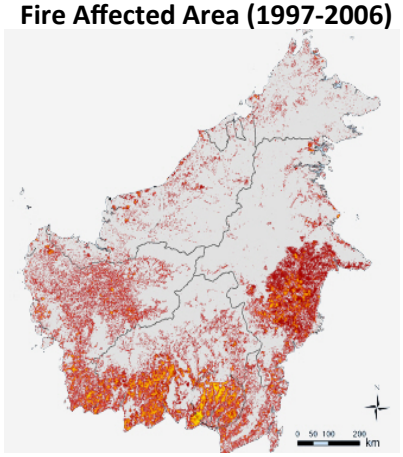
Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model (4)

INDONESIA

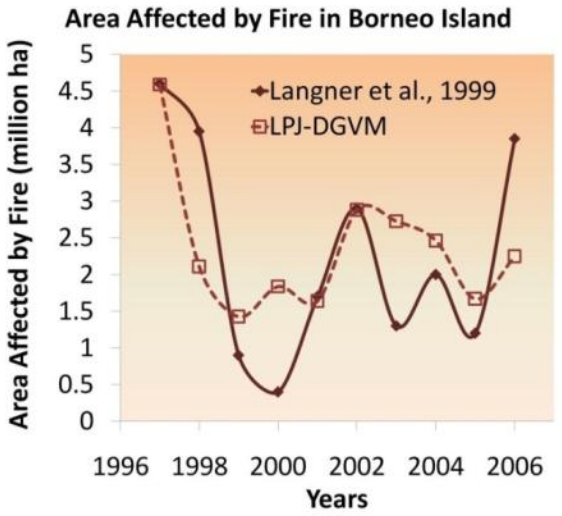
Simulation Result: Area Affected by Fire







Langner & Siegert (2009): Compiled from NOAA AVHRR and MODIS hotspot



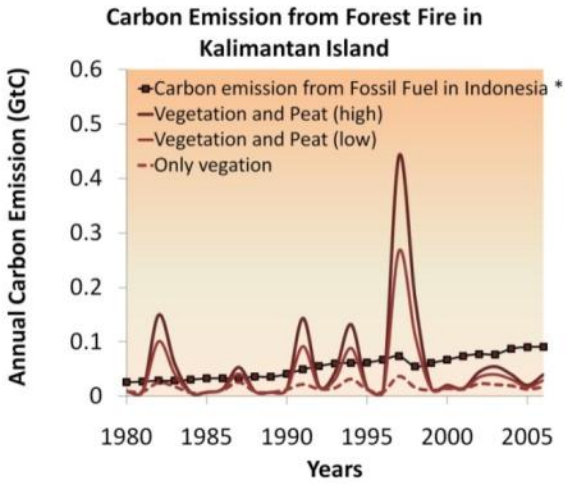
- **Langner & Siegert (2009)** use **satellite data** from NOAA AVHRR/ ATRS hotspots (1997-2001) and MODIS hotspot (2002-2006) to analyzed the area affected by fire in Borneo Island.
- Simulation in the **North of Borneo** tends to be overestimate (due to the absence of air humidity in defining fire occurrence). In **East Kalimantan**, high emission is predicted from area to the North of Samarinda, with slightly overestimate in the area near Tarakan. In **West Kalimantan**, simulation result shows similar pattern with the satellite data.

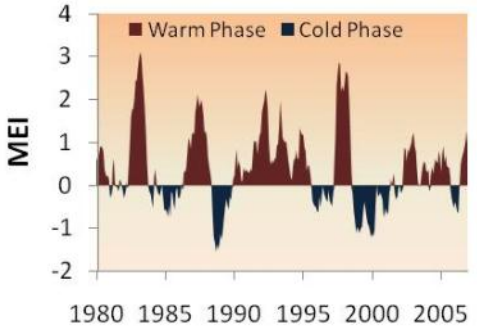
Risk Assessment of Forest Fire Generated by Potential Water Scarcity Model (5)

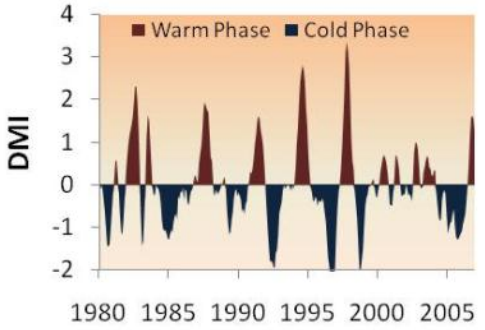
INDONESIA

Simulation Result: Carbon Emission from Forest Fire

- Based on this 1997-1998 forest fire, **three scenarios** of fire emission are used:
  1) **High scenario** by assuming ~50cm of peat is burned,
  2) **Low scenario** by assuming ~25cm of peat is burned, and
  3) by assuming **no peat fire**.
- The **average carbon emission** from 1980 to 2006 is between **0.02 GtC/year** (for no peat scenario) to **0.06 GtC/year** (for high scenario).
- During 1997-1998, the total carbon emission from forest fire is between **0.05GtC** (for no peat scenario) to **0.62GtC** (for high scenario).
- During **extreme drought**, carbon emission from forest fire might be **higher than carbon emission from fossil fuel**.







