

**The 7th International Coordination Group (ICG) Meeting
GEOSS Asian Water Cycle Initiative (AWCI)**
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**Several Challenges of Flood Control Development
in Citarum River toward MDG 2020**

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Topics of Discussion

1. Introduction
2. Flood Problem
3. Flood Related Problem
4. Conclusion

Introduction

- Citarum is the most important river in Indonesia as it serve (MSB Kusuma, 2007) :
 - Supplying raw water for more than 15 million people and more than 10 000 factory in Jakarta, Bandung, Bekasi, Purwakarta and Karawang.
 - Irrigating for more than 540 000 ha rice field, crops and Tea Plantation
 - Preventing more than 20 000 ha of most productive industry and agriculture area from flood in its downstream.
 - Generating more than 1500 MW hydropower
- The management of Its catchment area divided into
 - Upstream part where its water is reserved in 4 cascade reservoir
 - Downstream part where its water is used
- Annual flood occure in its upstream part and recently in its downstream
- Flood control which could maintain the above function becoming national priority to develope.

Introduction



West Java Province

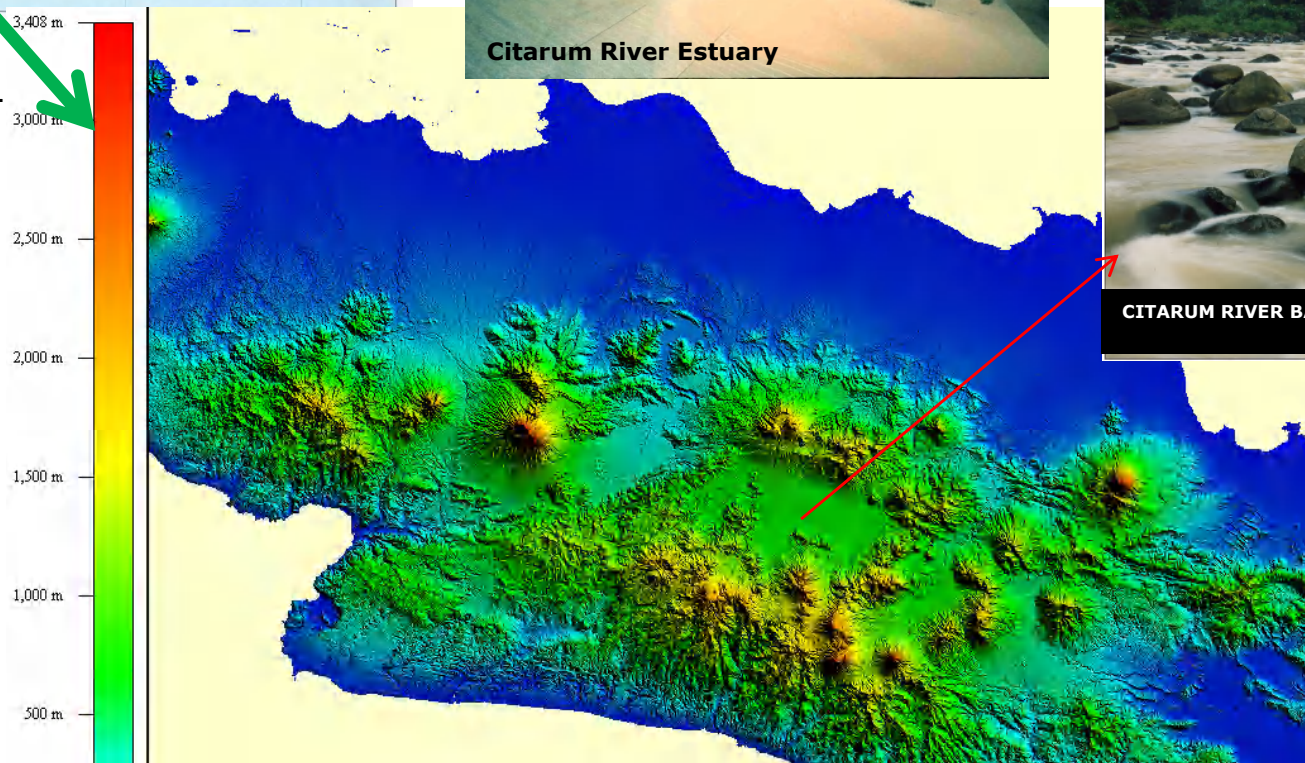


Citarum River Estuary



CITARUM RIVER BASIN (UP-STREAM)

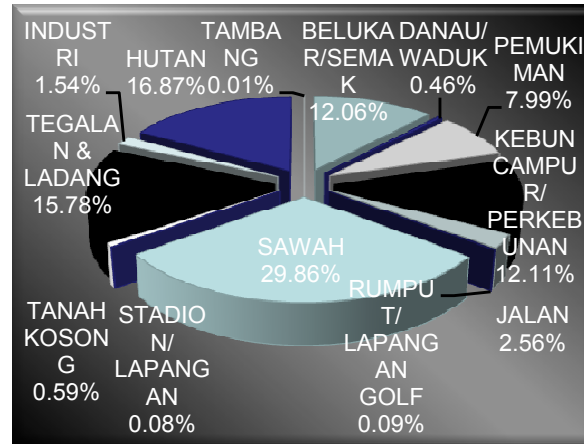
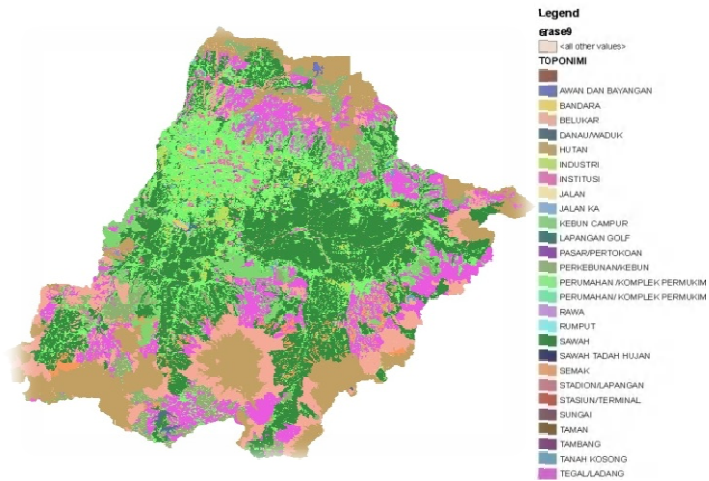
- Catchment area : 4.500 km². (BANDUNG CITY, Cianjur, Subang, Sumedang).
- Length of River \pm 300 km (Bandung Plateau, Purwakarta, Muara Bungin and Muara Karawang, and Muara Gembong Bekasi)



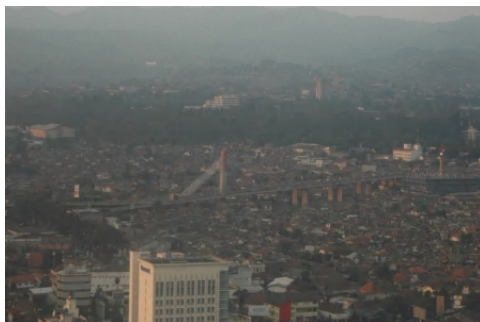
Citarum Spring
Wayang Mountain
MATA AIR SUNGAI CITARUM
DI GUNUNG WAYANG

DEM of Citarum Cacthment Area (Minola Ginting, 2010)

