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Research Issues on Water Disaster Management and Climate Change in West Java Island, Indonesia

Prof. Dr. Ir. Muhammad Syahril Badri Kusuma

Research Division on Water Resources Engineering

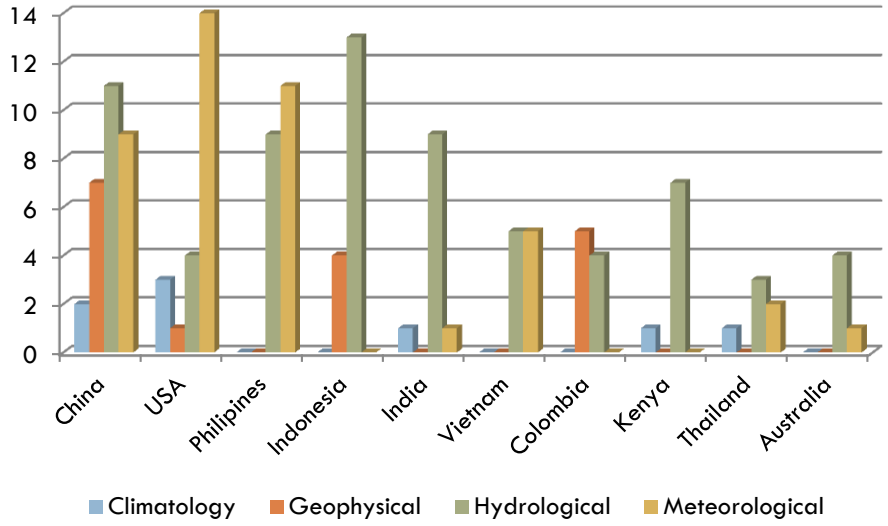
INSTITUT TEKNOLOGI BANDUNG

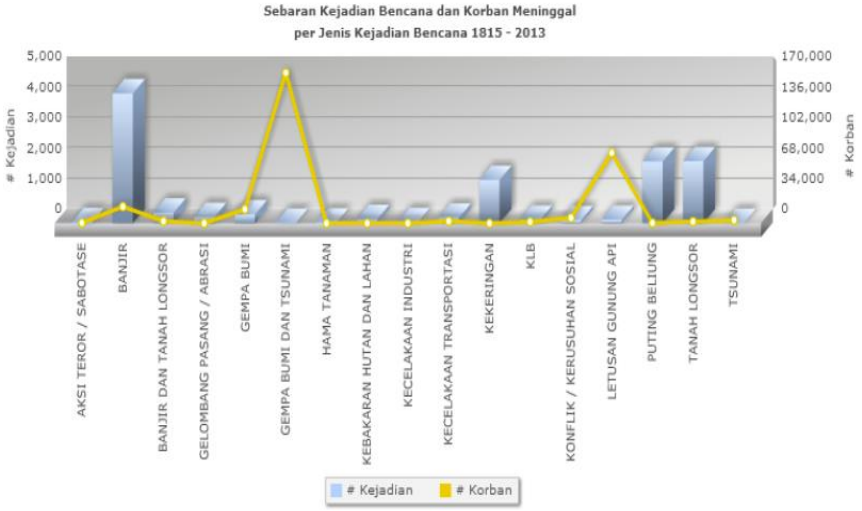
2015

Topics of Discussion

1. Water Disaster Management and Climate Change in West Java, Indonesia
2. Research Activities and Contribution
3. Conclusion

Water Disaster Management and Climate Change in West Java, Indonesia





Disaster	Natural	Man Made	Main Disaster	Collateral Disaster
Flood	V	V	V	V
Fire	V	V	V	V
Drought	V	V	V	V
Earthquake	V		V	V
Tsunami	V			V

Strategic Issue how to contribute :

- Limited Resources for too many disasters cases
- Optimized effort tend to Disaster Risk Reduction (DRR)
- Selected Research on the most priority for supporting DRR program

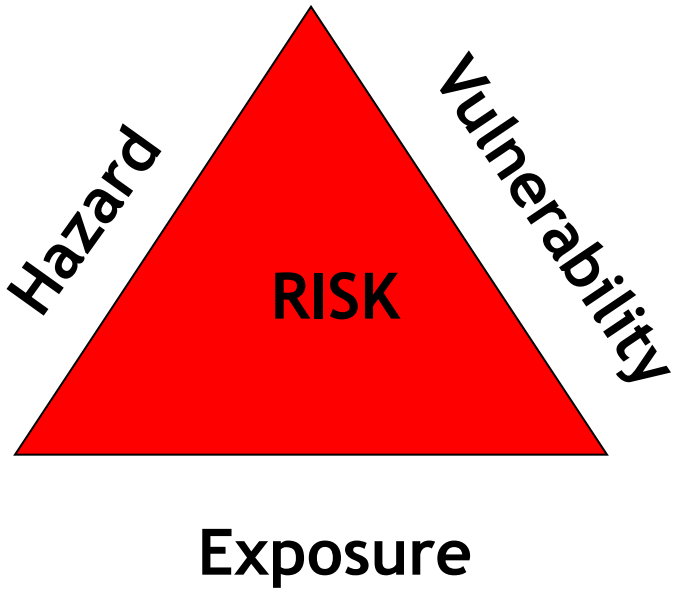
Water Disaster Management and Climate Change in West Java, Indonesia

Risk Concept:

(Harkunti PR, 2008)

The probability that a community's structure or geographic area is to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction, and proximity to a hazardous area

The Risk Triangle:

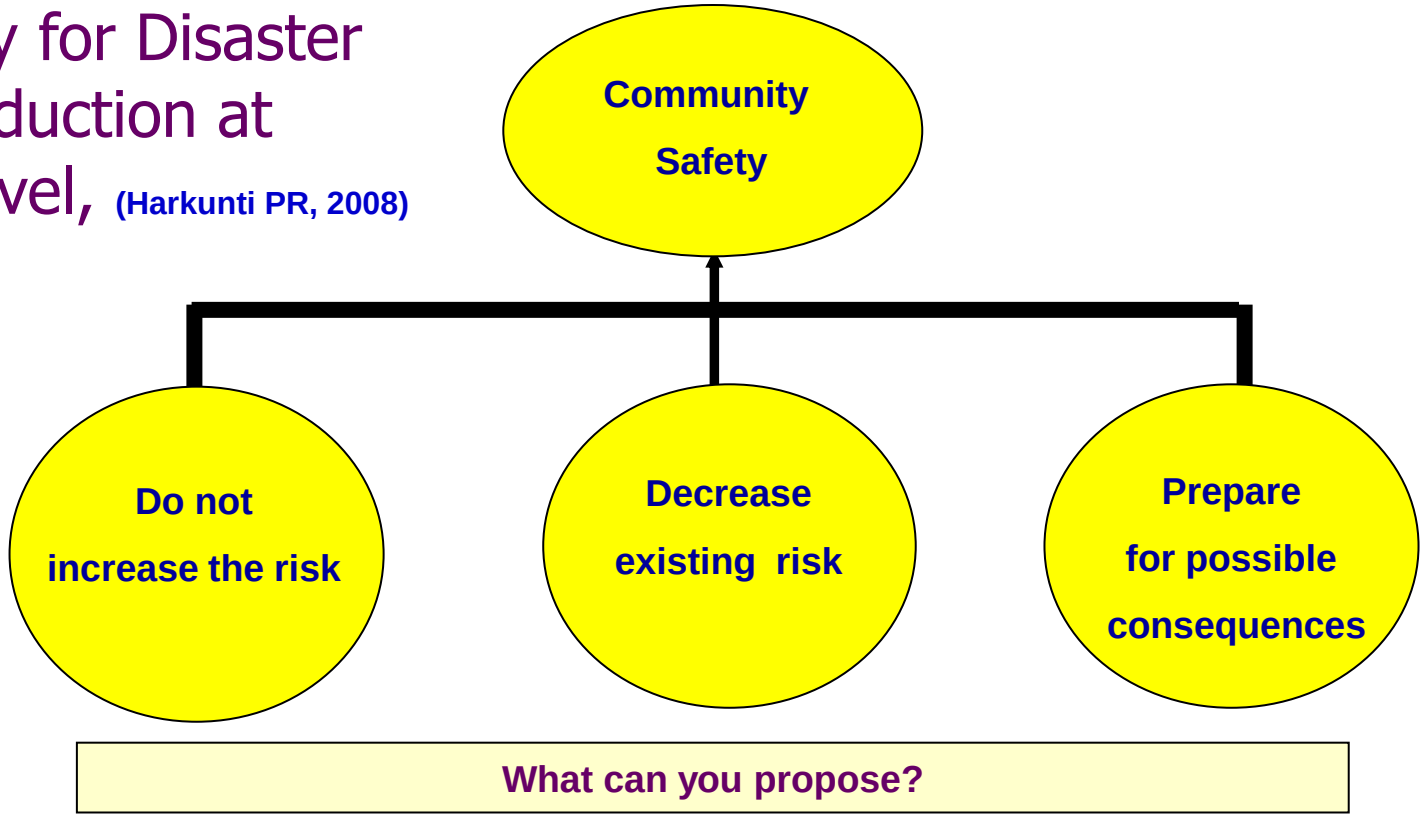


If size of any one of the components increases, the level of risk also increases.

Growing Risk should be reduced through a comprehensive approach with a strategy to manage all three components.

Water Disaster Management and Climate Change in West Java, Indonesia

Strategy for Disaster Risk Reduction at Local level, (Harkunti PR, 2008)



What can you propose?

Long term DRR can be achieved through emergency response planning, Practices to promote mitigation & Preparedness, creating safer shelter, infrastructure and lifeline facilities in order to **make the development actions are sustainable**

Water Disaster Management and Climate Change in West Java, Indonesia

Optimized DRR Program :

- Most Frequent/Probable event → eg Flood
- Highest Risk → Local, National and Regional Impact
- Most applicable of Sustainable Solution → Common Practice of the most adapted to the local people
- Immediate Impact → Political View

Type of DRR Program :

- Improve the existing Capacity → Structural (Infrastructures) and Non Structural (Local People)
- Decrease the Hazard → Long term conceptual effort, unrealistic
- Prepare Most Probable Consequence → Short Term

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

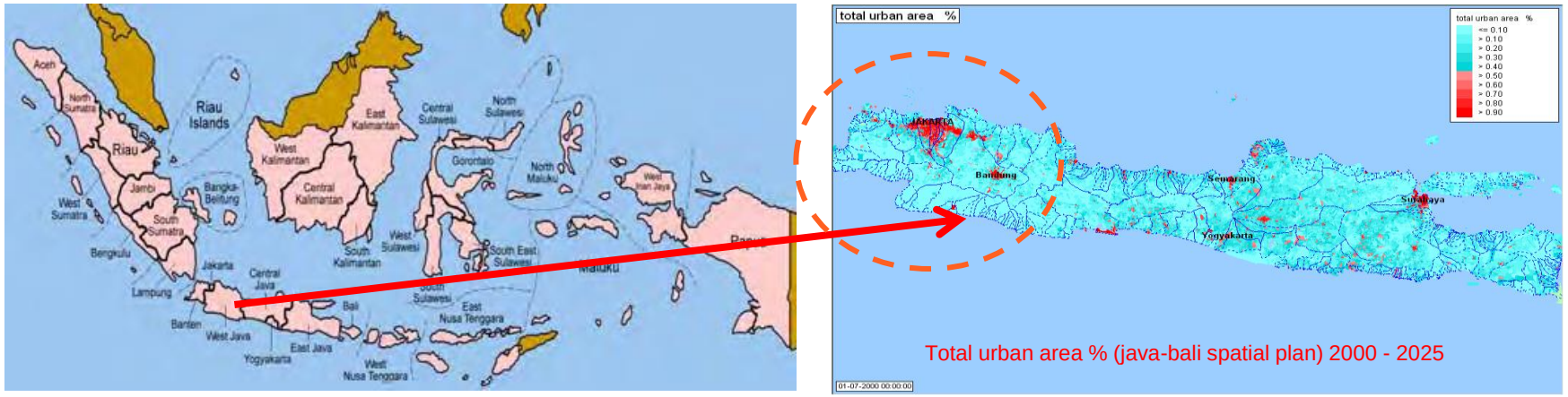
- Most frequent and a well known disaster in Indonesia
- Caused by :
  - Maximum annual rainfall → current discussion — **Regular**
  - Extreme climate : La Nina
  - Tidal surge→ Rob
  - Tsunami

  } **Irregular**
- Collateral disaster :
  - Famine and Epidemie
  - Environment disaster
  - Economic failure
- Type of flood disaster :
  - Disaster Scale
    - Small scale : bad drainage/flood control system → under designed or chucking
    - Large scale : Increasing flood hydrograph due to the catchments area degradation or climate change and tsunami
  - Flood sources :
    - Local: Maximum annual of daily precipitation
    - Distance Flood : propagated flood from upstream area or tsunami

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

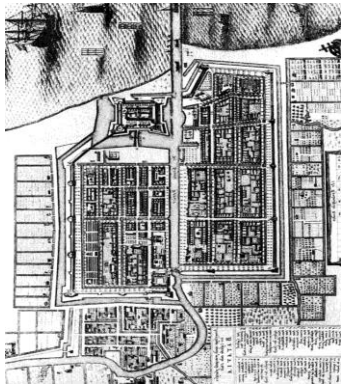
- **Regular Flood** (up to 200mm/day)
  - Early warning system is available (from very poor to poor)
  - Vulnerable community trying to live with→ affordable/acceptable losses.
  - Constraint : unresolved social economic problem → political and high cost/technology solution
- **Tsunami**
  - Most unpredictable → historical/hypothetical data are available
  - Less structural mitigation→ Focused on emergency response and TEWS
  - High risk : unacceptable losses/damages
  - Most of the survivor resisting to going back to their vulnerable home land.
- **La Nina**
  - Amplified warning → effective loss reduction
- **Tide Surge**
  - Bad assessment →less prepared/awareness
  - In accurate assessment of Sea Level Rise and Land Subsidence

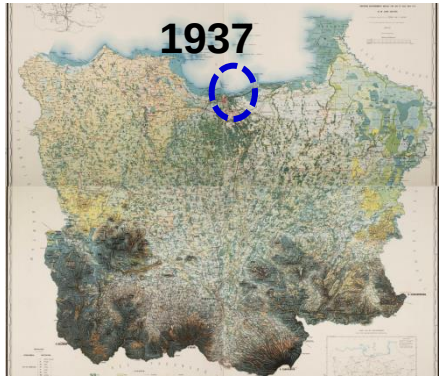
Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

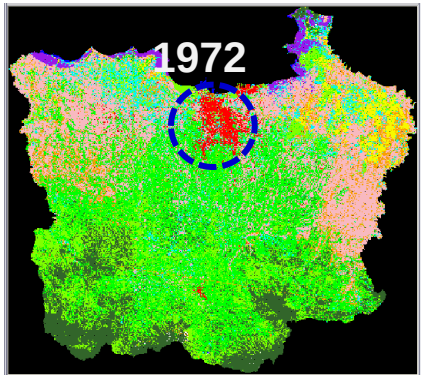


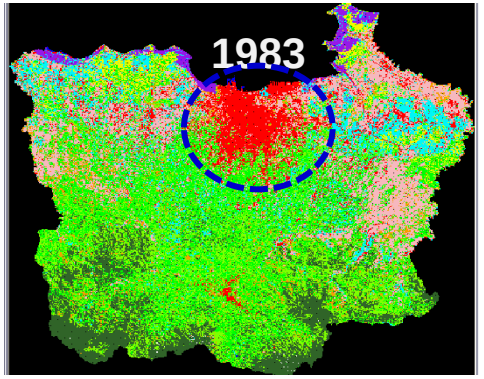
- Most Populated and Developed Area in Indonesia→ highest contribution for National Development with more than 60 % of Indonesian GDP/GNP
- Jakarta, West Java and Banten Provinces
- Water Related Disaster and Climate Change : Flood, Tsunami, Drought, Coastal Degradation, Sea Intrusion, Baby Tornado (Puting Beliung), Forest Fire, Ground Water etc.