Issues and needs

- Regionally common issues:
  - difficulty in quantifying the correlation of climate change to hydrologic parameters (local and regional such as La Nina/El Nino
  - intensification of variability
    - heavy rainfall: increment in non-uniformity, intensity, and frequency : eg Citarum River (Bandung Basin , West Java), and Ciliwung River (Jakarta). Scattered flood event occur in other area.
    - dry spell: longer period in arid area and scattered extreme occurrence found in other areas but data not available
    - small tornado (puting beliung): increasing occurrence on land (where originally it occurs on the sea).
    - wet and dry season period are shifting

Issues and needs

- Regionally common issues:
  - Available capability/resources:
    - Limited research fund from government and universities to study the impact of climate change to water resources management (flood, drought and food security).
  - Lack of capability:
    - Monitoring :
      - only for strategic-major rivers (such as Citarum, Bengawan Solo, Brantas, etc.) under River Authority (Balai Besar Wilayah Sungai)
      - Difficulty for automatic monitoring due to social problem in maintaining instruments
    - Modeling
      - Limited access to the available computer modeling regarding climate change
      - Limited resources to perform climate model.

Issues and needs

- Regionally common issues:
  - Inventory of water resources
    - Identifications of water resources issues in Indonesia have been done thoroughly, yet the database available to support problem-solving study is very limited.
    - This limited database problem is related to lack of monitoring and prioritization to create a sufficient water resources database.
  - understanding planning & management
    - Updated efforts in building code not yet available
    - Lack of knowledge of decision maker in climate change

Issues and needs

- Critical and specific issues:
- Water Quality Dynamic
  - Generated by water quantity (budget) variation
- Sea level rise
  - High tide flooding are worse in several big cities in Java Island eg in Jakarta the rate is 0.57 mm/year.
- Depletion of ground water
  - Ground water level is mainly falling down and generate further sea intrution in coastal area
- Trans-boundary and international coordination (MRC)
  - Need improvement to empower its cooperation
- Shifting snow residency, melting period, snow-line
  - The snow covered area in Jayawijaya mountain was identified decreasing from 20 km^2 to only 2 km^2 now.

Future Activities

- Specific request to GEOSS and to international community (data/tools accessibility)
- Inventory and summary directory – what kind is needed in your specific case
  - Hydro-climatology data
  - Hydraulic structure
  - Operation and maintenance
- Data request function responding to new needs – what kind of function
  - Early warning
  - Risk assessment
- Data access and information exchange
  - Online based accessibility
- Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose
  - Mitigation (structural and non structural)
  - Planning and evaluation (monitoring and long term river basin development planning)
  - Operation (water supply-demand and reservoir system)
  - Management (water resources and water quality)
- Regional office and/or data center – what kind of function you expect for the office
  - Center for data base management for sharing and exchanging

Future Activities

- Coordination between water cycle integration and capacity development strategy
- - Identify contents of capacity development needs in your country
  - awareness to adapt issue related water and climate information
  - capacity improvement to analyse data and information, risk assessment and adaptation of climate change
- Synchronize capacity development of national implementation programme-regional progamme
  - Data Base Development : need support for related atmospheric data, land use change and instrumentation for ground observation
  - Risk assessment : need support for bias modelling and rain.
- Training for not only researchers but also practitioners from top level to operator/technician's level.
  - Updating existing method of assessment for flood hydrograph and depenable flow
  - Capacity building of local people of the flood prone area to live with flood
- Short term capacity development workshops.
  - Developing risk map, evacuation map for local people of the flood prone area
- Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)
  - ADPC, AWCI
- Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation.
  - PROMISE Project, USAID for Jakarta City in collaboration with ADPC and Jakarta Province.

Future Activities

- **Empowering Network**
  - AWCI/Tokyo University for Data Base Development and assessment capacity improvement
  - APN submission...??
  - LAPAN : Data sharing and research
  - Hiroshima Univ., Tohoku Univ. For research
  - Ministry public work : education and training
- **Education / Training**
  - Apllication of updated curricula of Master Study Program on Water Resources Engineering
  - Preparing the opening of Water Resources Engineering for engineer/bachelor degree
  - Exchange program for faculty member and student : looking for partner
  - Training for private institution and government official (ministry of public work and Environment)
- **Research**
  - Foccus on Citarum river and Kalimantan :
    - Research proposal for DGHE (Directorat General of Higher Education)
  - Looking other opprtunity for research funding..:
  - APN submission...??

THANK You

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Website: http://www.ftsl.itb.ac.id/kk/water_resources_engineering/