Introduction

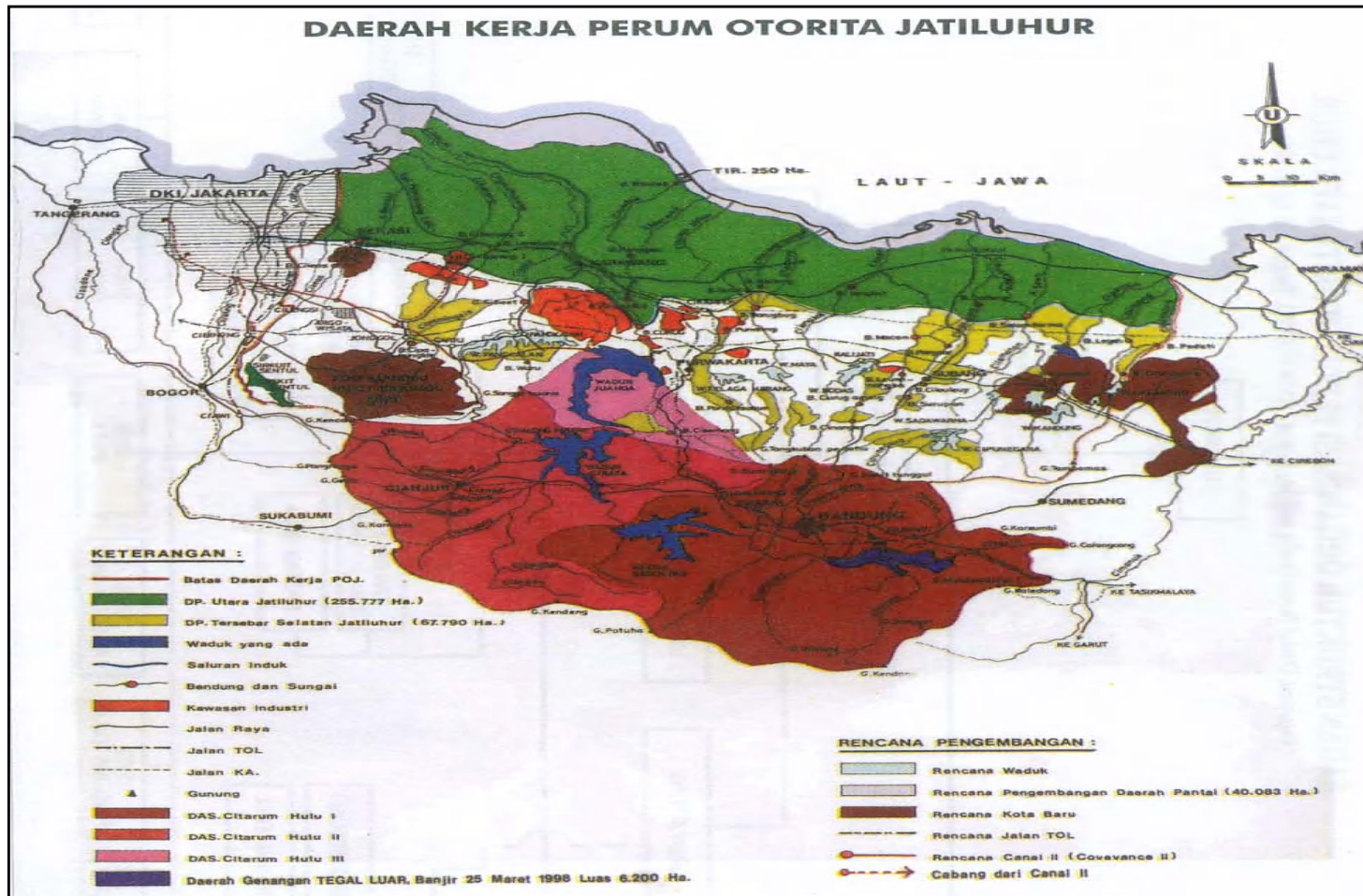


Land Use in 2005 (ITB-PUSAIR-PEMDA 2010)



Downstream and upstream of Bandung Basin, MSBK, 2005

Introduction



Terintegrasi dalam pengelolaan waduk kaskade (Jatiluhur, Saguling dan Cirata, POJ (2003))

Introduction



Three Cascade Dam

(Plan in 1957, POJ, 2003)

- Saguling is operated and managed by PT Indonesia Power (1984)
- Cirata is operated and managed by PT PJB (1988)
- Jatiluhur is operated and managed by Jasa Tirta II Public Corporation (1967)
- Raja Mandala (Next Development)

Introduction

Hydraulics Control structure

(POJ, 2003)

CURUG WEIR AND MINIHYDRO



BEET WEIR IN CIBEET RIVER



MACAN WEIR IN CIASEM RIVER



SALAM DARMA WEIR IN CIPUNEGARA RIVER
Operation of 1923



WALAHAR WEIR IN CITARUM RIVER BASIN



Introduction

FARMING AREA



Aqua Culture (20 000 Floating Net Fishery)



Function of the three Cascade Reservoir

(Plan in 1957, POJ, 2003)

INDUSTRY ZONE



Tourism



Flood Problem

1. Flood Characteristic in Citarum River

- Upstream (Bandung Basin) and downstream part (Karawang and Bekasi)
- Its management will influence water supply for Jakarta and its downstream area

2. Flood problem

- Land use change and urbanization
- Erosion, sedimentation and garbage
- Flat area and bad drainage
- Natural flood plain

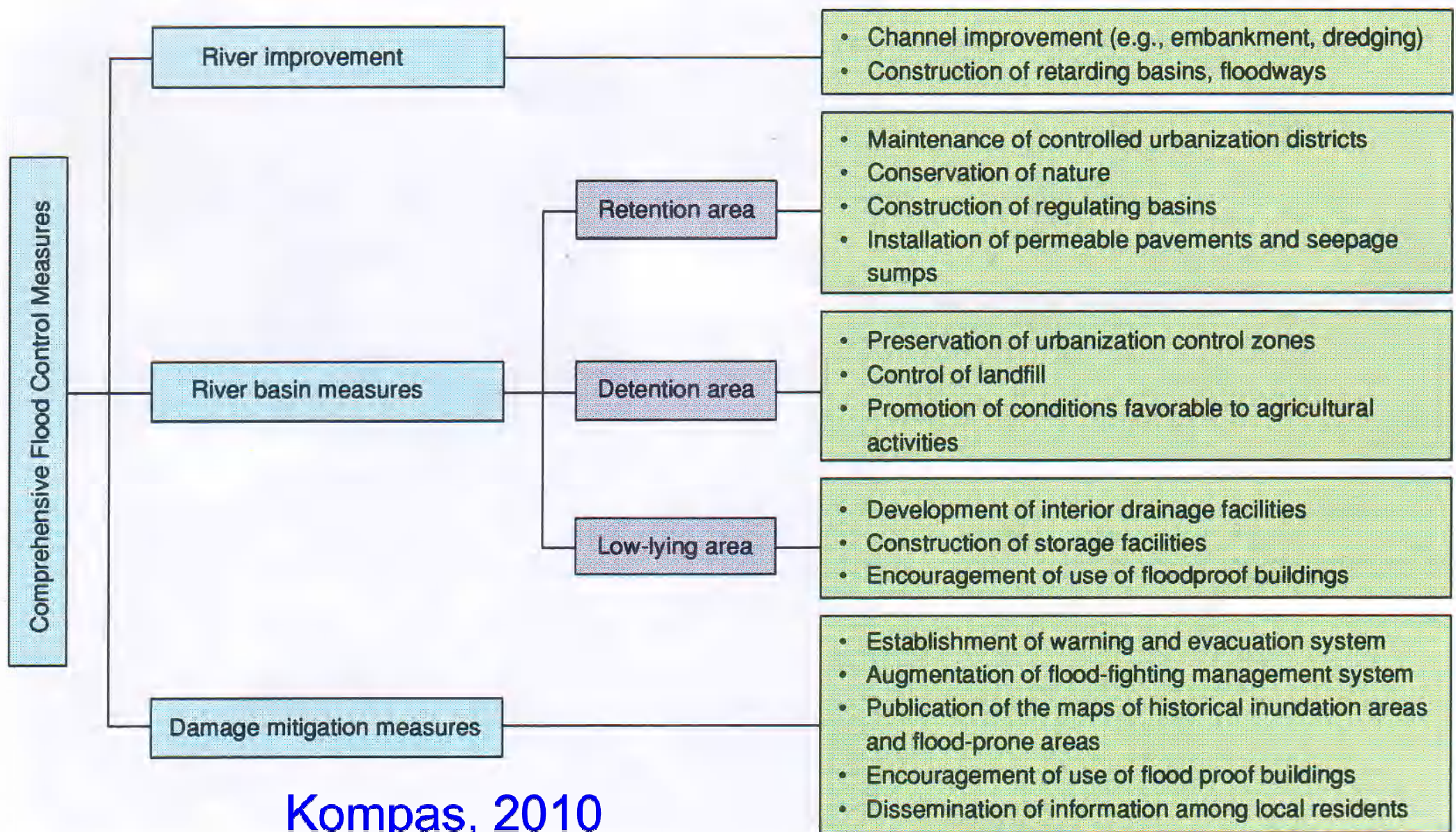


3. Existing Flood Mitigation Effort

- ⌘ Short cut, reservoirs, dikes, gates and pumps station
- ⌘ Data base and roadmap development
- ⌘ Several Approach to deal with flood parameters



Flood Problem : Existing Flood Management Concept



Flood Problem

- Lack of hydrology data
 - hujan/debit kurang
 - Budget share responsibility between central and local government
 - Lack of observation
- Lack of assessment tools
- Engineering solution
- No incentive and disincentive for downstream and upstream of the Catchment area

Flood Problem : Upstream Area



Jalan Pajajaran, anonim ,1996.



Increasing flood

- Hydrograph
- Index : duration, depth and frequency
- Risk



Jalan Maribaya, Msbadrik ,2006.