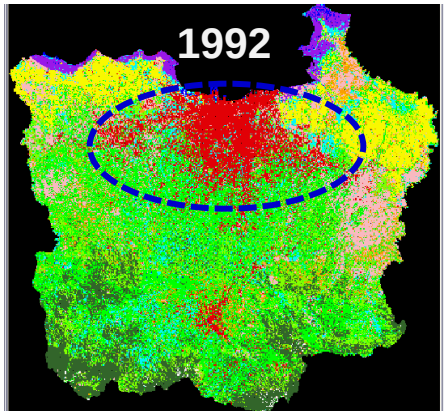
Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

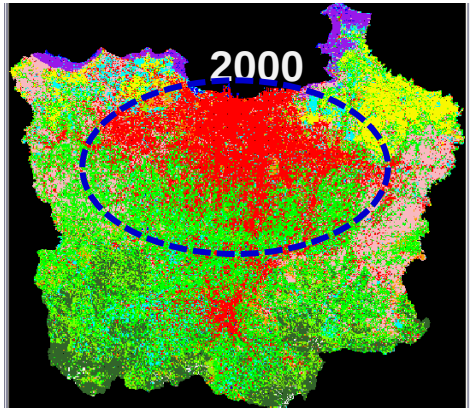


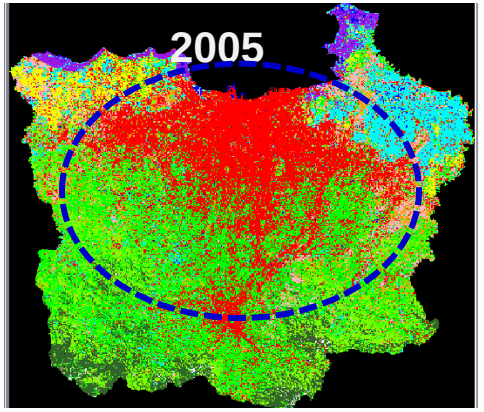






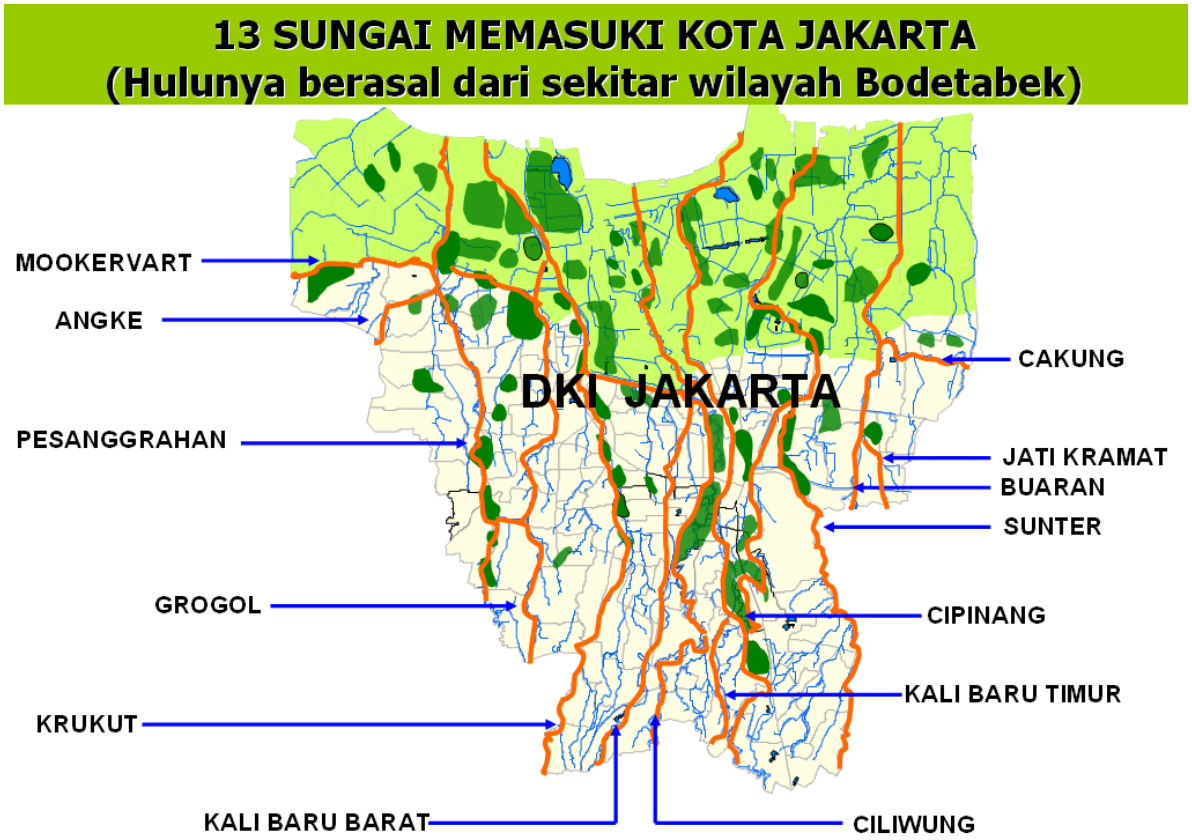






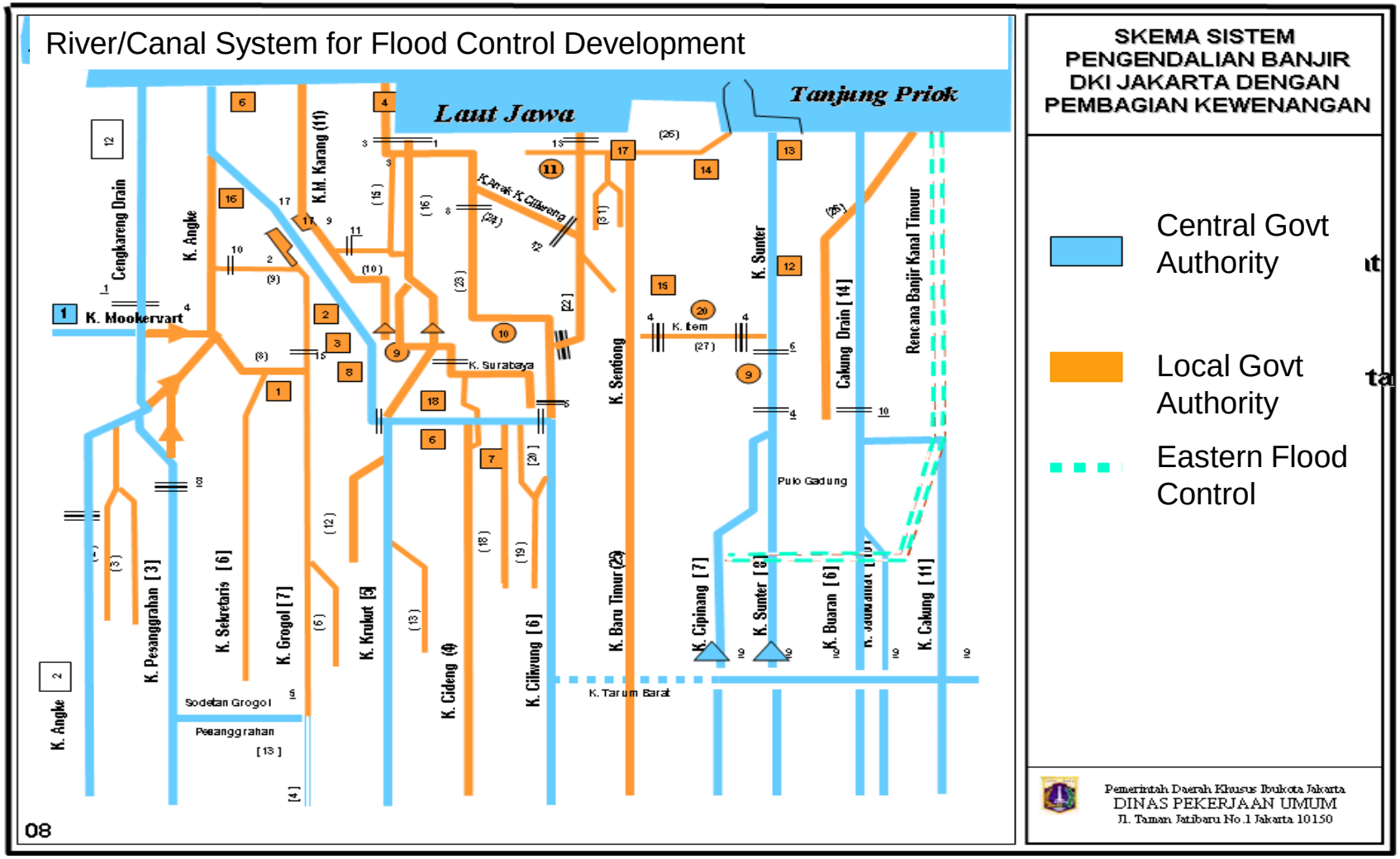
Jakarta in VOC era (fist column : Top, Berkeley WEB, Below Delft WEB) and current condition (rest of the columns, DKI)

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



- 40 % of ± 65.000 Ha is below sea level

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



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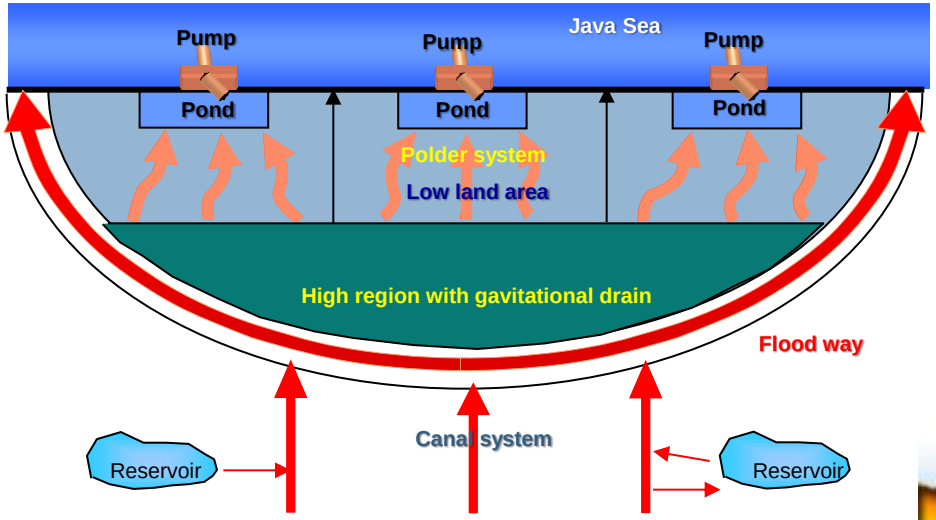
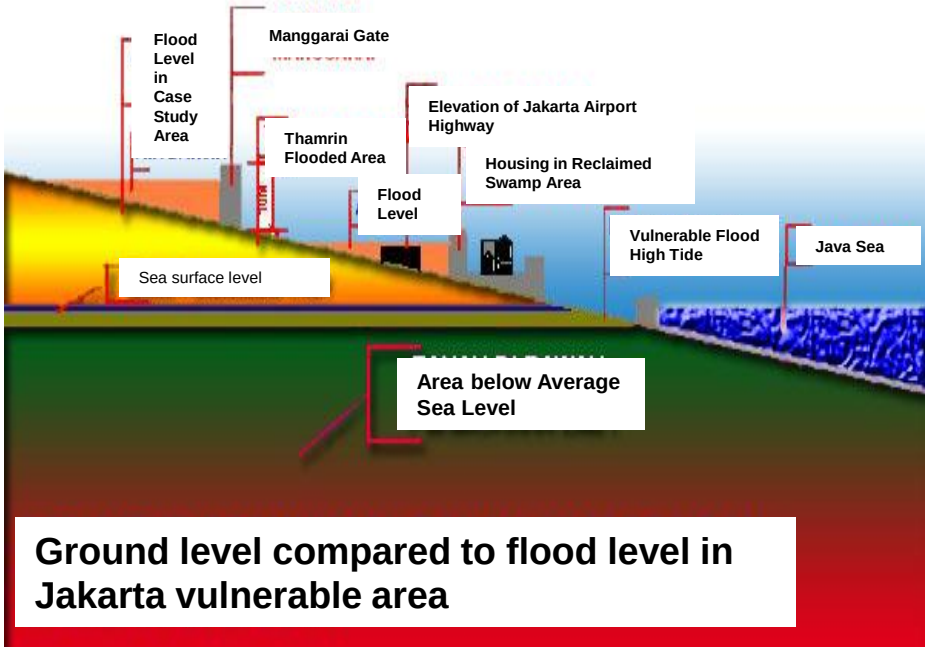


Structural Mitigation



Ground level compared to flood level in Jakarta vulnerable area

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Figure 8. Photograph just upstream of the river outlet of the Sunter

Figure 9. Photograph just upstream of the outlet of the Sunter River

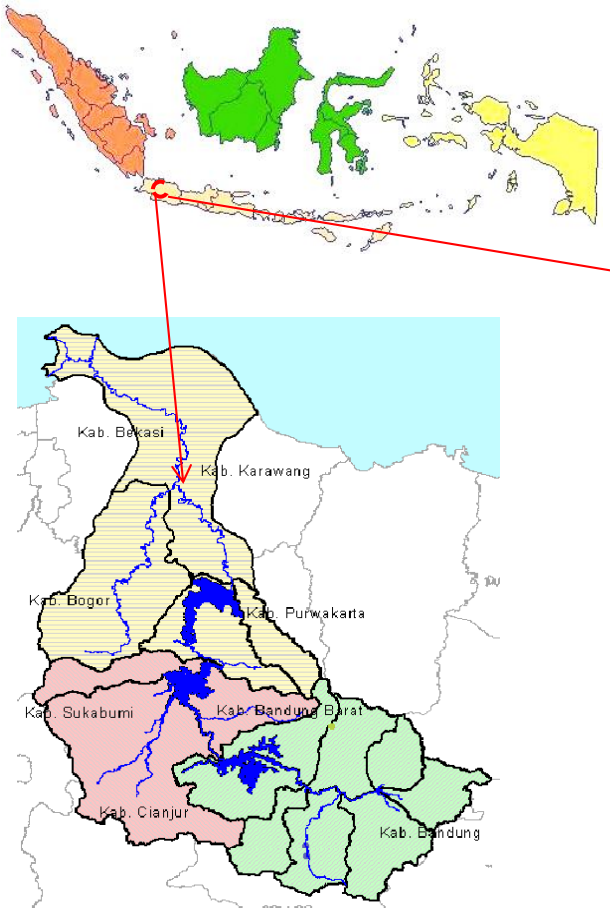
Jakarta Flood 2002 and 2007

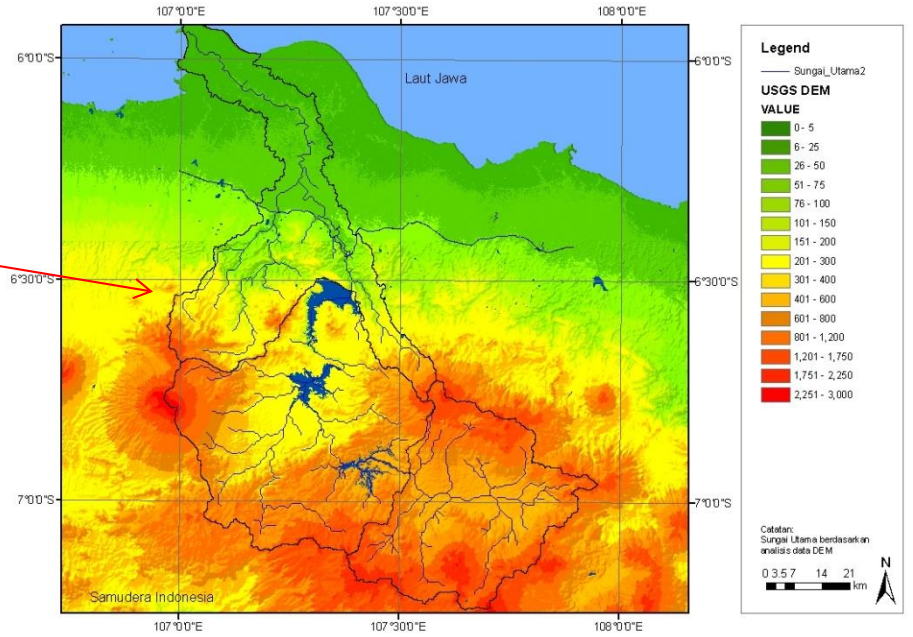
Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Several Current recorded flood in Jakarta