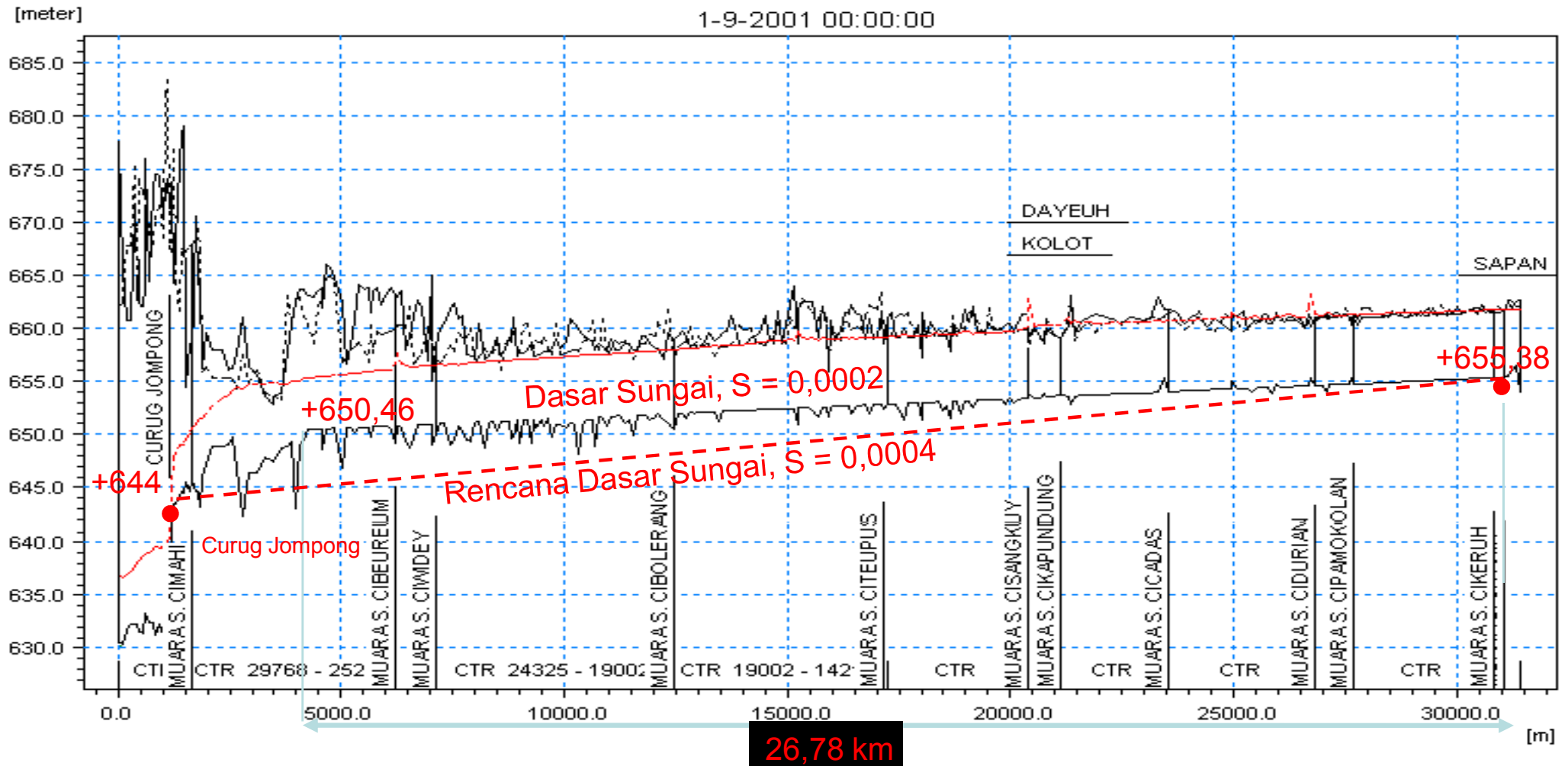
Bale Endah, Msbadrik, MSBK, Februari 2010)

Flood Problem : Upstream Area



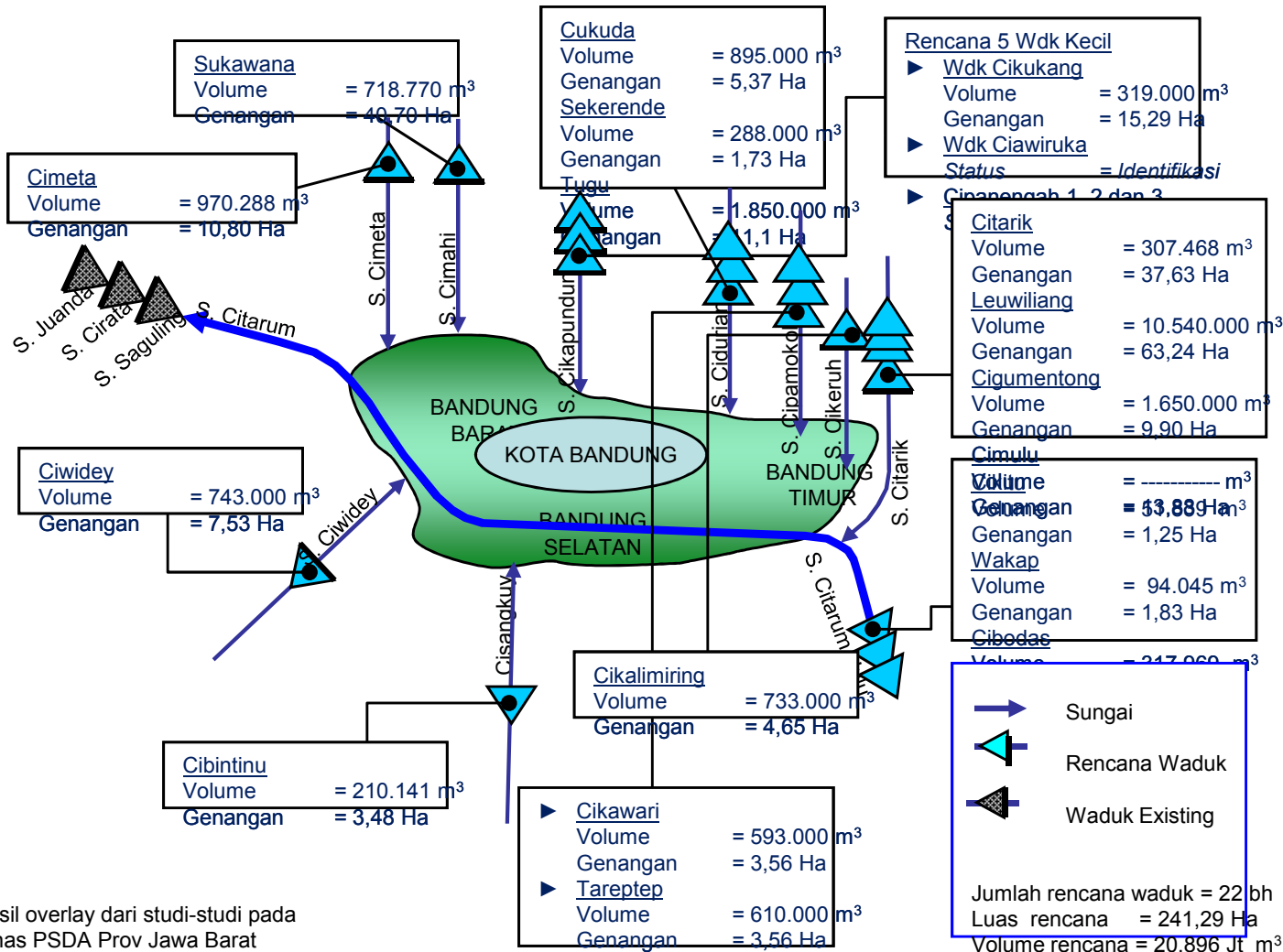
Botle Neck in Curug Jompong (Kompas-ITB-
PUSAIR Discussion, 2010)

Flood Problem : Upstream Area



Longitudinal profile of upstream Citarum river (average slope 0,0002 → flat, Yadi Suryadi, 2006)

Flood Problem : Upstream Area



Hasil overlay dari studi-studi pada Dinas PSDA Prov Jawa Barat

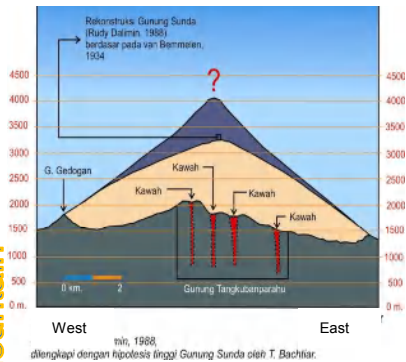
- Developing small reservoir in upstream area (Kompas-ITB-PUSAIR Discussion, 2010) for
- Decreasing the flood peaks and risk
- Decreasing sedimentation
- Increasing water availability
- Increasing land use change
- Flood plain area remind

Flood Problem : Upstream Area

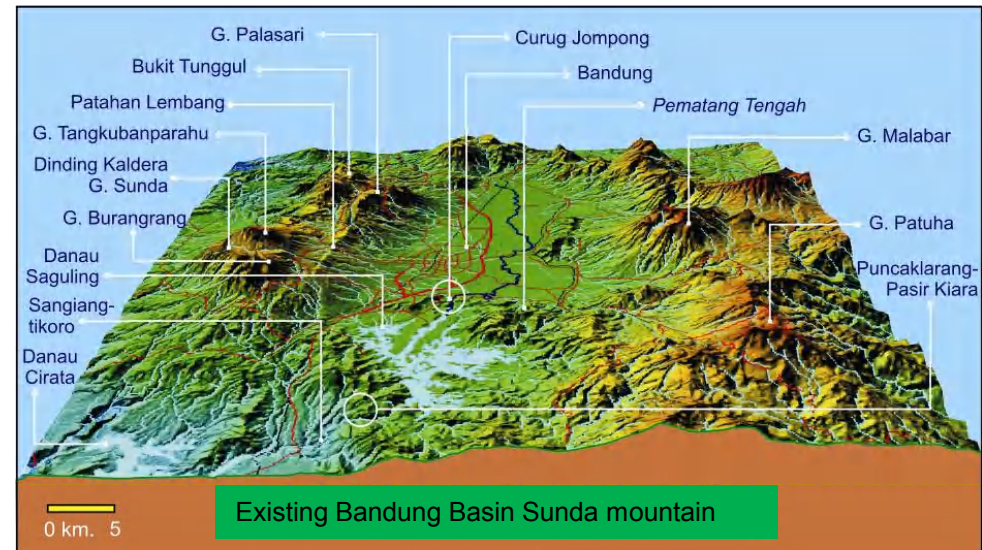
- The existing effort foccused on Engineering solution
- Current flood control system work unproperly
- Trend to repeat the fault
- Several Problem (MSB Kusuma, 2007) :
 - **Engineering**
 - Influences to the capacity and safety of three cascade reservoir
 - Unidentified of flood hydrograph and contribution of each river
 - Current flood building code should be updated
 - Current infrastructure development should not be foccused only along the citarum river
 - Require more flood alternative solution
 - Require more holistic solution
 - **Non Engineering**
 - Influences to the function of three cascade reservoir
 - Knowledge, awareness and contribution of stakeholder to flood risk reduction is very low
 - No roadmad for flood infrastrucstur development