Top Left Des 2013 and Right Mai 2013, Bottom Left Des 2013 and Right Jan 2014

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



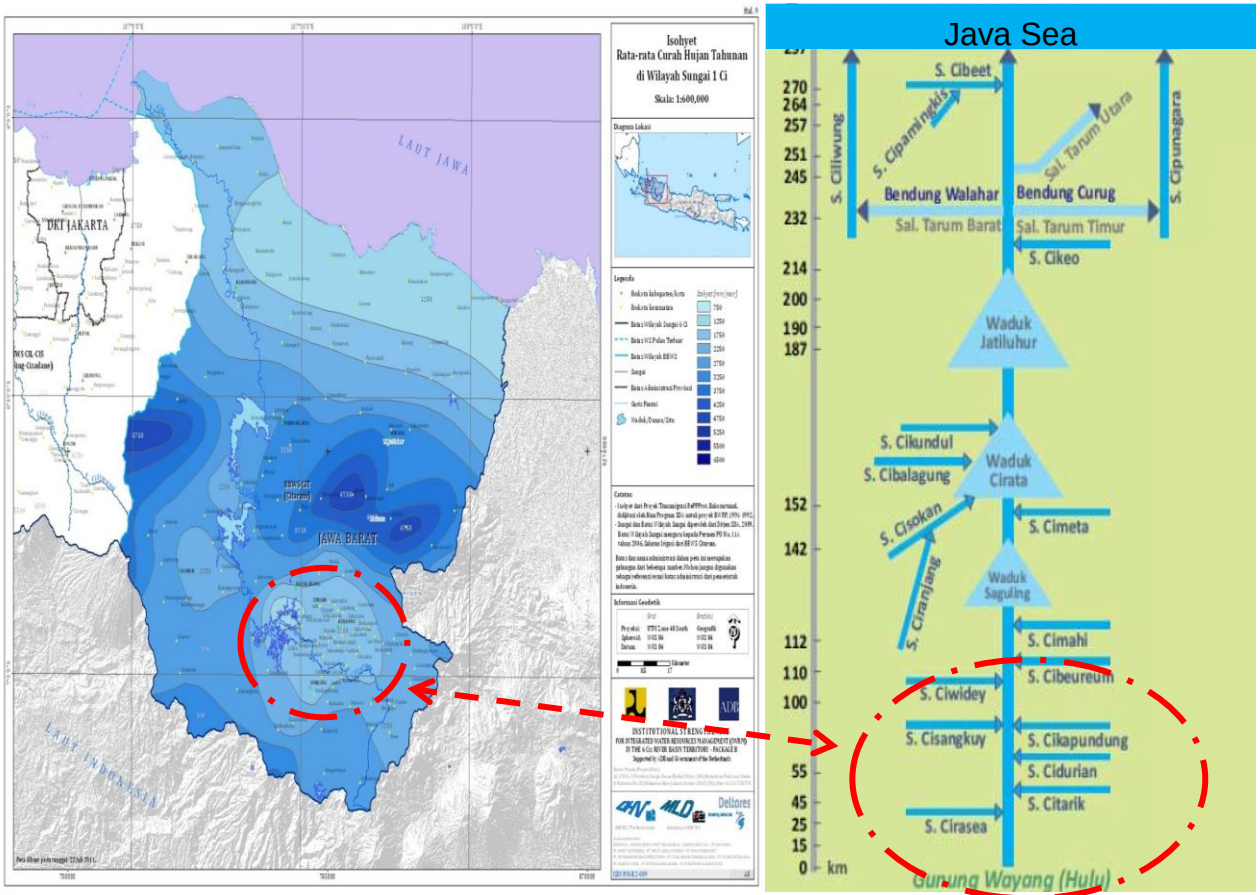


Citarum Catchment Area (ADB, 2010, left below) and Citarum Water Management (PU, top right)

Climate Change Issue in River Management : Citarum case

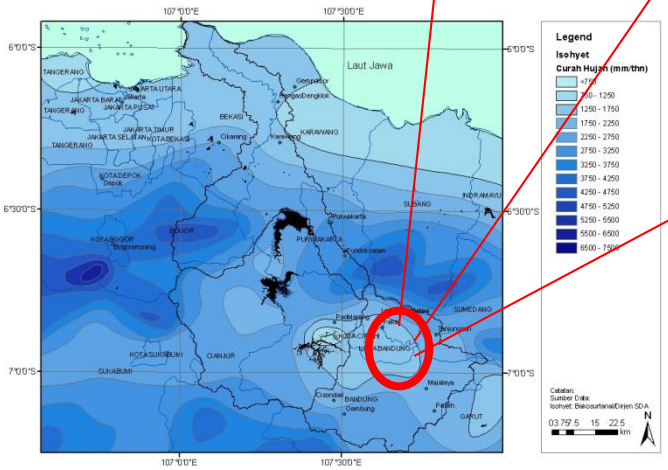
Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Climate Change Issue in River Management : Citarum case



Bandung Basin as an upper part of Citarum River Catchmen Area (BBWSC, Atlas Citarum, 2012

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



Three weeks flooded in Dayeuh Kolot, natural flood plain area of upstream Jatiluhur Reservoir, 2013

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

190 Tons of organic waste from farming (8,000 cows produce 24 kg of waste each)

The annual uncollected garbage that invariably ends up accumulating in the drainage system and rivers amounts **500,000 m^3/year**

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



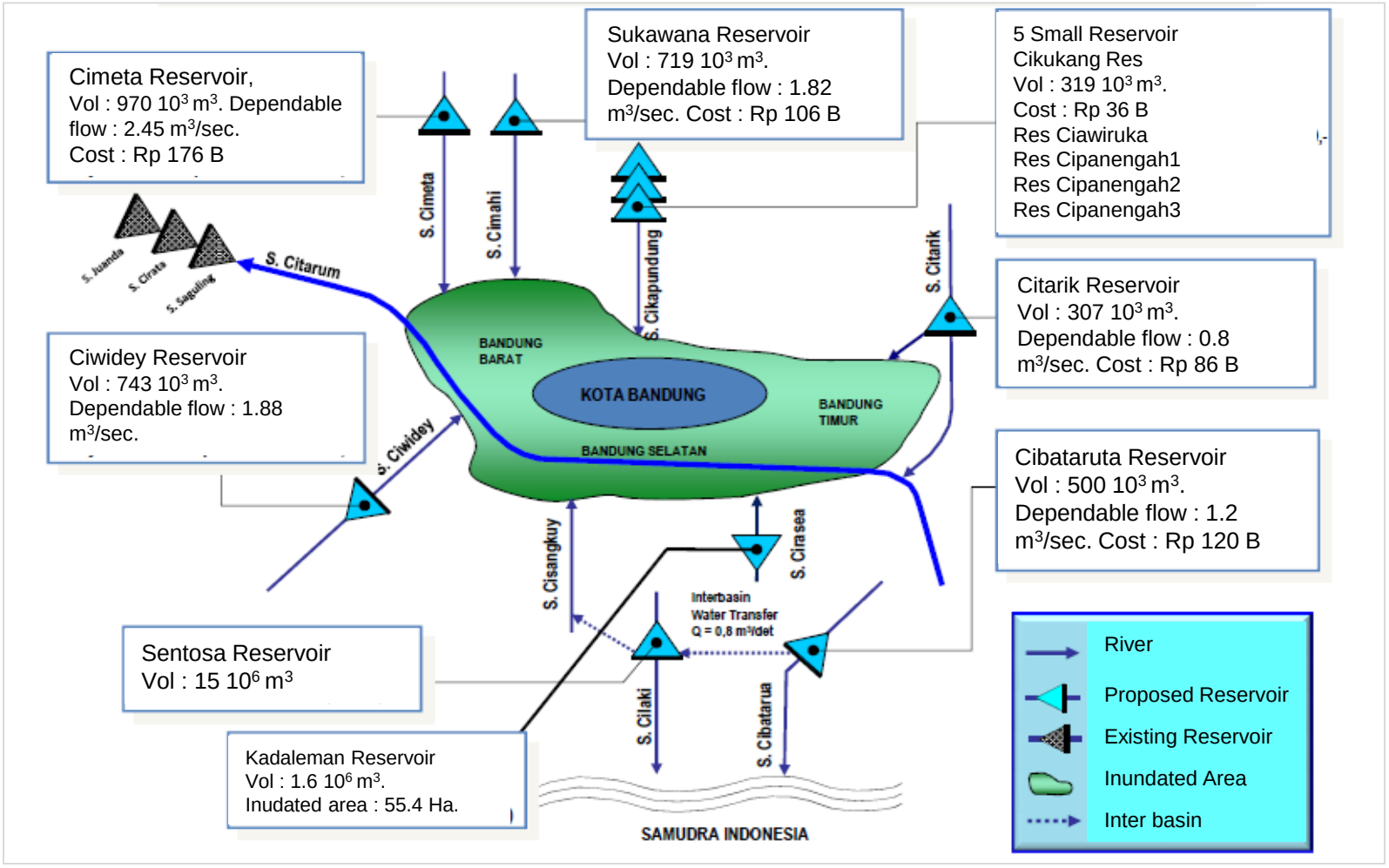
Land Use Change Problem

Pengalengan, Ciwidey, Southern part of upstream area, msbadrik 2005 and City Center, msbadrik 2010

Average annual sedimentation into the three reservoirs estimated at
8 million m^3/year

This caused flood in rainy season and water scarcity in the dry season
(ASER 2008, BPLHD)

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia



Structural Mitigation : Storage System, River normalization and dikes, ITB-Kompas, 2010)

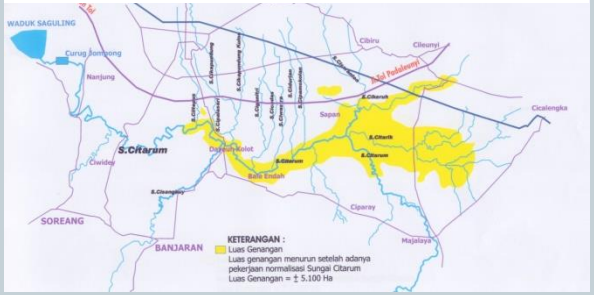
Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Before normalization project

1986 Inundation Area 8600 Ha

After fist stage of normalization project

1994 Inundation Area = 5100 Ha



After 2nd stage of normalization project

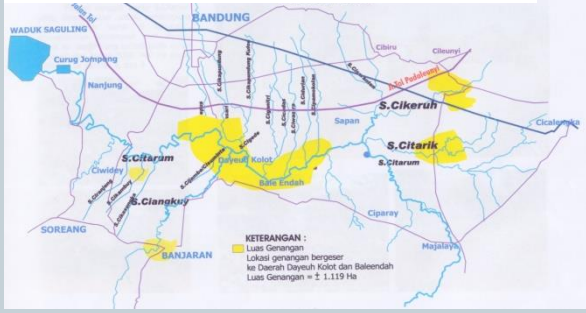
2001 Inundation Area :

After final stage of normalization

2003 : Inundation Area = 820 Ha

Two year After normalization project

2005 : Inundation Area = 1120 ha



Two year After normalization project

2010 Inundation Area ≈ 5100 Ha

Source: ICWRMP

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Water Scarcity in 2012

Jatiluhur, Citarum River, West Java

Pacal, West Java

Gajah Mungkur , Solo River, West Java

Water (Flood & Drought) Disaster Management and Climate Change in West Java, Indonesia

Forest Fire Event in 2012


Ciremai West Java


Papandayan, West Java


Sindoro, Central Java

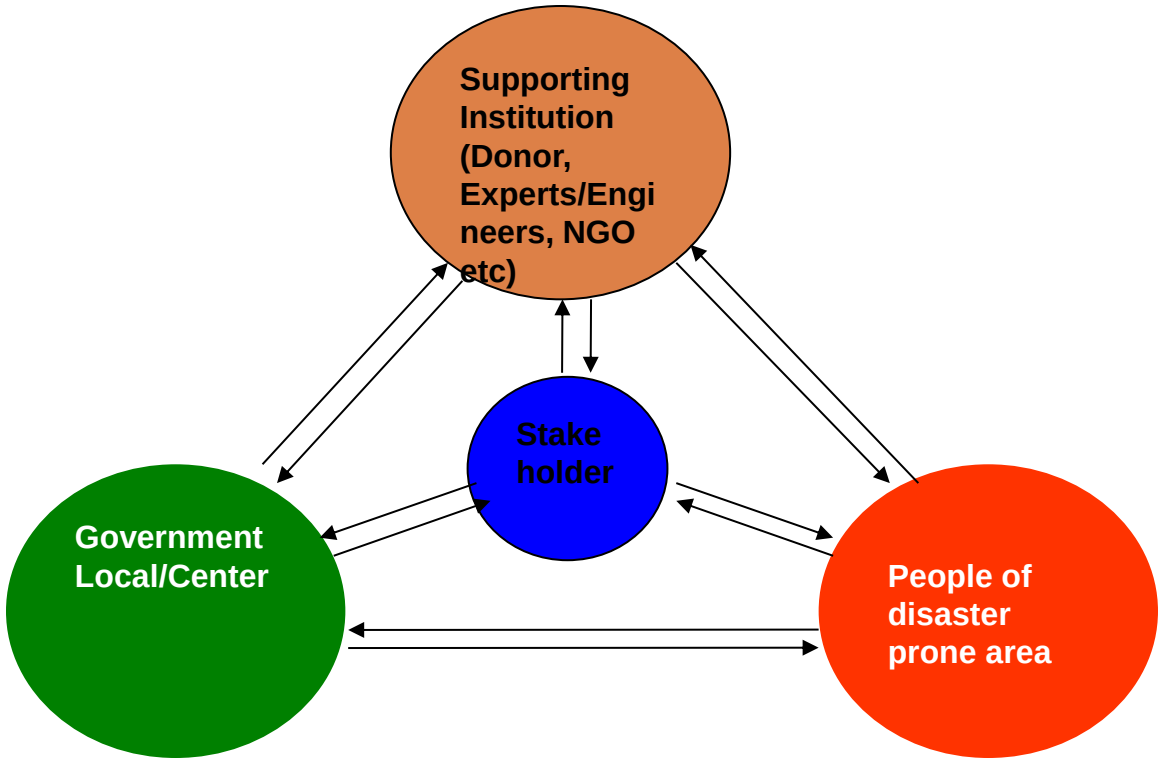

Rokan Hulu, Sumatera, tv one


Agung, Bali island, detik.com


Rinjani, Lombok Island, detik.com

Research Activities and Contribution

Research Issues, Strategy and Contribution



Disaster Stake holder → Potensial Resources Sharing for Appropriate Contribution

Research Issues, Strategy and Contribution

- Flood and Drought Problem : Very complex from engineering to social and environment aspect
- Resources Support : Lack of Data, Limited Budget and un appropriate Methodology
- Cooperation with the stake holder of related disaster → resources optimization for the most applicable solution where each of them contribute based on their capacity

Research Issues, Strategy and Contribution

- Flood and Drought Problem : Very complex from engineering to social and environment aspect
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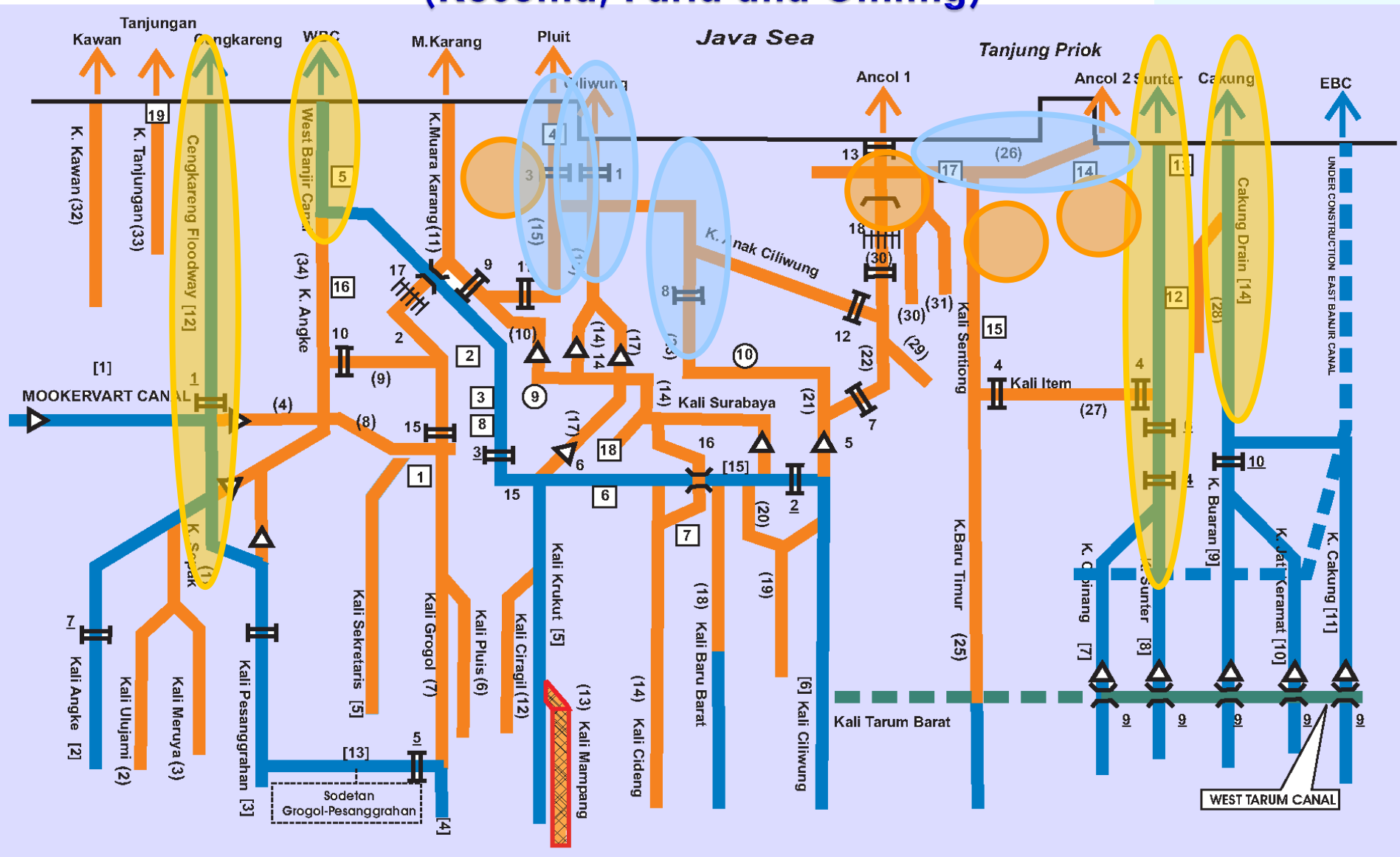
Research Finding :