Flood Problem : Upstream Area

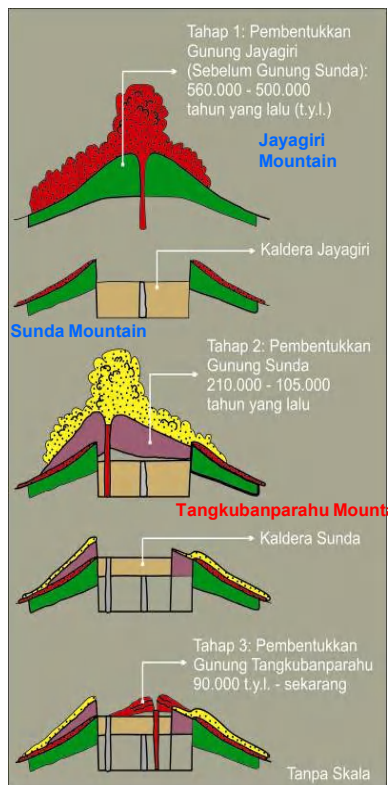
Original Sunda mountain after geologist analysis



Recontruction of Bandung Basin (Bachtiar)

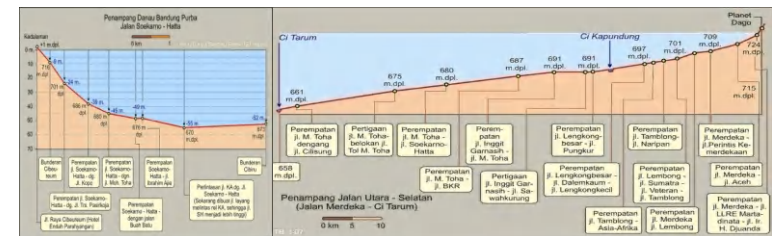


Exploitation of Sundai mountain



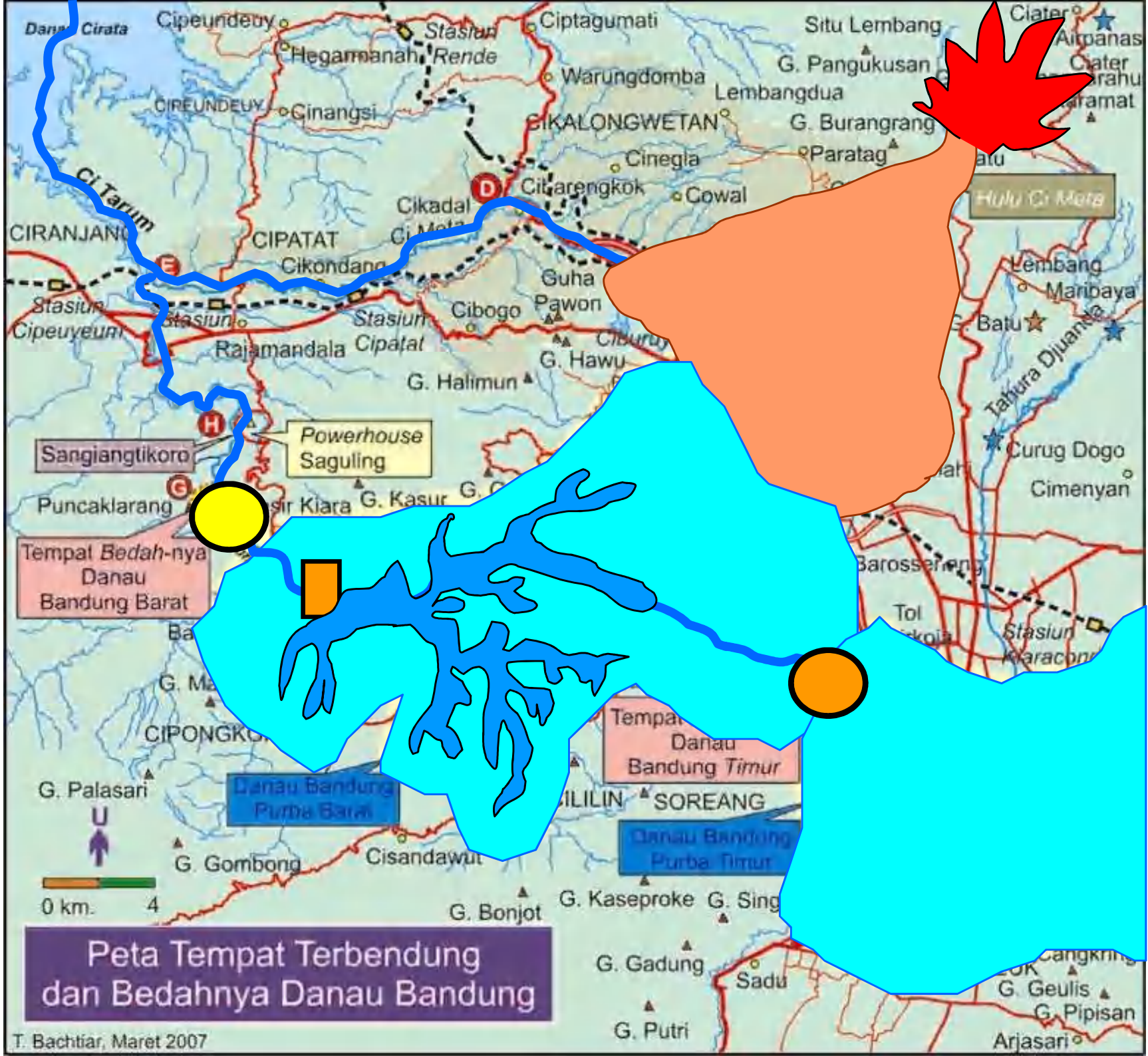
Bandung basin as the upstream part of Citarum River is natural flood plain which is developed as

- Agriculture area
- Textile industry
- Tourism
- Hydropower
- Aqua Culture
- 5th big city in Indonesia



(M. Nugraha Kartadinata, 2005)

Flood Related Problem : Upstream Flood, (Bachtiar, 2010)



Flood Related Problem : Upstream Flood



Erosion due to vegetable crops upper part of Citarum River (Bachtiar)



Land slides upper part of Citarum River (Bachtiar)



Drought in situ lebang, upper part of Citarum River (Bachtiar)



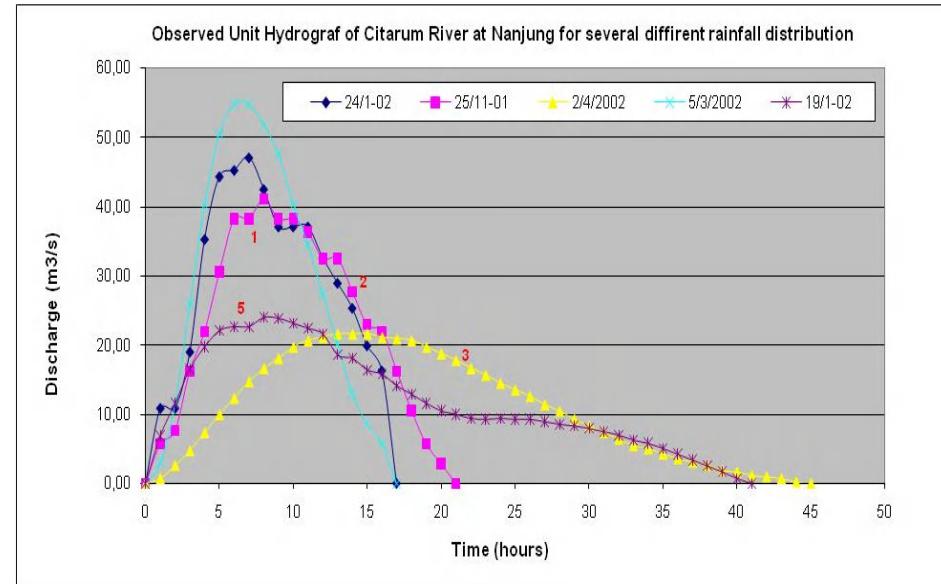
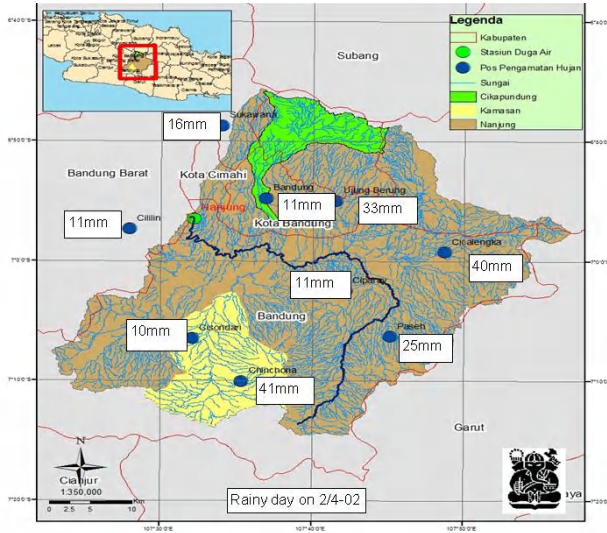
Sedimentation in downstream area (4,2 Million m³/year in 1982, (Bachtiar))

Bricks production using dredging material in sedimentation area, (Bachtiar)

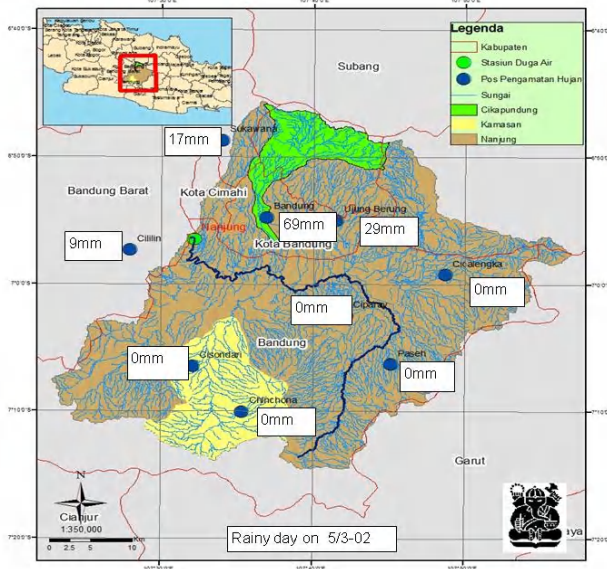


Flood Related Problem : Upstream Flood

Spatial distribution of rainfall observation on 2-4-2002 (yellow line)



Spatial distribution of rainfall observation on 5-3-2002 (blue line)



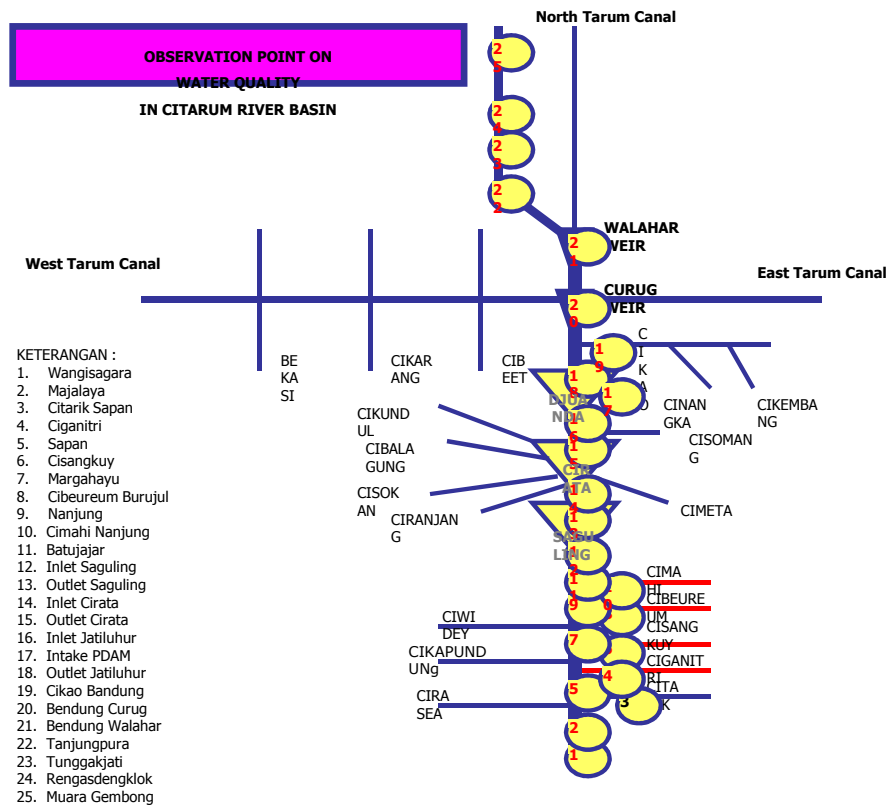
Observed Unit Hydrograph of Citarum River for Several Rainfall Distribution (Ariani, 2010)

Its unit hydrograph form depend on :

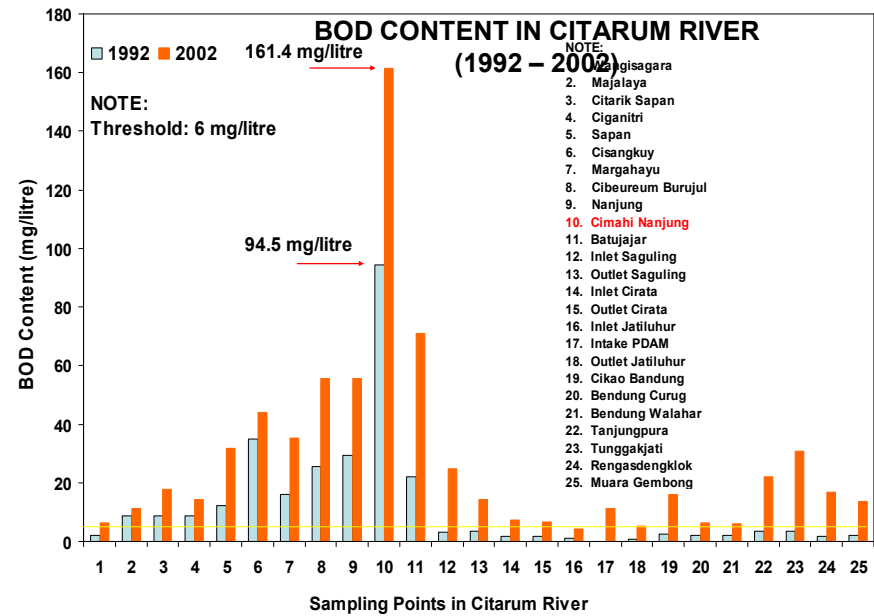
- rainfall distribution that generate its runoff
- Flood plain capacity

Large deviation results analysis between the well known methods:

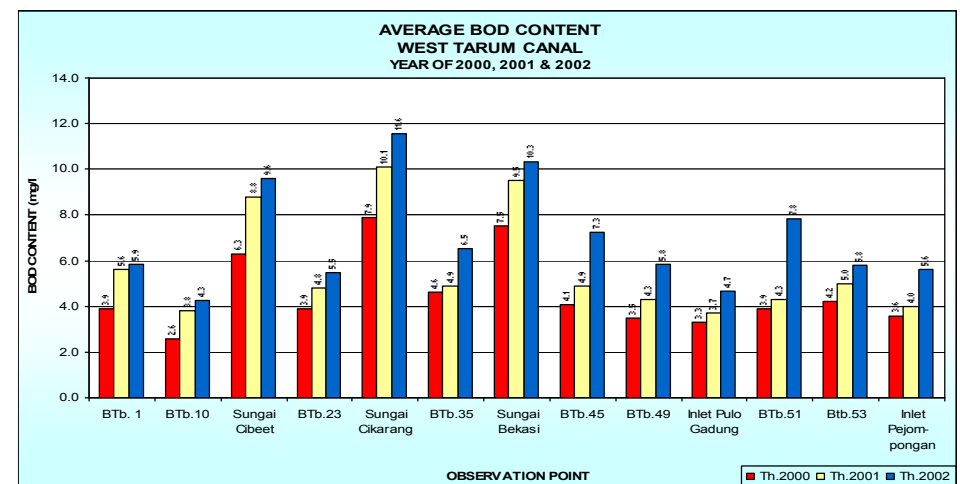
Flood Related Problem



Water quality problem in the reservoir which influenced by flood (Jasa Tirta, 2005 and MSB Kusuma, 2009)



AVERAGE BOD CONTENT IN WEST TARUM CANAL



Flood Related Problem



Debris in Cibeeet Syphon



Debris in Curug Weir



Algae in Jatiluhur Dam



Debris and algae in Bekasi Weir



ENVIRONMENT MANAGEMENT IN CITARUM RIVER BASIN Jasa
Tirta, 2005 and MSB Kusuma, 2005