Assessment of The Best Improvement Scenario of Jakarta Flood Control

(Kusuma, Farid and Ginting)



Research Finding :
Assessment of The Best Improvement Scenario of Jakarta Flood Control
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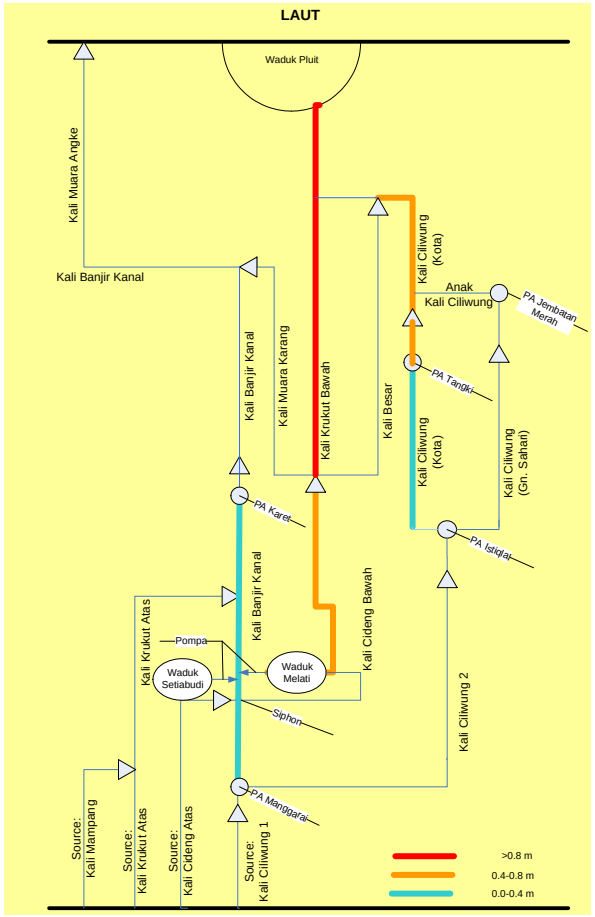
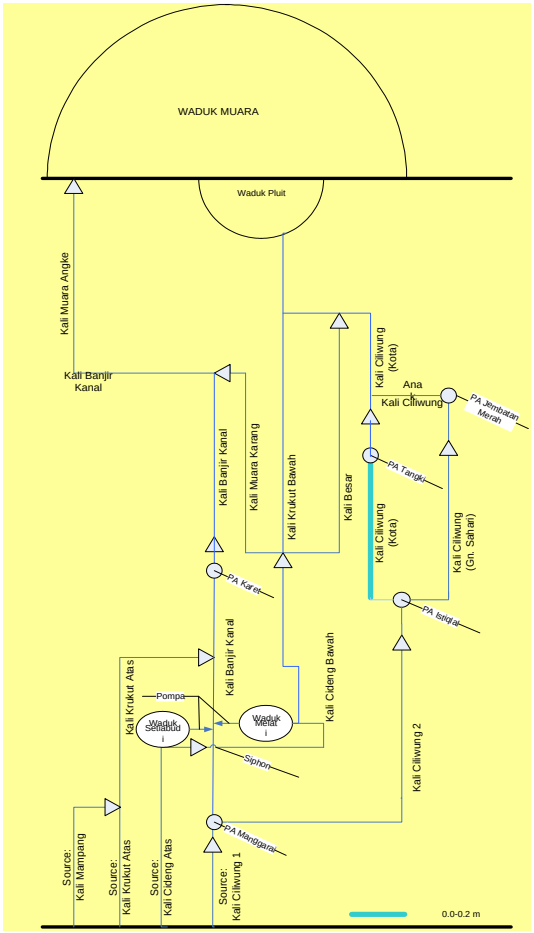


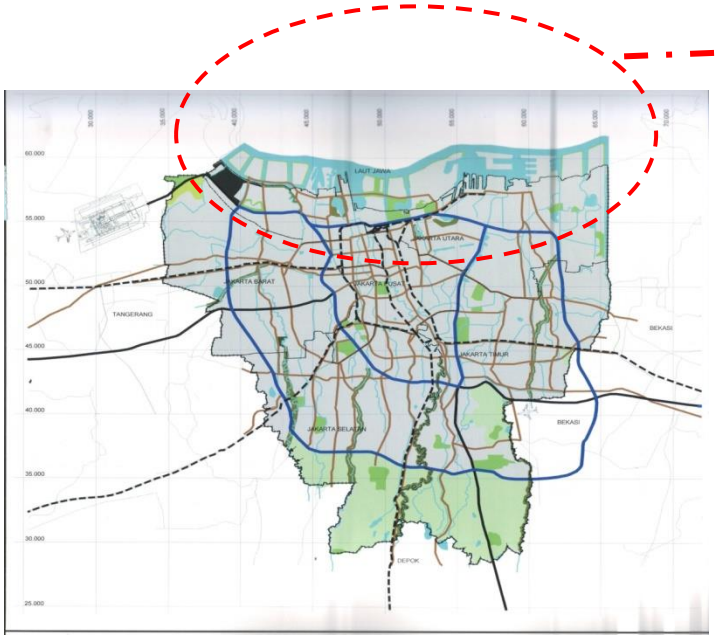
One of the basic idea for “giant sea wall” development)

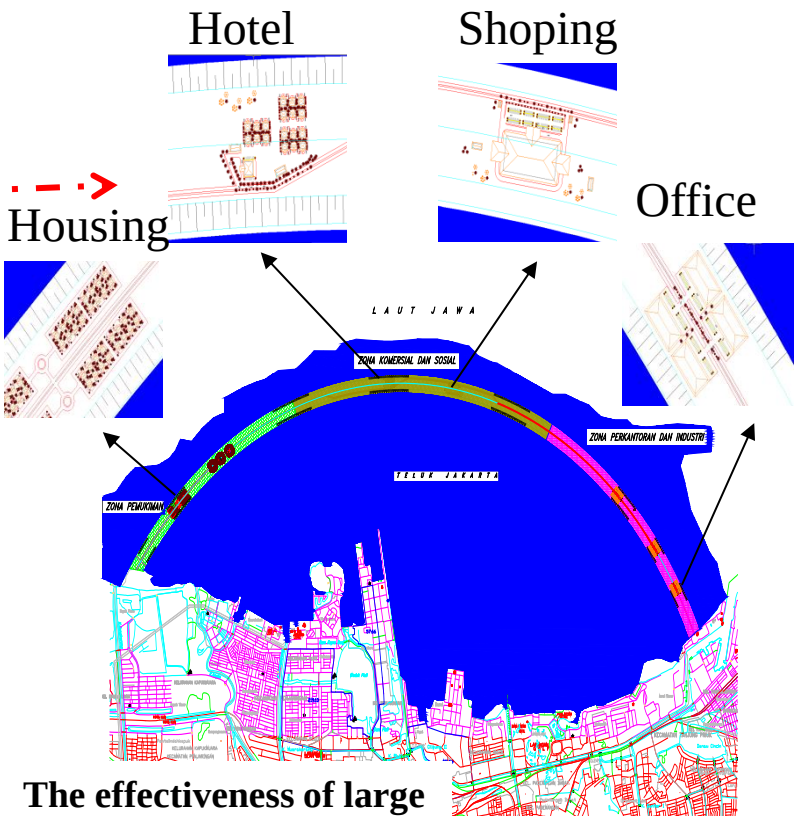


Flood 2002 based on 1000 years Return period left with existing flood control, right supported with estuary reservoir (still required river normalization to have steeper slope)

Research Finding :
Assessment of The Best Improvement Scenario of Jakarta Flood Control
(Kusuma, Farid and Bagus)

The masterplan of Jakarta



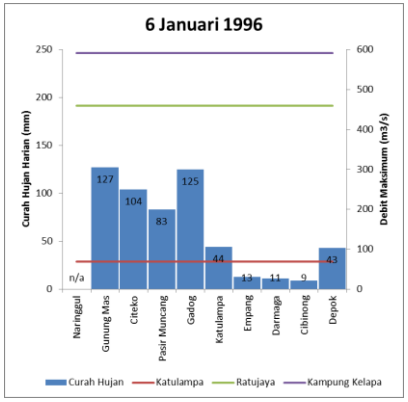


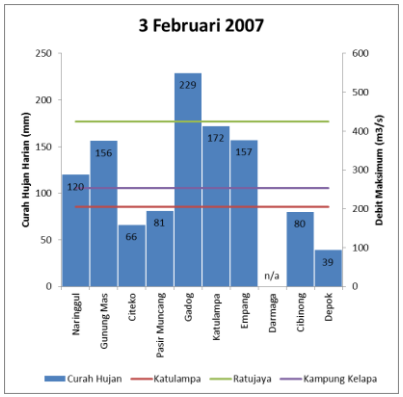
The effectiveness of large polder in coastal area

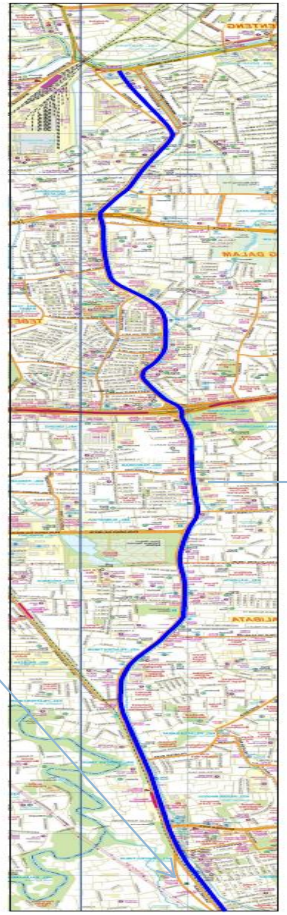
Research Finding :

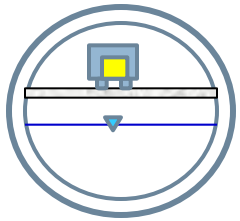
Assessment of The Best Improvement Scenario of Jakarta Flood Control

(Kusuma and Farid)







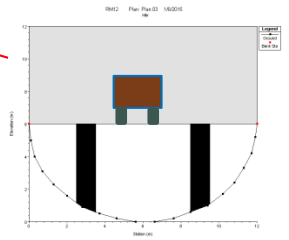


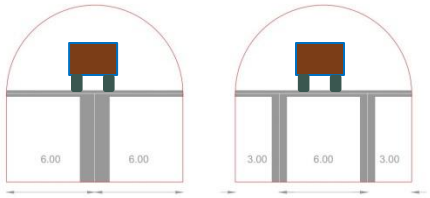
Multi Purpose Flood Diversion Tunnel in Jakarta

Research Finding :

Assessment of The Best Improvement Scenario of Jakarta Flood Control (Kusuma and Farid)

No of Simulation	River Discharge (m^3/s)	Upstream Flow Depth at outlet (m)		Downstream Flow Depth at inlet (m)		Tunnel Discharge Capacity (m3/s)		
		Rectangular	Semi Circular	Rectangular	Semi Circular	Rectangular	Semi Circular	% Increment
1	150	1.9	2.2	3.7	3.7	42.82	23.71	81
2	350	3.7	4.0	5.9	5.9	98.34	67.12	47
3	400	4.1	4.4	6.3	6.3	111.12	78.62	41
4	450	4.5	4.8	6.8	6.8	123.45	90.04	37
5	750	7.1	7.4	9.3	9.3	137.91	100.33	37
6	1100	9.8	10.0	11.9	11.9	138.91	100.84	38
7	1800	14.6	14.8	16.6	16.6	140.00	101.4	38





Multi Purpose Flood Diversion Tunnel in Jakarta

Research Finding :
Assessment for Maximum Inundation Depth in Jakarta
(Kusuma, Harkunti, Farid and Arno)

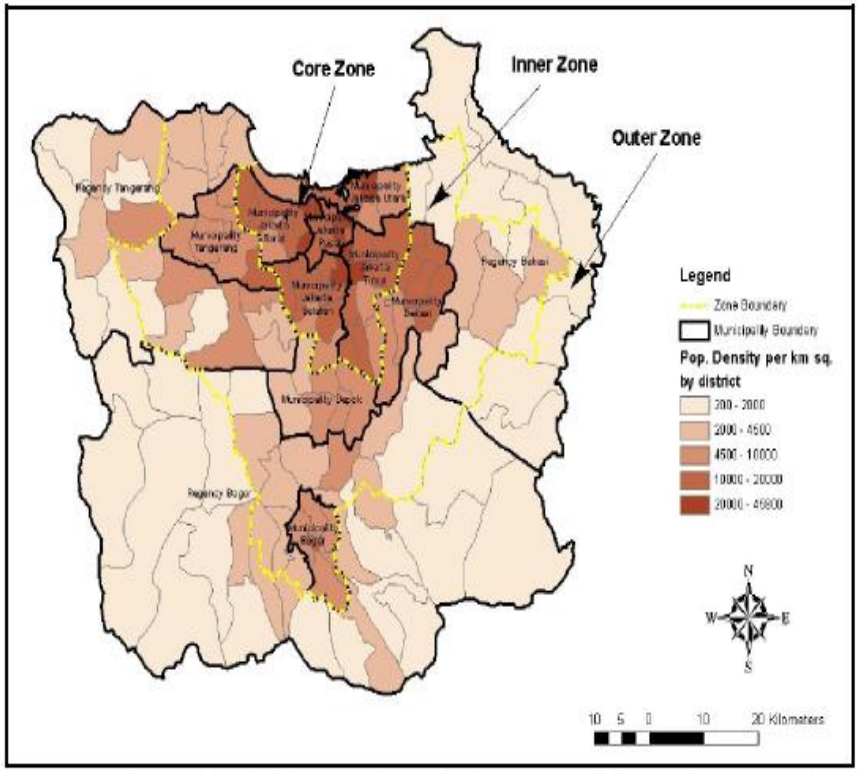
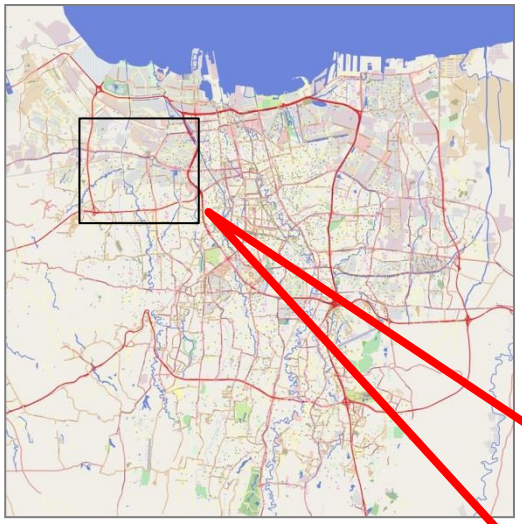