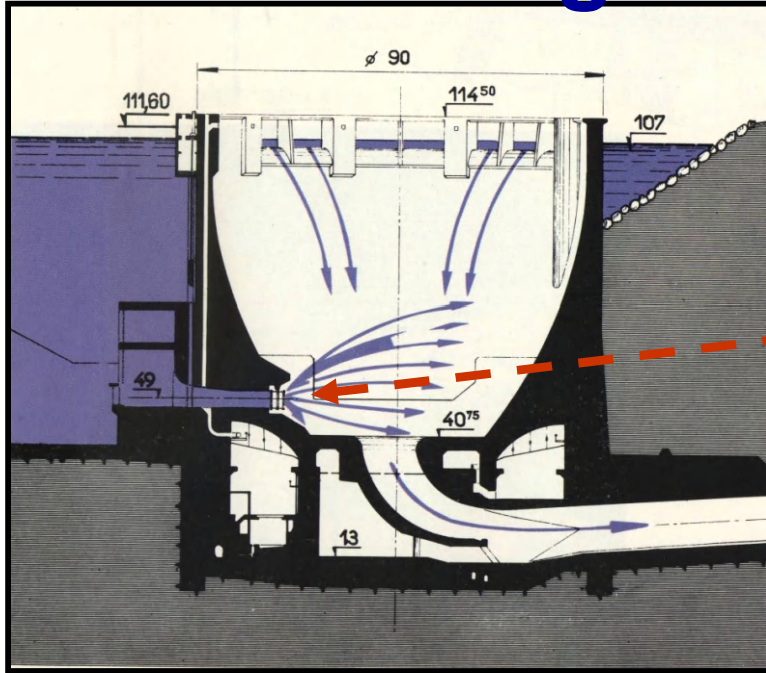
Flood Related Problem : Damage of control structures



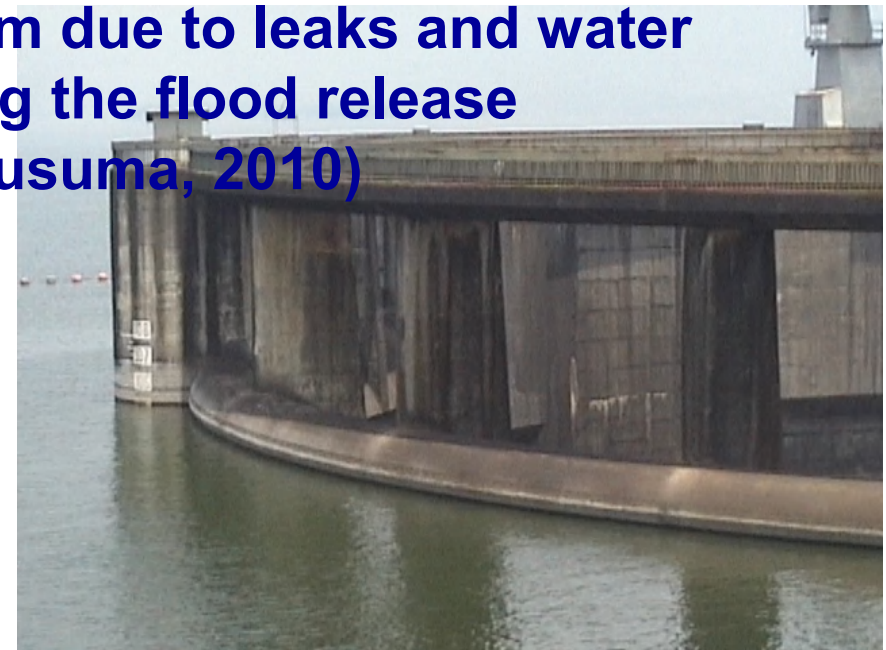
Damaged hydraulic structure by flood flow, MSB Kusuma, 2008



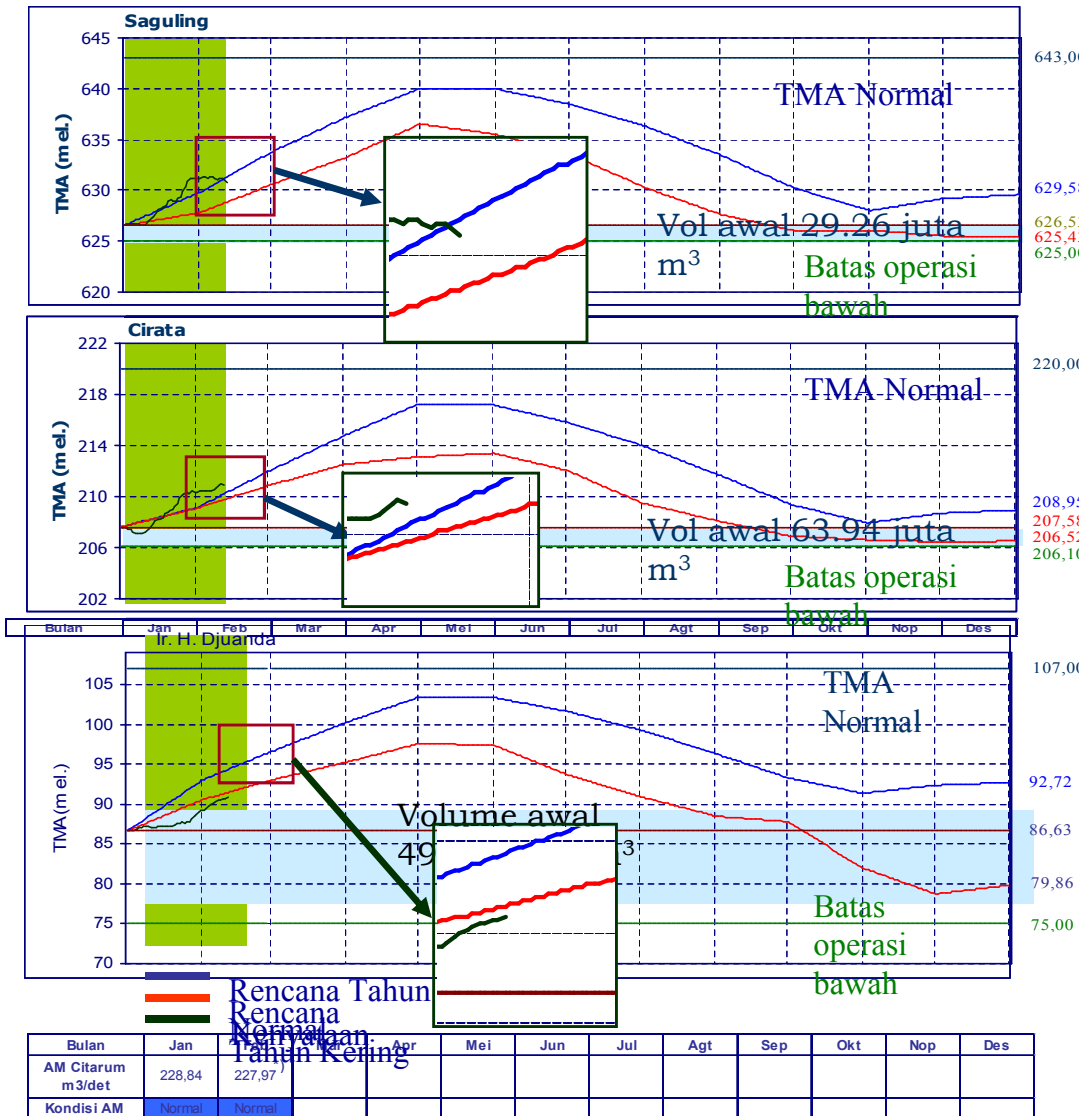
Flood Related Problem : Damage of control structures



**Maintenance and safety problem due to leaks and water pressure especially during the flood release
(Anom and MSB Kusuma, 2010)**



Flood Related Problem : Water Allocation



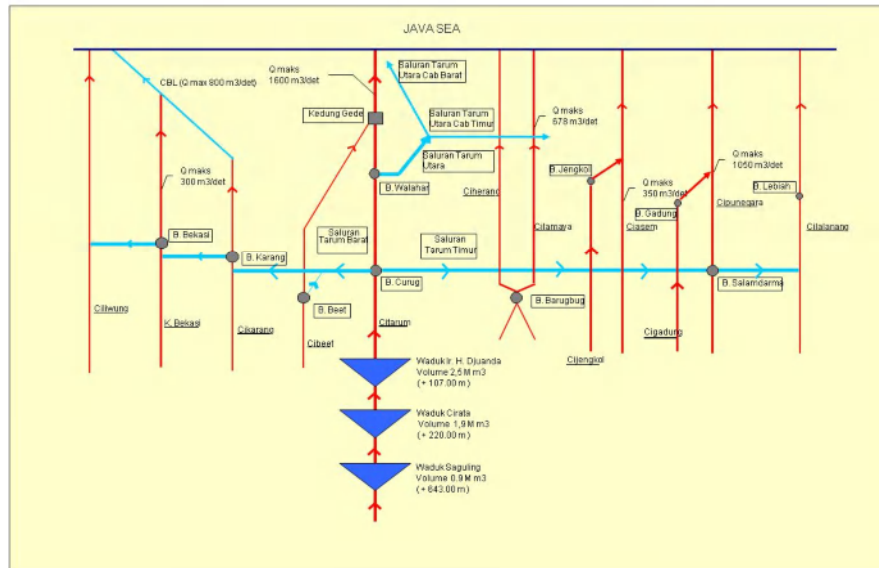
Catatan: *) s.d tanggal 13 Februari 2004

DESCRIPTION	TARIFFS	
	IDEAL (1999)	REALISATION (2003)
Electricity	137	115.51
Jakarta Water Supply Company (PAM Jaya)	136	80
Domestic & Industry	54	40 / 50