Figure 1. Zone Division of Jabodetabek based on Population Density, 2000

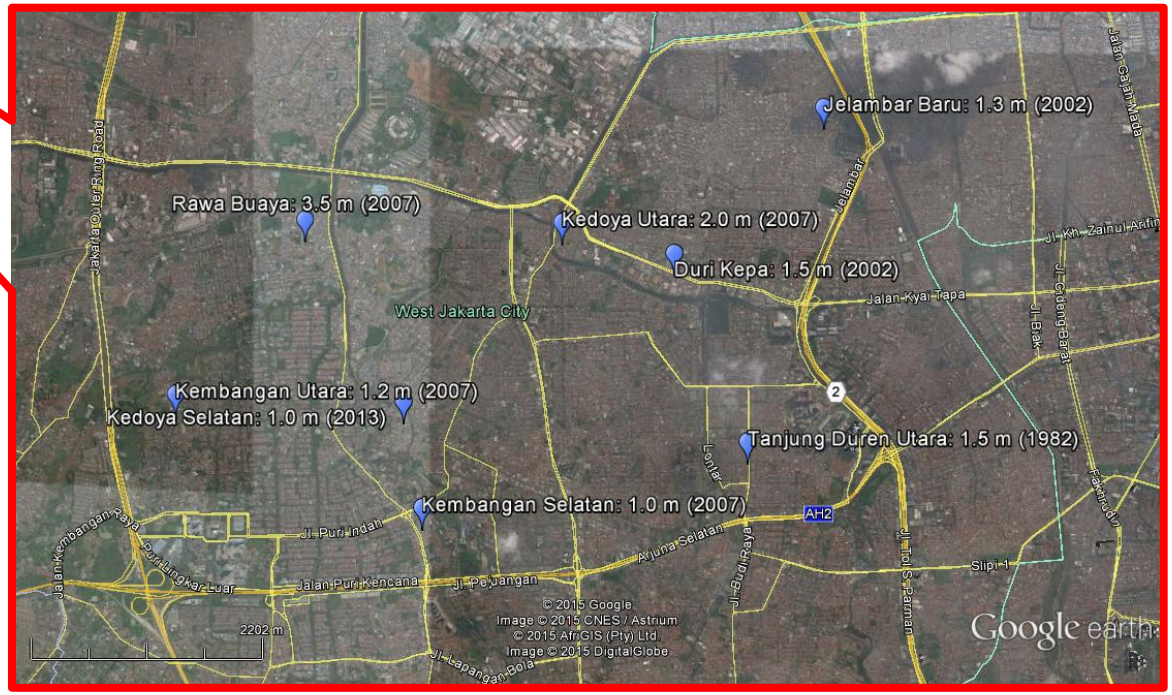
- **Population**
  - Night + 8,9 M
  - Day ± 10,2 M
  - Women 49.97%
  - Childern < 15 Y : 7.35%
  - Old People > 60 Y : 5.65%
  - Family : 2,25 M House hold
- **Density :**
  - Average : 13-15 10^3 people/km^2
  - High : 20-30 10^3 People/km^2

Research Finding :
Assessment for Maximum Inundation Depth in Jakarta
(Kusuma, Harkunti, Farid and Arno)



- Simple method (ITB)

- Field observation
- Visual and Interview with local people
- Could be used to confirm the flood map



Research Finding :
Risk Assessment for Most Flooded Area in Jakarta

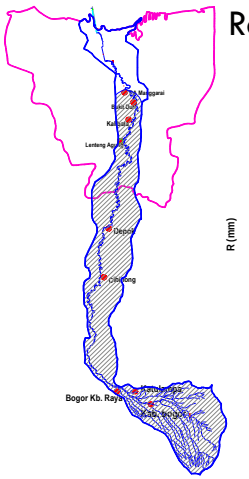
(Kusuma, Harkunti, Bagus and Farid)

Non Structural Mitigation

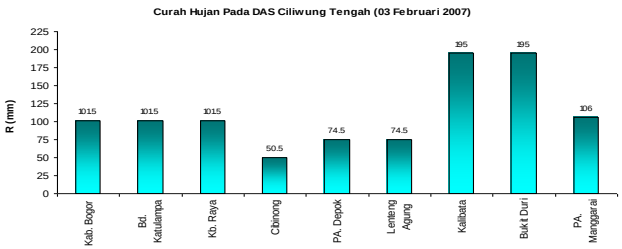
- Polder System
- Risk map was developed for Improving Local People Capacity by

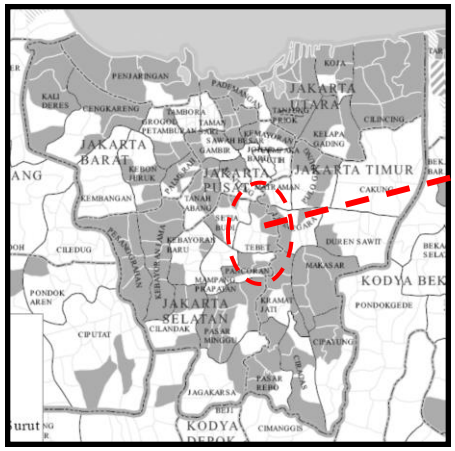
Research Finding :
Risk Assessment for Most Flooded Area in Jakarta

(Kusuma, Harkunti, Bagus and Farid)



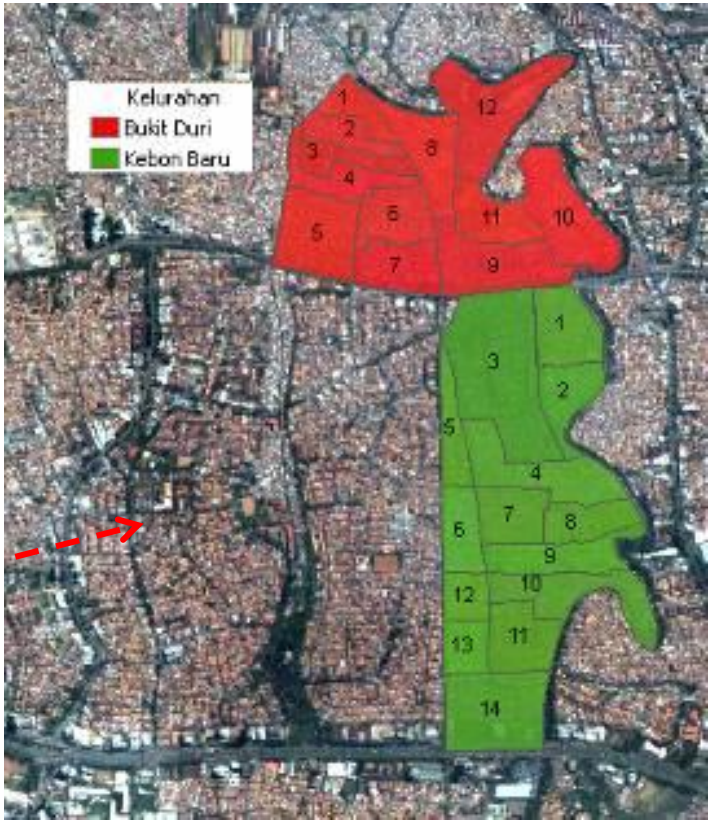
Recorded Rainfall during flood in 2007





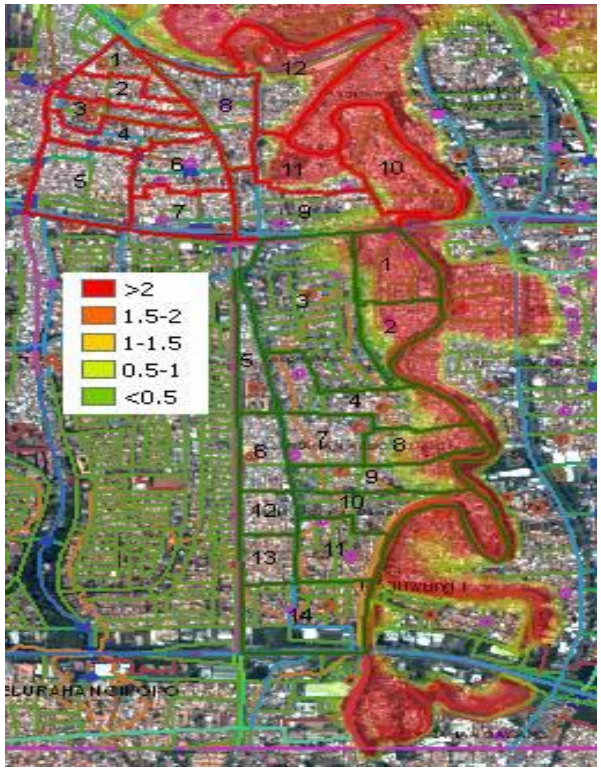
Flood 2007 in the Location of

- Bukit Duri (12 Community)
- Kebon Baru (14 Community)



Research Finding :
Risk Assessment for Most Flooded Area in Jakarta

(Kusuma, Harkunti, Bagus and Farid)



Flood Hazard Map - FHM berbasis RW

Inundated area more than 2 meter

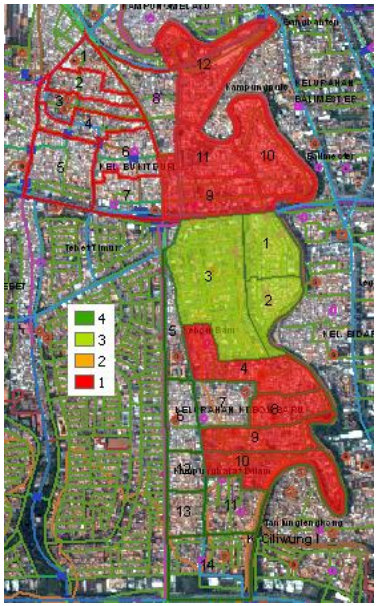
- 4 RW di Bukit Duri (9,10,11,12)
- 7 RW di Kebon Baru (1,2,3,4,8,9,10)

FHM Index

- Index 4: more than 80% is inundated > 2 meter
- Index 3: 40%-80% of The area is inundated
- Index 2: 10%-40% of The area is inundated
- Index 1: Less then 10% of The area is inundated

Research Finding :
Risk Assessment for Most Flooded Area in Jakarta

(Kusuma, Harkunti, Bagus and Farid)



Capacity

- Parameter:
  - River/Drainage Capacity : Dike, Pumps, Canal
  - Early Warning
  - Stake Holder (Especially Local Peaple) Awareness/Capacity

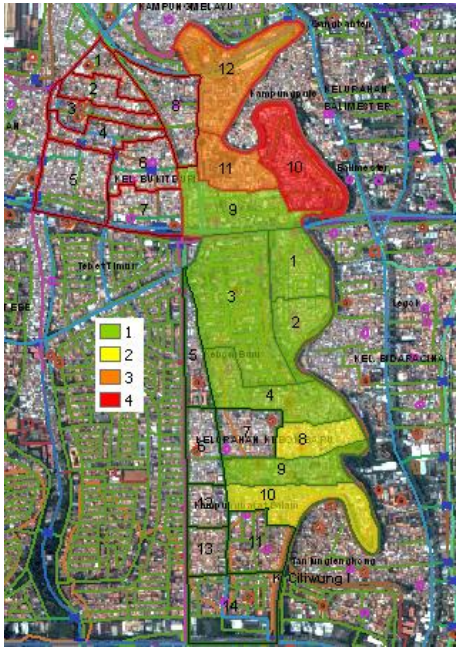
Capacity Index = 0.5 x Dike index + 0.5 x Pump index

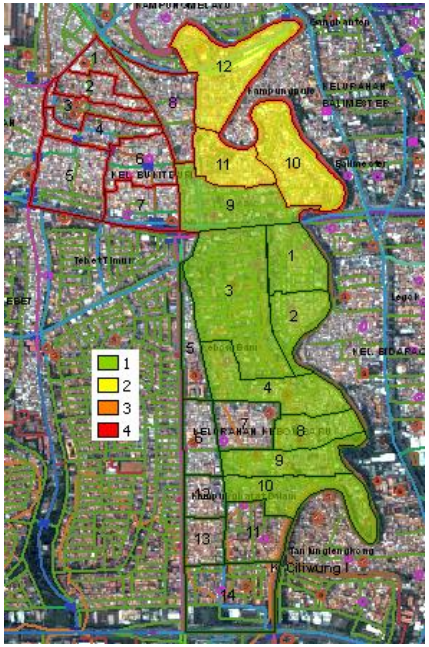
- Index 4 : very good
- Index 3 : goood
- Index 2 : Low
- Index 1 : Very low

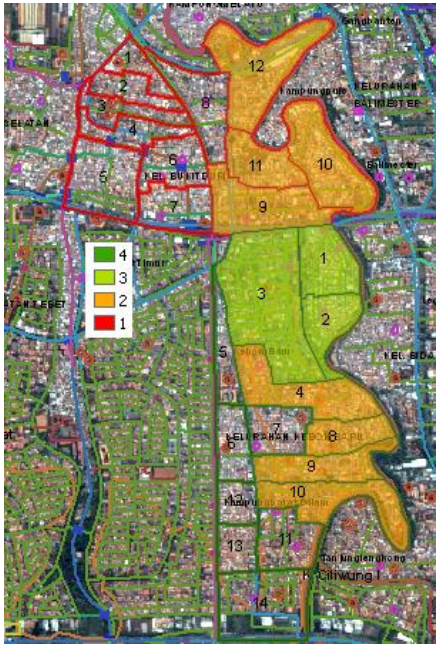
Research Finding :

Risk Assessment for Most Flooded Area in Jakarta

(Kusuma, Harkunti, Bagus and Farid)







Risk

Risk Index

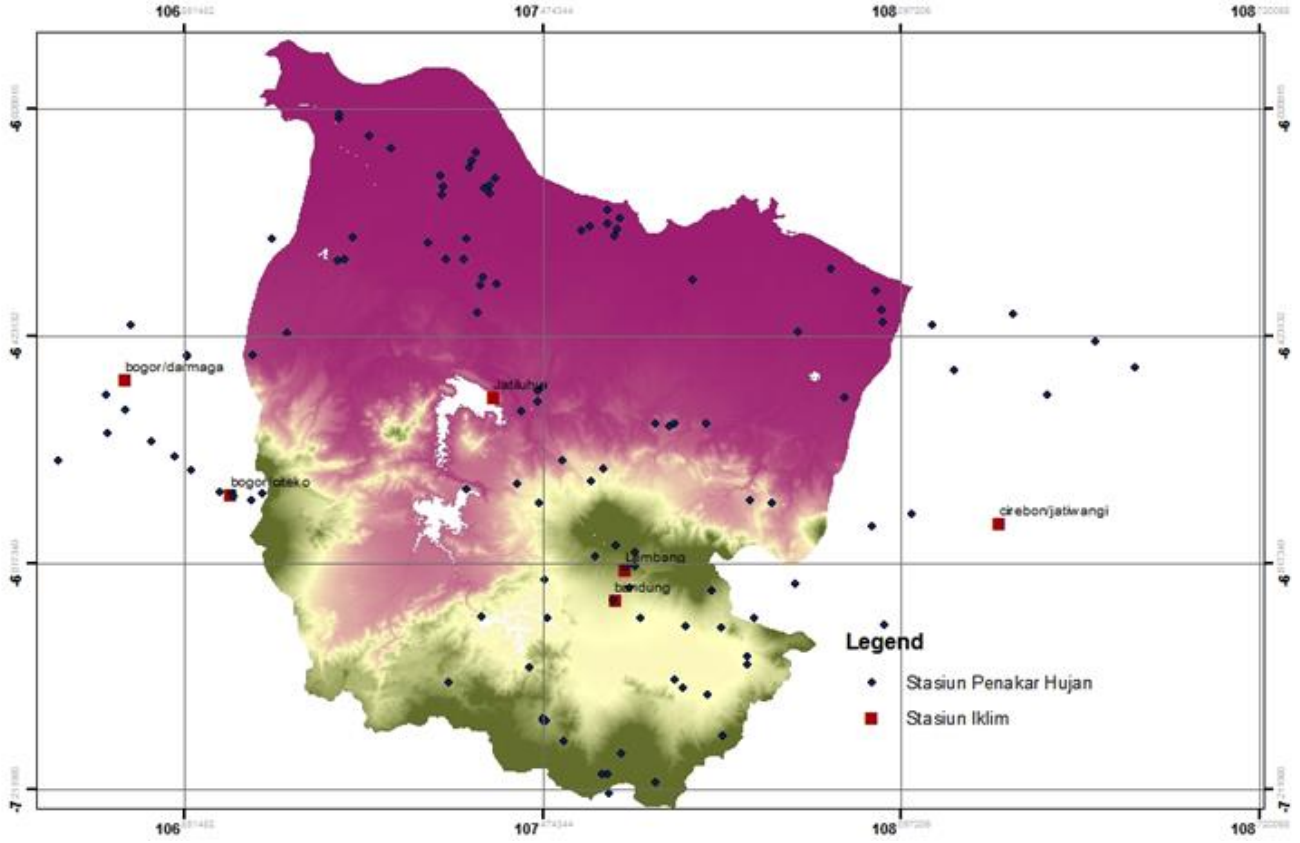
- **Index 4 : Very High**
- **Index 3 High**
- **Index 2 : Medium**
- **Index 1 : Low**

Existing **Optimistic and Pesimisstic Intervention**

Risk = Hazard X Vulnerability / Capacity

Research Finding :
Improvement of Data Base

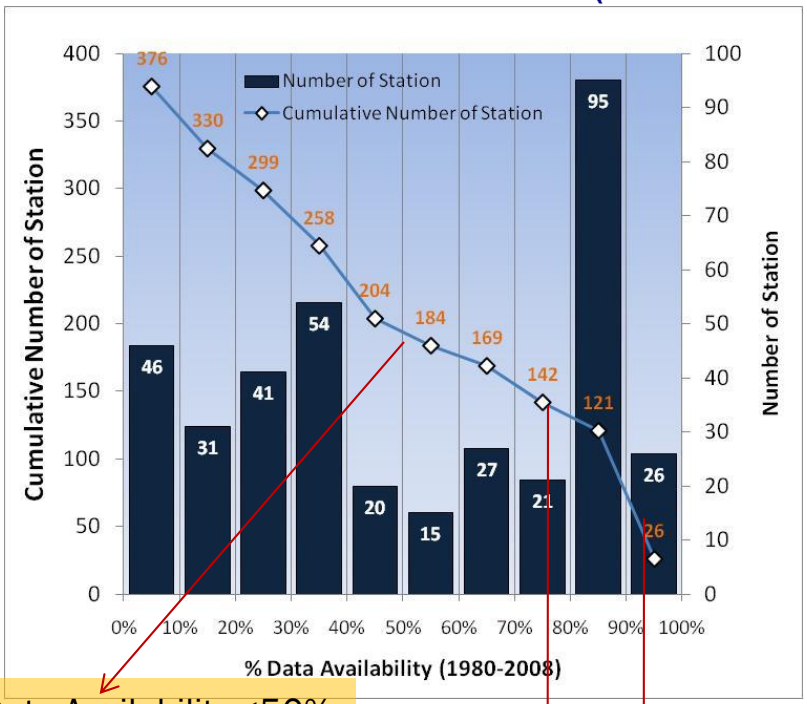
(Kusuma Hadi, Arno and Hadi)



- There are **376 rainfall stations** in Citarum River Basin with different data sources for the period of 1980-2008.