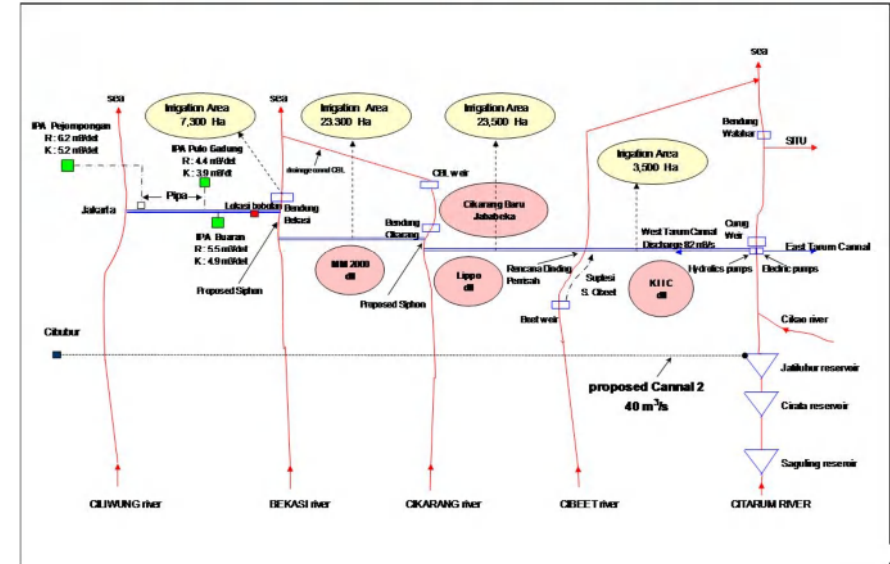
- Water allocation for each reservoir (freshwater, irrigation and hydropower)
 - Appropriate Supply for existising irrigation
 - Change of land use and channel system function → water supply inefficiency
 - Flood control (downstream and upstream).
- Sedimentation and Water quality Control
- Affordable aquaculture in each reservoir (Now Rp 1 T meanwhile Reservoir Management Rp 400 B)
- (Data Jasa Tirta, 2005, Conclusion MSB Kusuma, 2010)

Flood Related Problem : Water Allocation

Scheme of Citarum Water Resources System

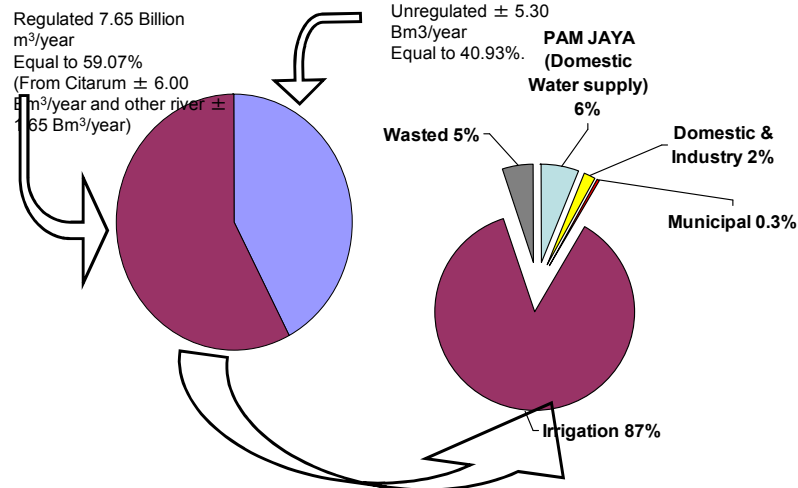


SCHEMATIC OF WEST TARUM SUB SYSTEM



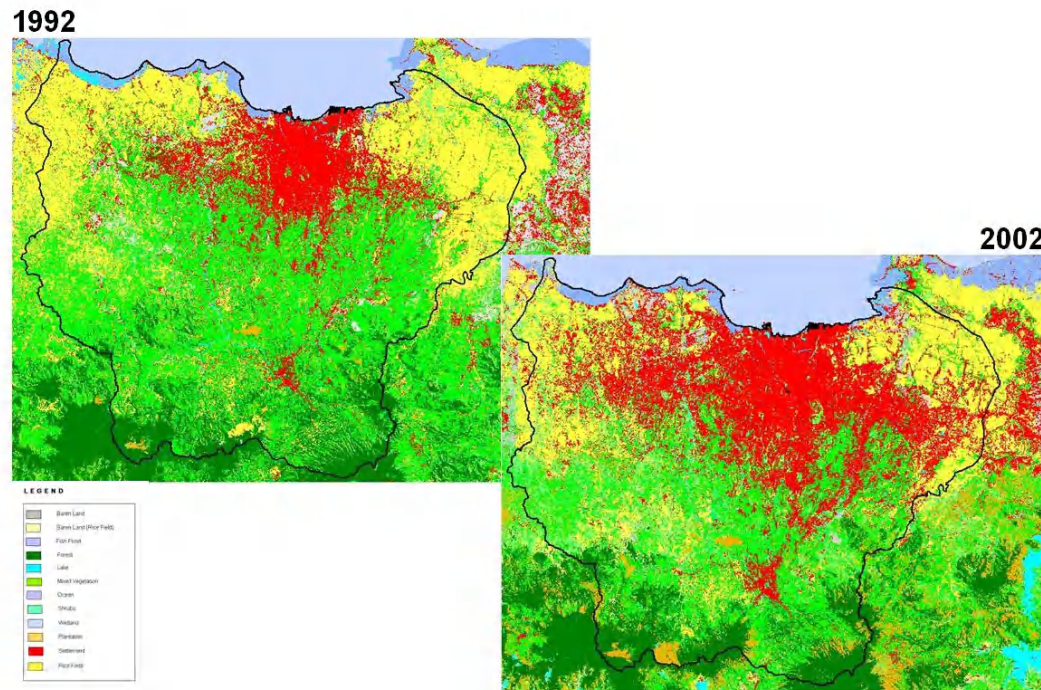
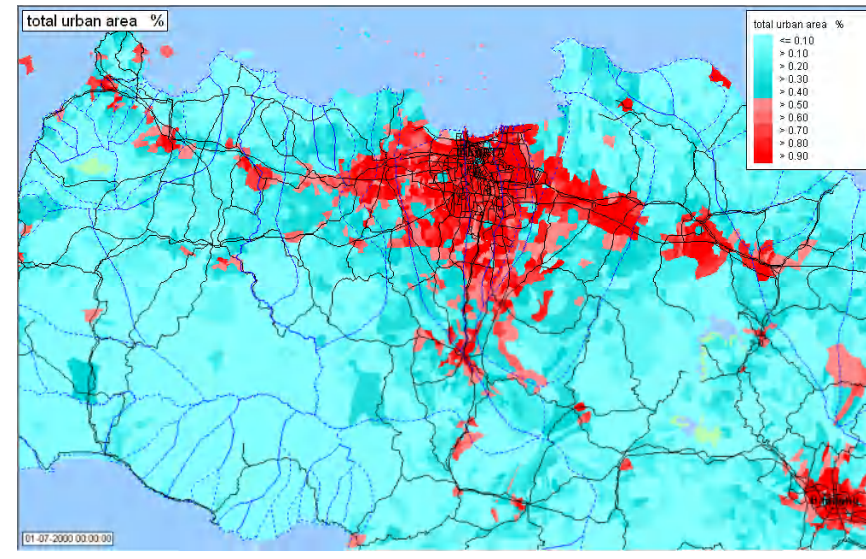
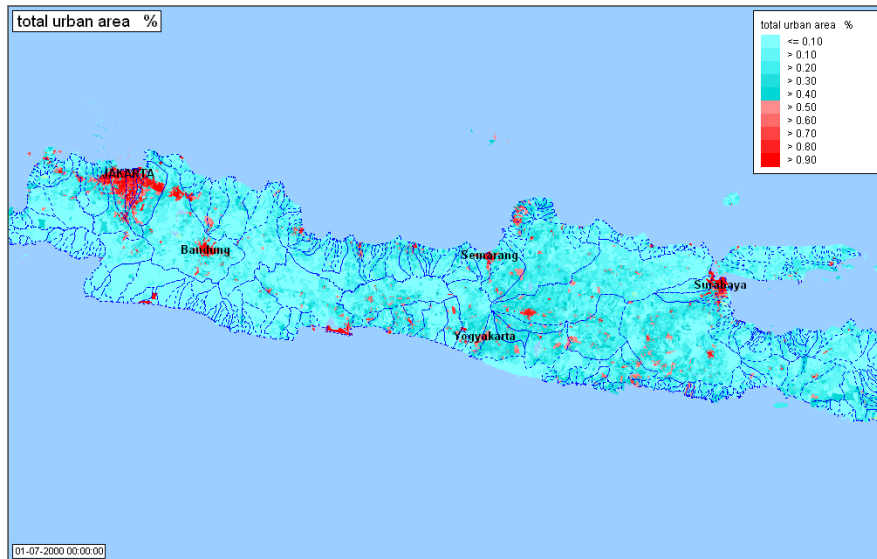
WATER RESOURCES POTENTIAL IN CITARUM RIVER BASIN

Total ± 12.95 Billion m³/year
 Citarum : 6.00 Bm³/year
 Other river : 6.95 Bm³/year