Research Finding :
Improvement of Data Base

(Kusuma Hadi, Arno and Hadi)



Data Availability <50% (192stations)

Data Availability >70% (142 stations)

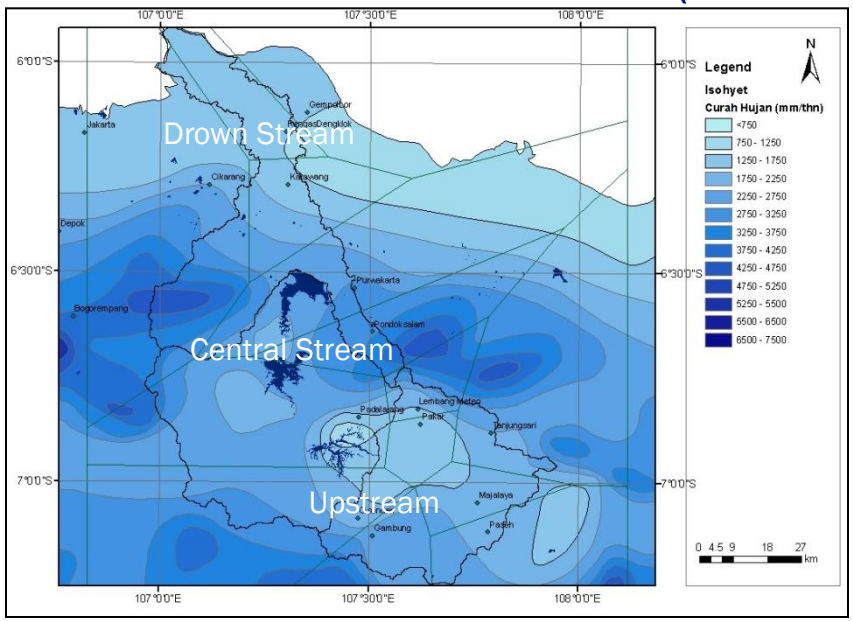
Data Availability >90% (26stations)

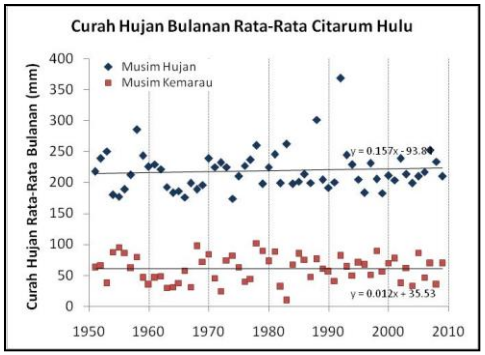
From those 376 rainfall station :

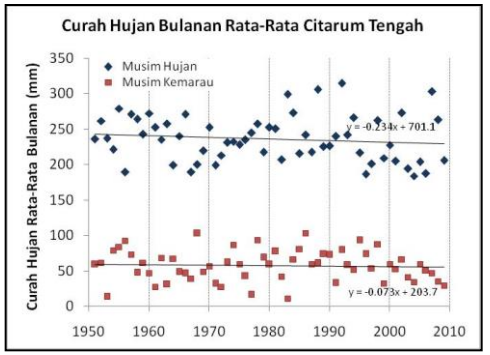
1. Only 26 stations (6.9% of the total rainfall stations) consist of very good data record with data availability more than 90%;
2. 142 stations (37.8% of the total rainfall stations) consist of relatively good data records with data availability more than 70%;
3. 192 stations (51.2% of the total rainfall stations) consist of data records with data availability less than 50%

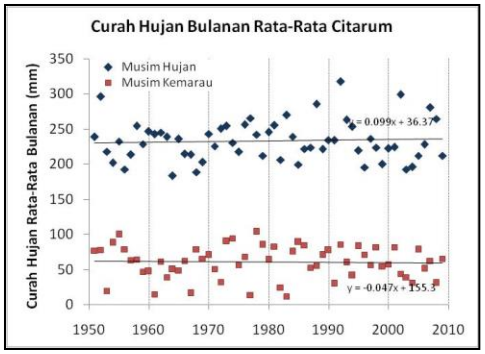
Research Finding : Improvement of Data Base

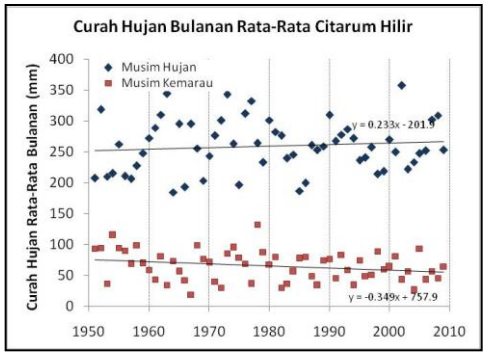
(Kusuma Hadi, Arno and Hadi)











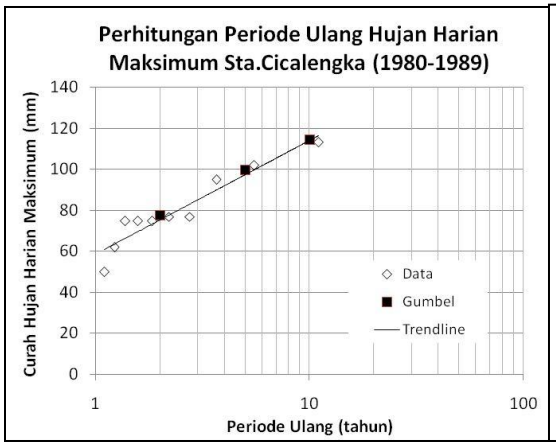
Monthly Average Rainfall in CRB

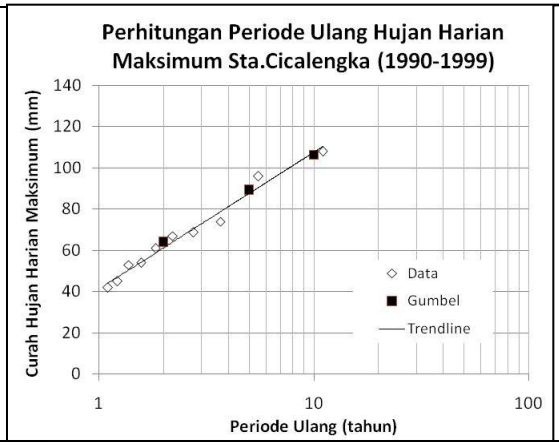
Monthly Average Rainfall in Lower CRB

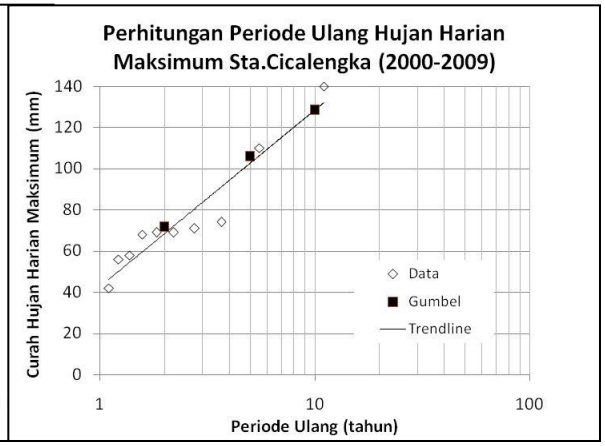
Trend:
Changes in rainfall trend tend to occur in lower Citarum, where rainfall in wet season tends to increase while rainfall in dry season tends to decrease

Research Finding : Improvement of Data Base

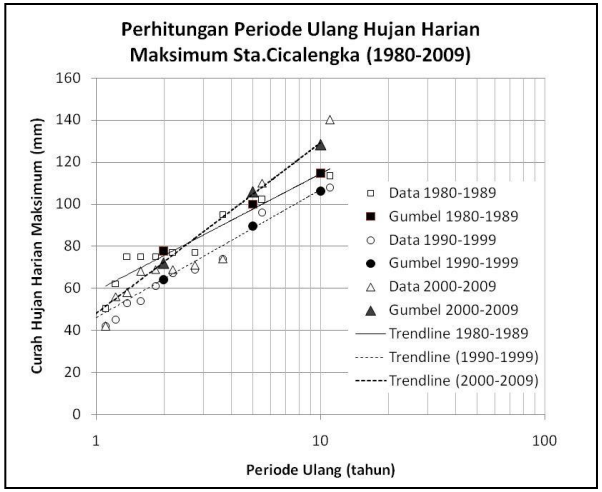
(Kusuma Hadi, Arno and Hadi)





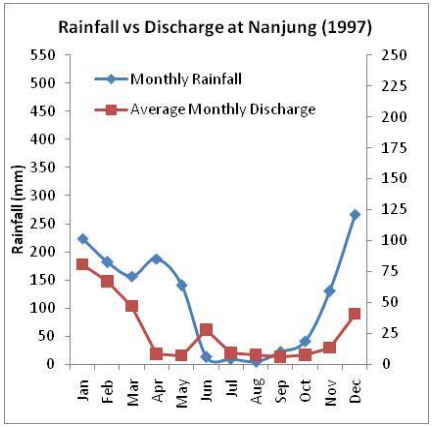


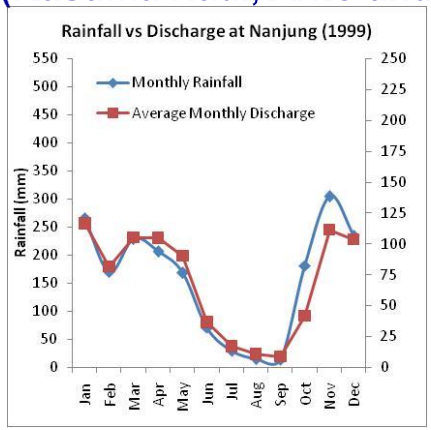
Trend:
Based on data from maximum daily rainfall for the period of 1980-1989, 1990-1999, and 2000-2009, there are no change in extreme value for return period of 5 and 10 years **(Kusuma, Arno and Farid)**.

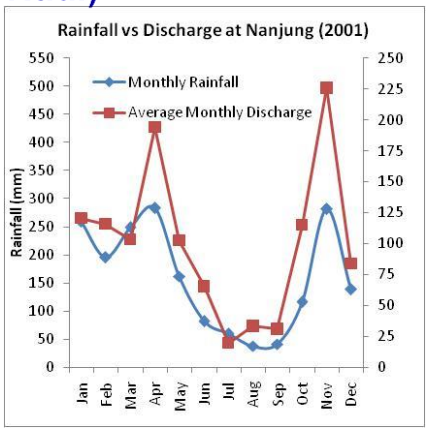


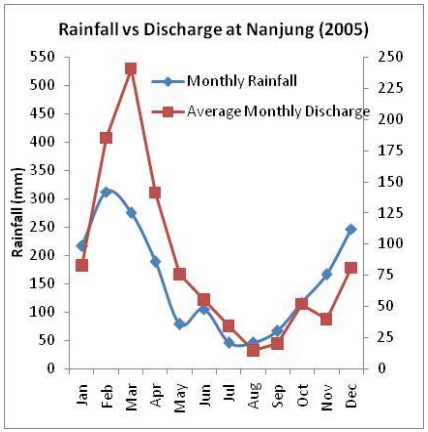
Research Finding :
Improvement of Data Base

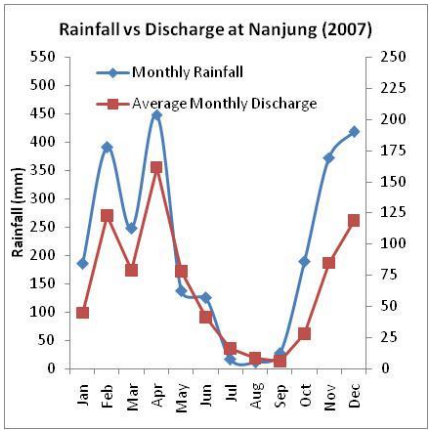
(Kusuma Hadi, Arno and Hadi)

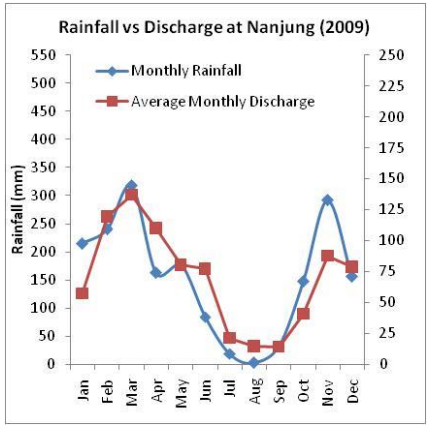






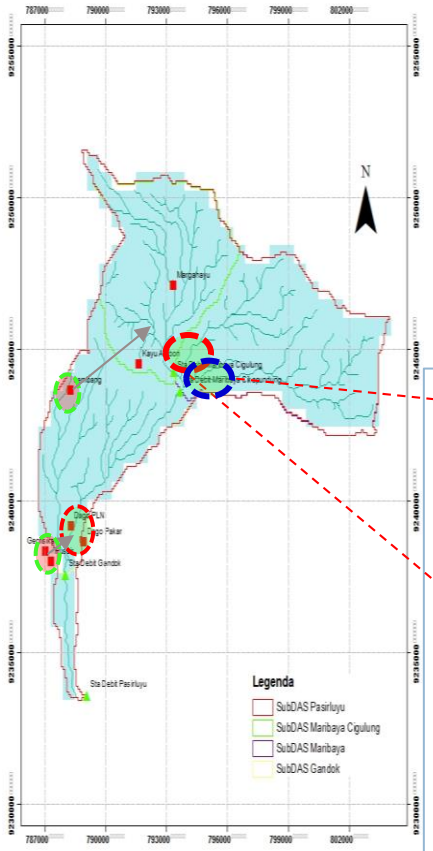


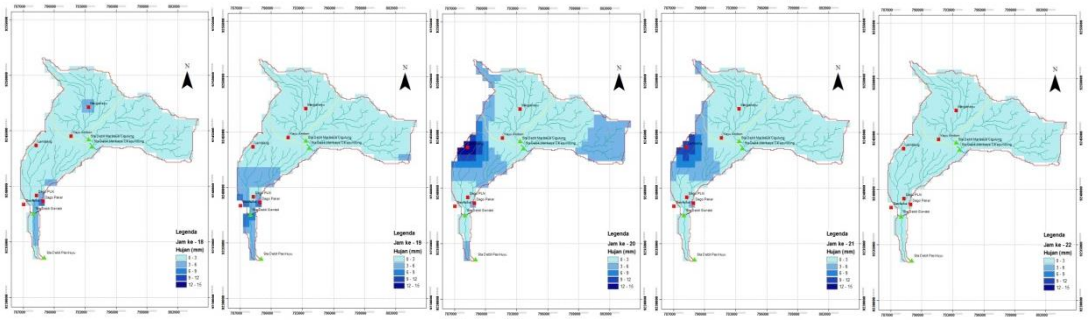


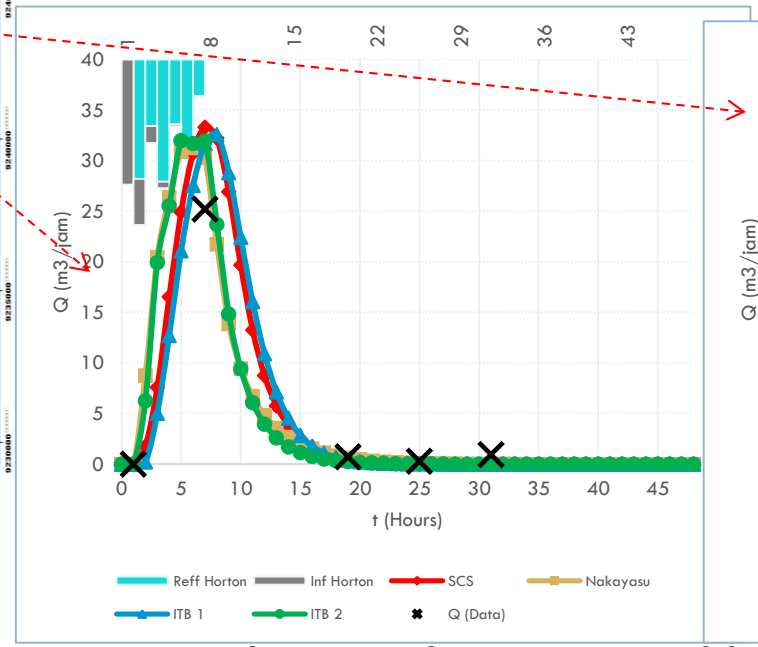


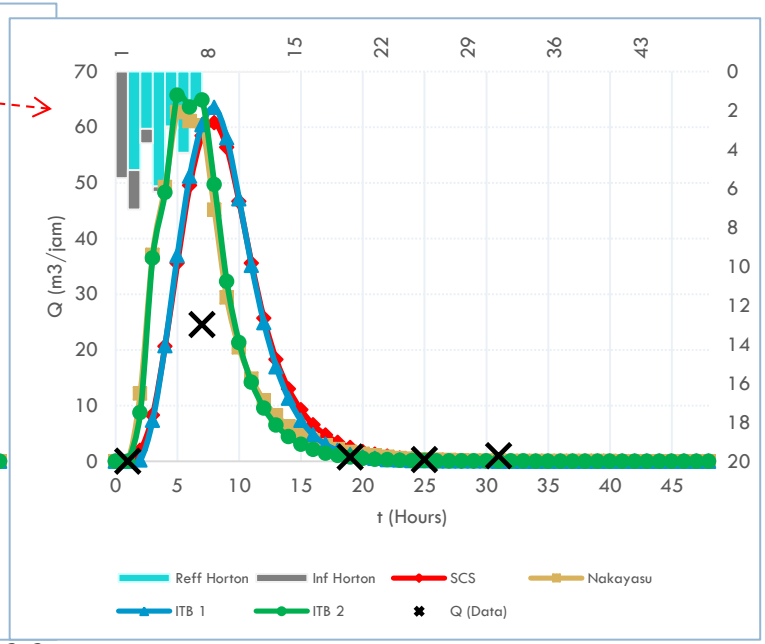
Monthly rainfall seems to have a strong correlation with monthly discharge which indicates the typical of runoff in developed area with high variation between wet and dry season and relatively low base flow **(Kusuma, Arno and Farid)**

Research Finding :
Improvement of Assessment Methodology
(Wulan, Kusuma and Arno)







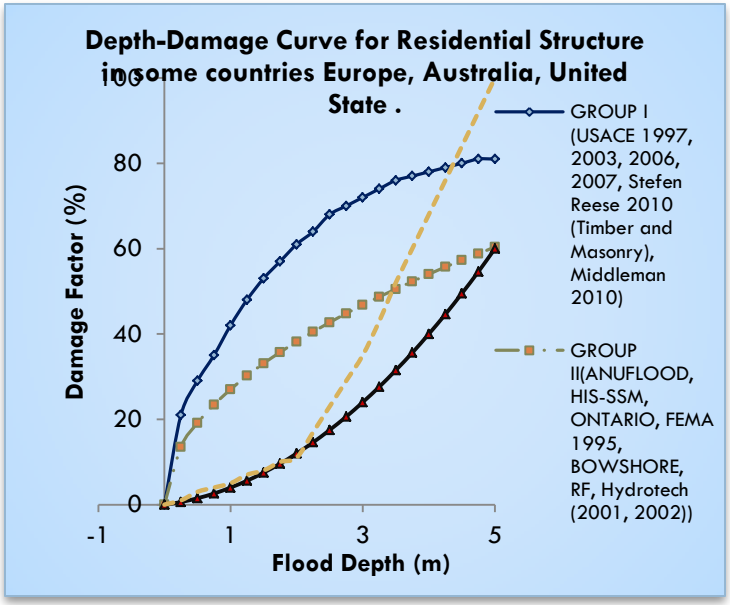


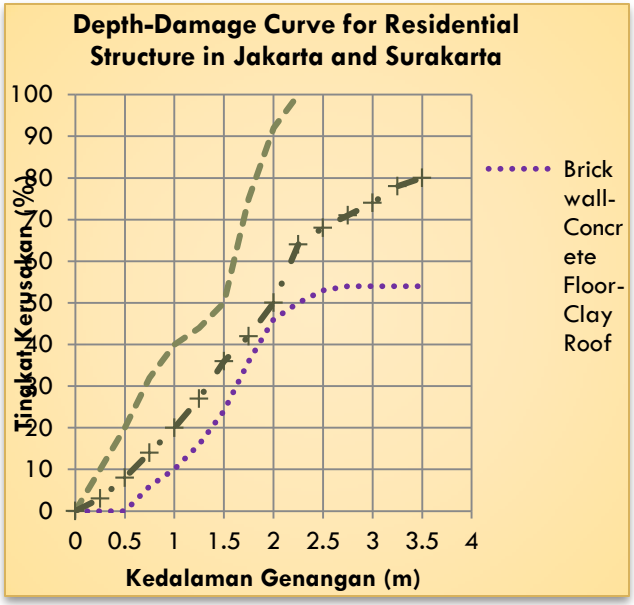
Spatial Distribution of Rainfall-Runoff Hydrograph

Research Finding :
Risk Assessment for Agriculture Area in Bandung

(Anik, Indratmo, Kusuma and Iwan)

Update hazard method : Depth-Damage Curve for Residential Structure in Citarum





Hazard Level based on BNPB (National Guidleine For Flood Study No.02, 2012) :

D < 0.76 m, Low Hazrad

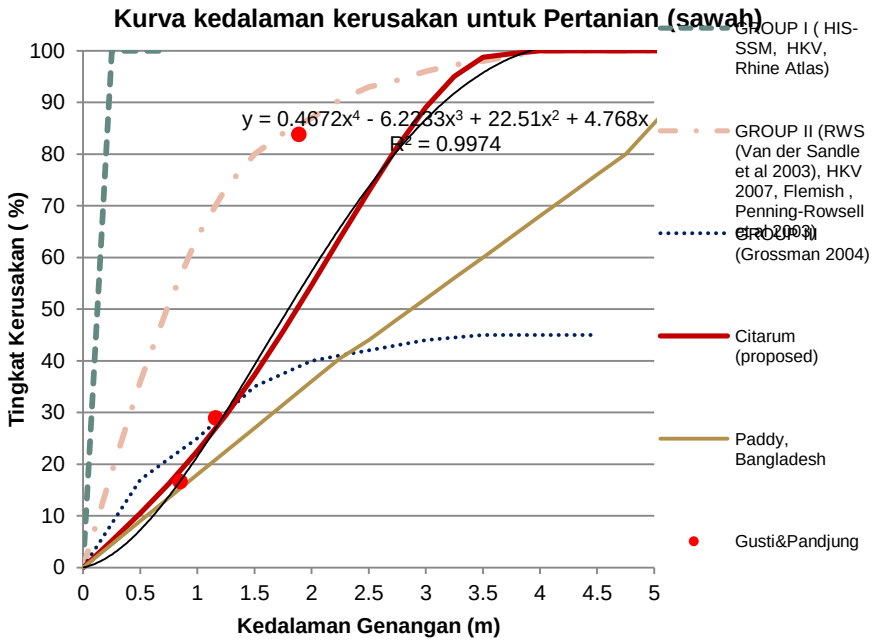
D 0.76 m – 1.5 m Medium hazard,

D > 1.5 m High Hazard.

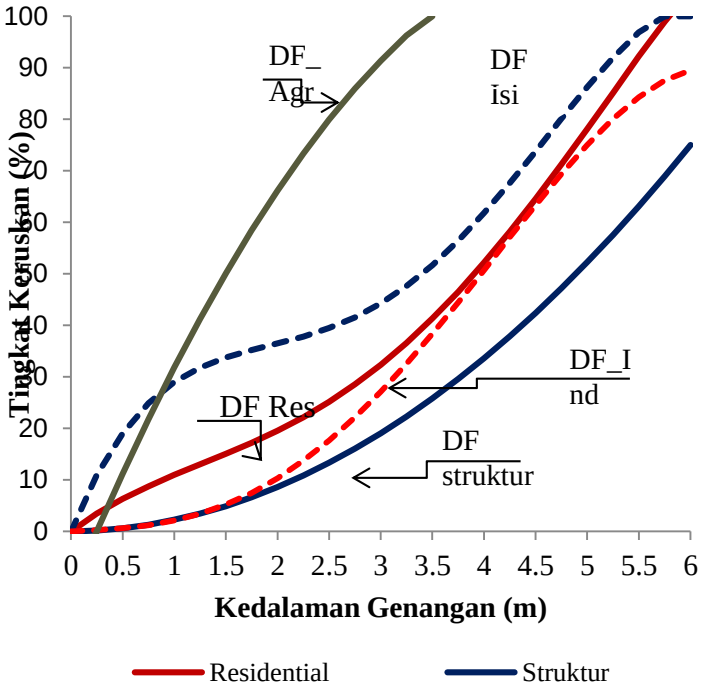
Research Finding :
Risk Damage Assessment in Bandung

(Anik, Indratmo, Kusuma and Iwan)

Agriculture

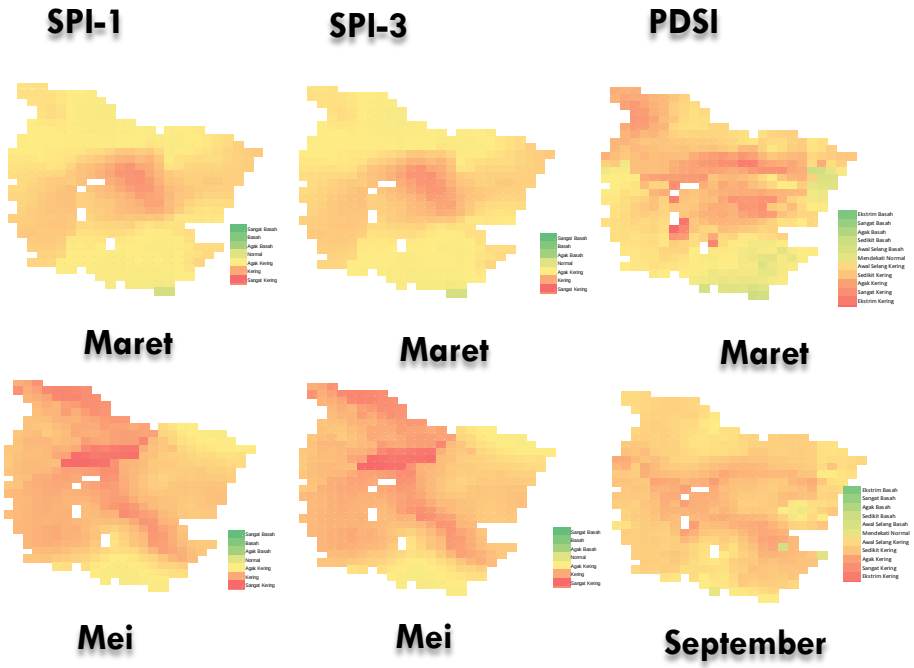


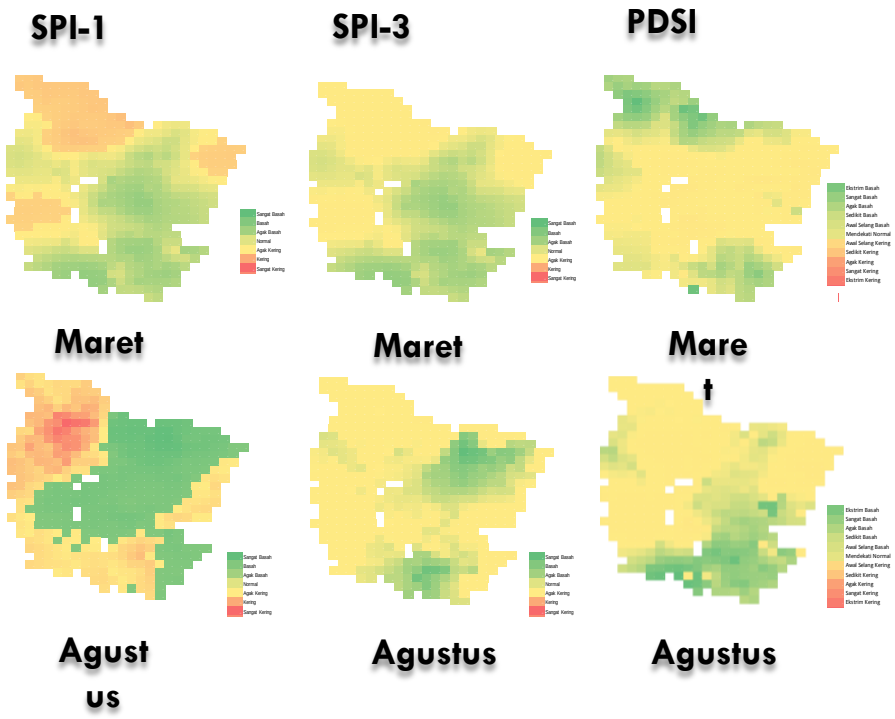
Housing



Research Finding :

Drought Assessment for Citarum River (Lisa, Kusuma and Arno)





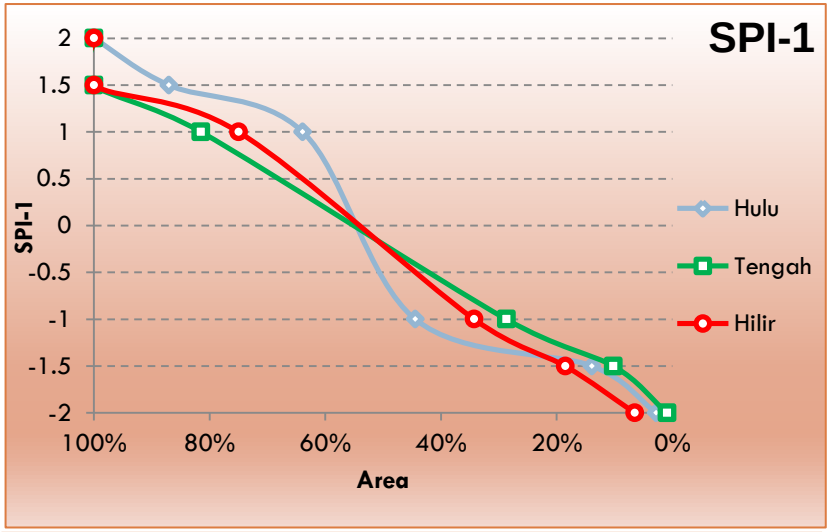
Dry Year 1997

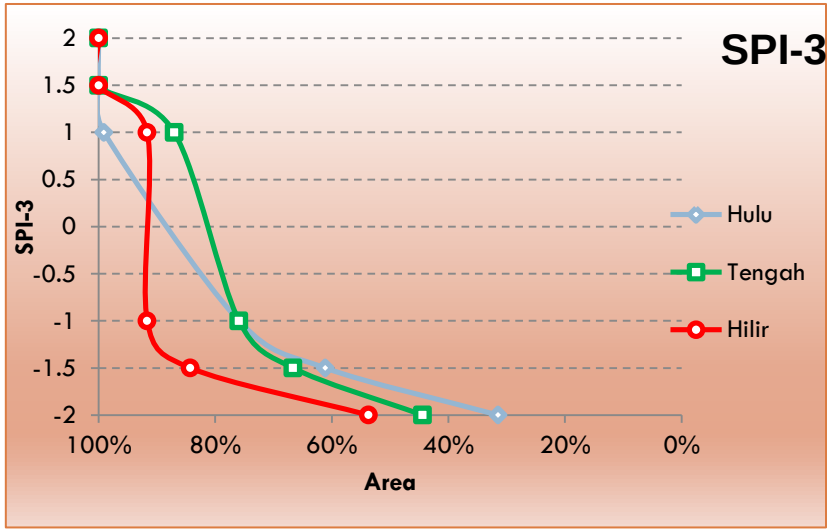
Wet Year 2007

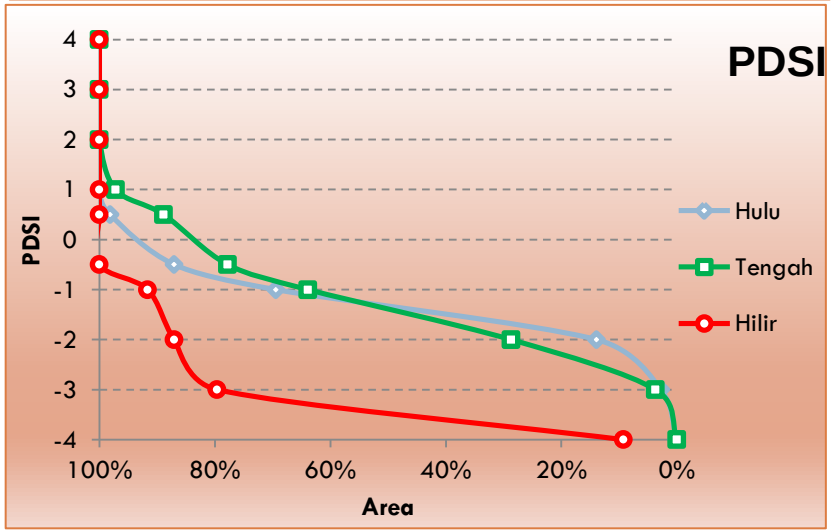
SPI = Standard Precipitation Index (1 for one month and 3 for three month)
PDSI (Palmer Drought Standard Index)

Research Finding :

Drought Assessment for Citarum River (Lisa, Kusuma and Arno)







DROUGHT SPATIAL DISTRIBUTION IN 1997

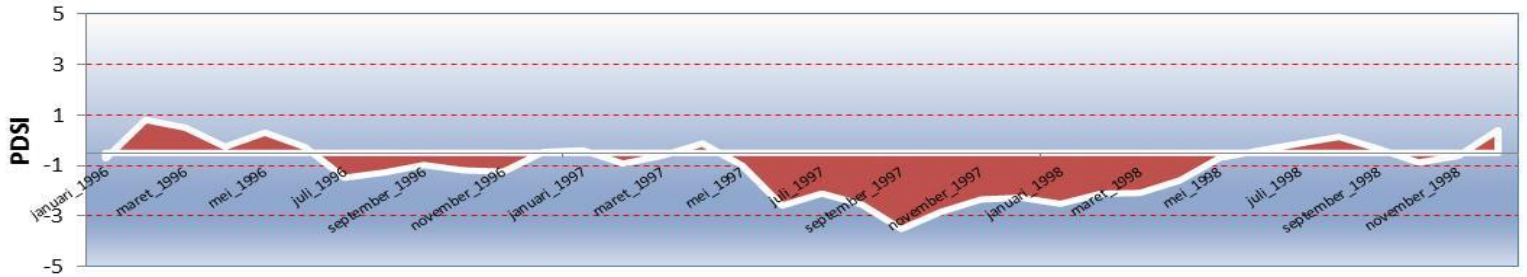
Spi-1 : 70% of downstream dry and 50% Very Dry.
SPI-3 : 70% Dry and 45%. Very dry
PDSI : 32% Dry and 4% Very dry

Research Finding :

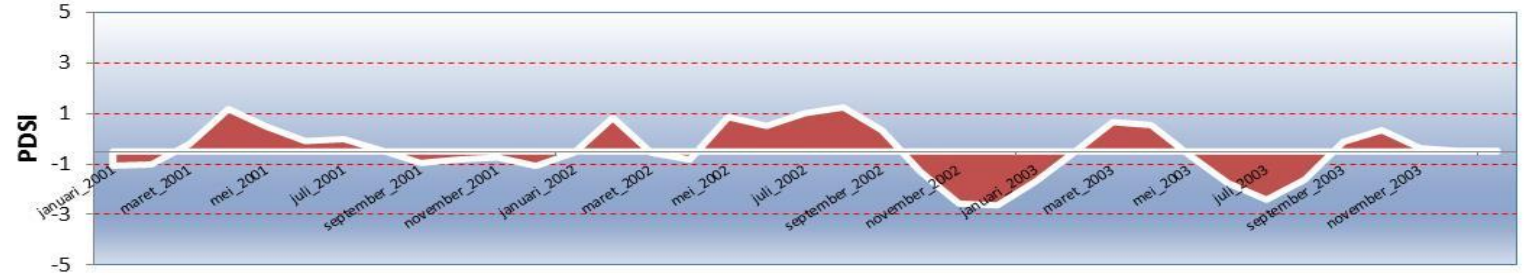
Drought Assessment for Citarum River (Lisa, Kusuma and Arno)

PDSI Scale of the East-West Cross Section of Lower Citarum River Basin

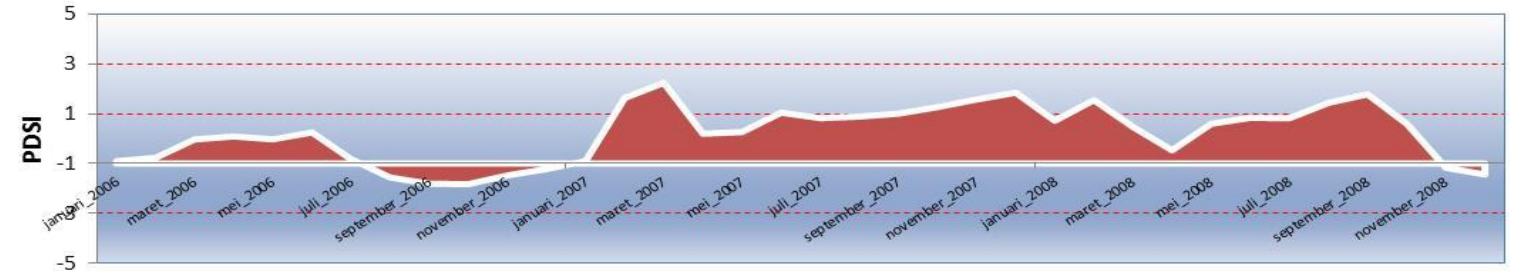
1996-1997



2001-2003



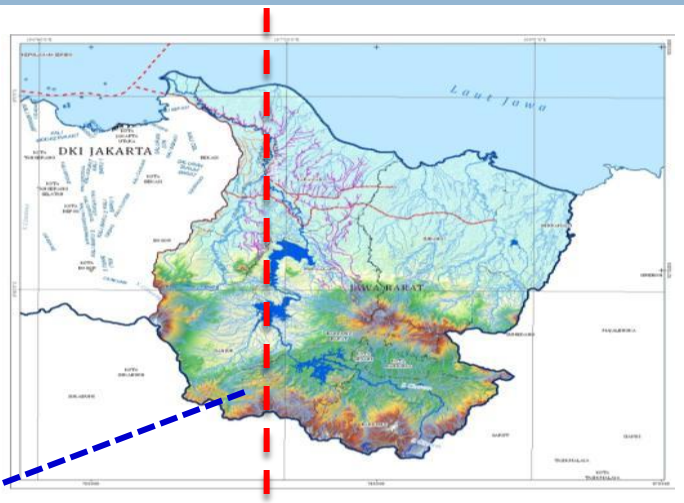
2006-2008

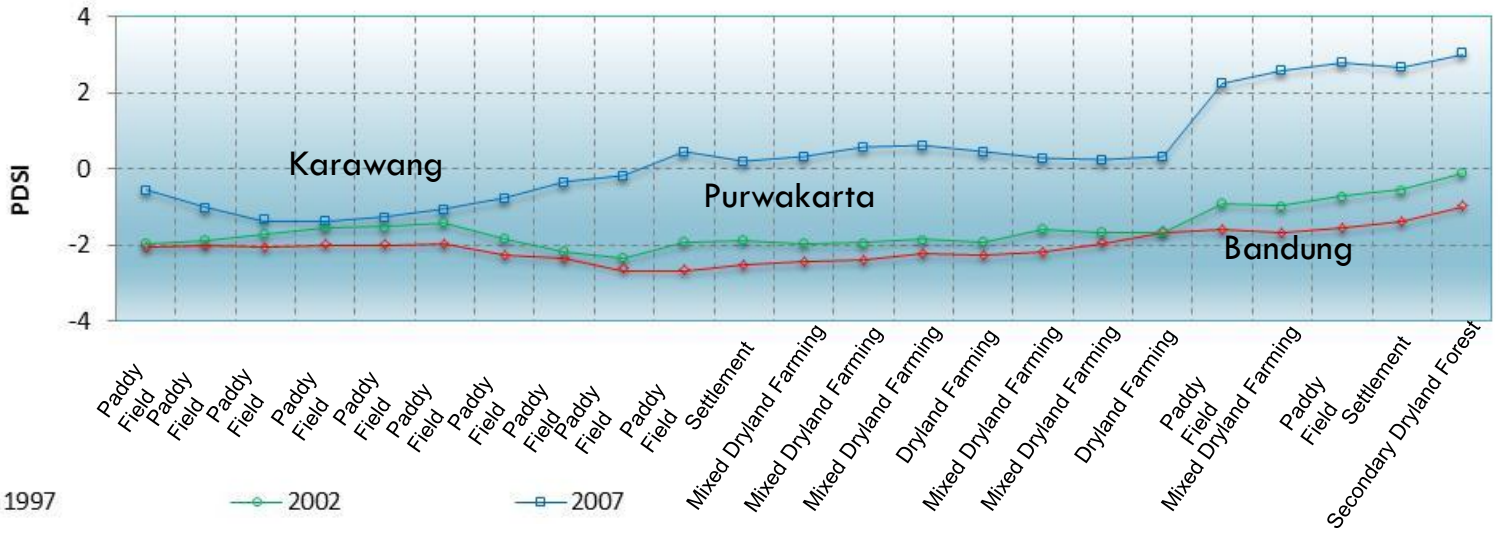


Research Finding :

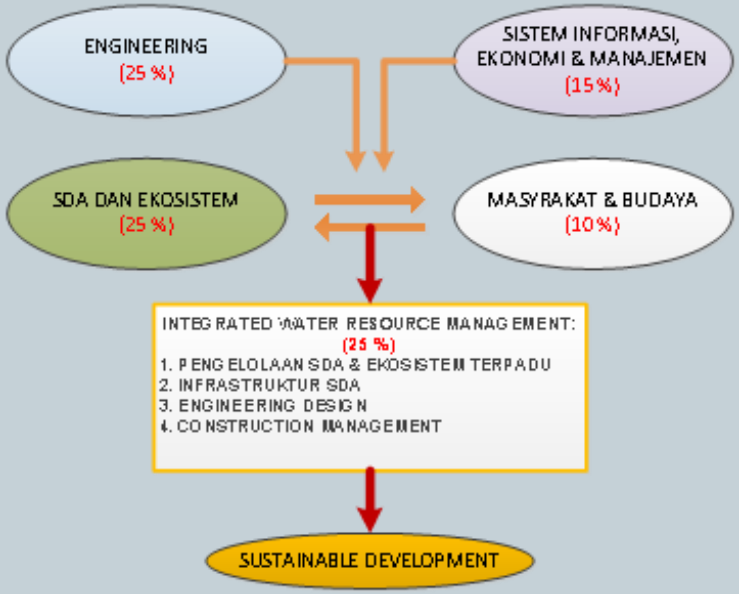
Drought Assessment for Citarum River (Lisa, Kusuma and Arno)

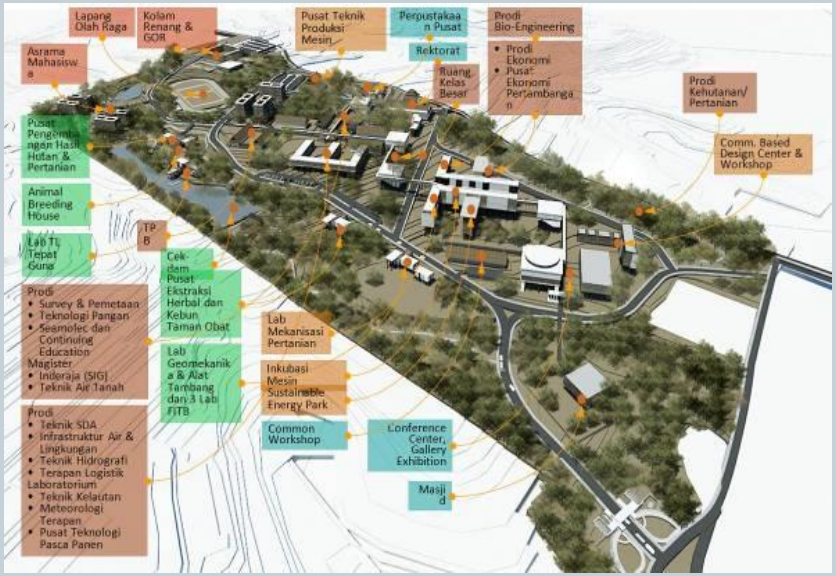
PDSI Scale along North-South Cross Section of Citarum River Basin





Establishment of new Undergraduate Program of Water Resources Management and Engineering in ITB



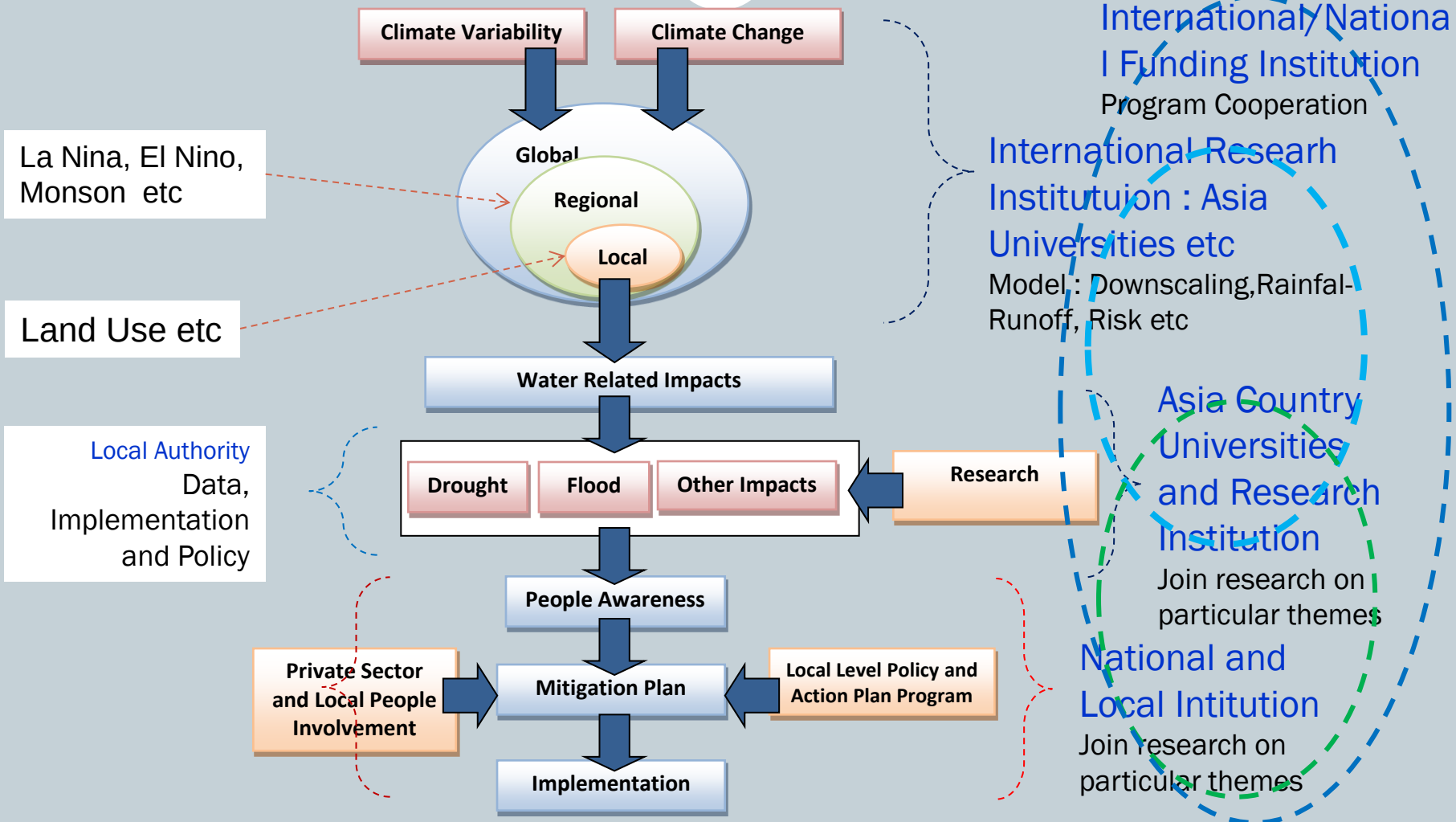


- Climate change adaptation effort is a long term effort.
- Lack of water resources engineering expert in water related Government and Private Institution
- The most appropriate systematic effort from university
- Supported by Ministry of Public Work, Min of Education and Local Government.

Coclusion : Potential Research Cooperation

- Improving Data Base
- Updating assessment methodology : flood hydrograph, and hydraulic/hydrology model
- Developing disaster risk map of both flood and drought
- Developing Applicable Action Plan for Local Stake Holder
- Contribution to Building Code Development and Improvement
- Technology Application for DRRP
- Capacity Building : New Program Study, Training
- Research, Education and Community Services

Coclusion : Research Cooperation Strategy



Thank You

KAMPUNKA

TERIMAH KASIH