- Increasing demand of drinking (quantity & quality) water capacity for Jakarta City, Bekasi, Kerawang and Purwakarta
- Increasing demand of water supply capacity for Industrial activity in JABEK
- Land transformation from agriculture to housing and industrial area in Bekasi, Kerawang and Purwakarta.
- Increasing price of fresh water for Jakarta due to the raw water degradation generated by the intrusion of industrial waste water through the junction of Tarum Barat channel with industrial drainage system.
- Transforming function of water supply system along Tarum Barat Channel and Irrigation system
- (Data Jasa Tirta, 2005, Conclusion MSB Kusuma, 2010)

Flood Related Problem : Jakarta Flood



Total urban area % based on java-ba spatial plan (2000 – 2025) and its progress

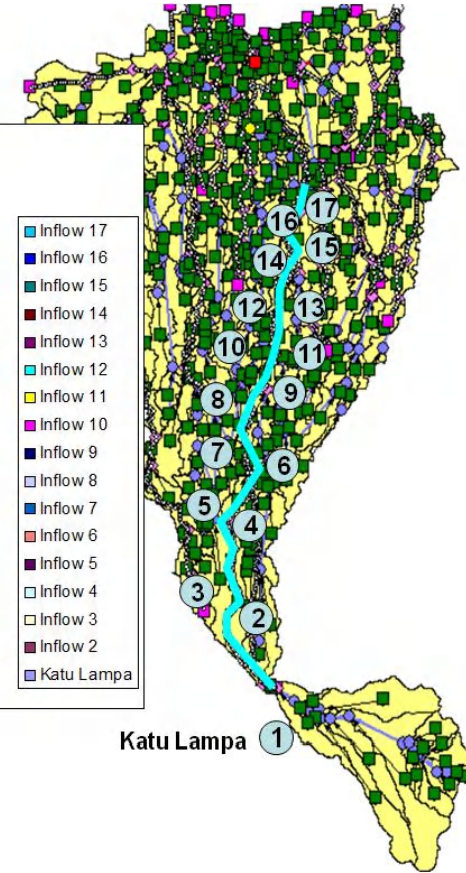
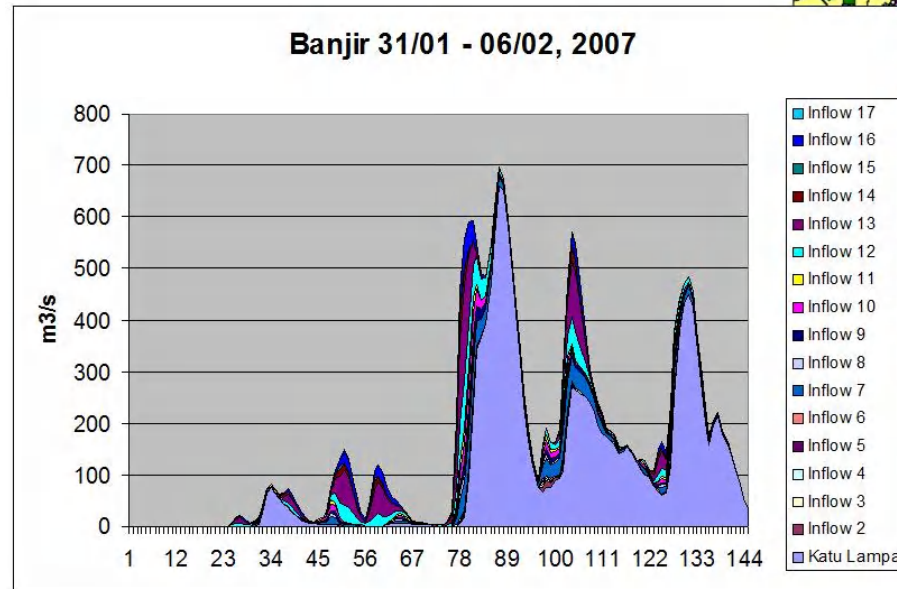
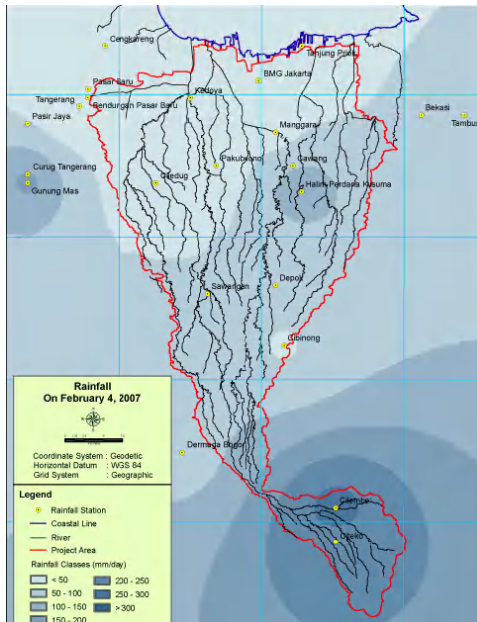
Updating water resources management system require more detail data on rainfall and discharge (Data : Delft/BAPPENAS 2007, and Conclusion : MSB Kusuma 2007)

Flood Related Problem : Jakarta Flood

Feb 2 at 07:00



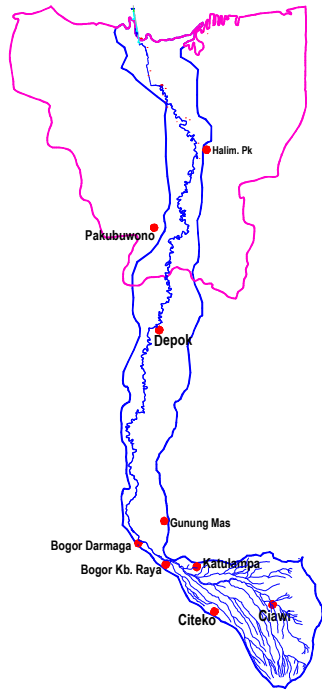
Feb 4 at 07:00



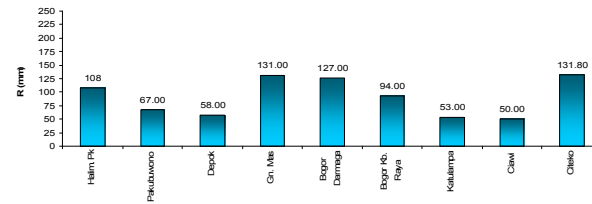
Daily rainfall on 2007
Flood in Jakarta

Discharge at several point of observation in Ciliwung jakarta on 2007 flood, (Data : Delft/BAPPENAS 2007, and Conclusion : MSB Kusuma 2007)

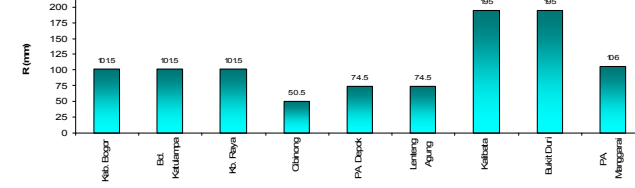
Flood Related Problem : Jakarta Flood



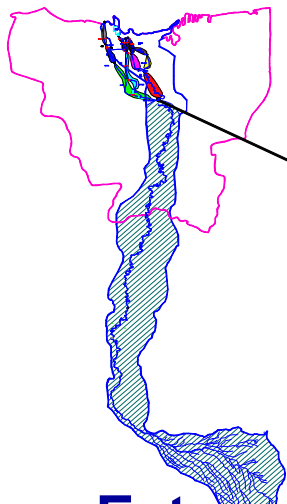
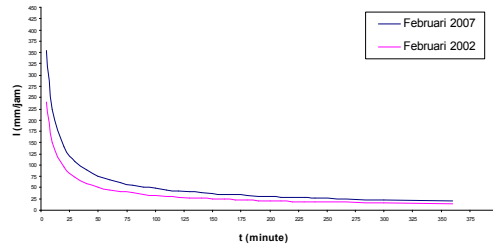
February 2002's Flood (Februari 2002)



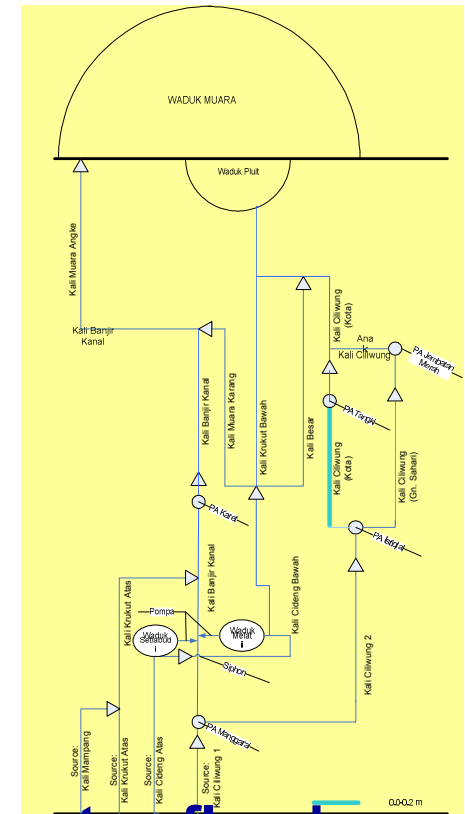
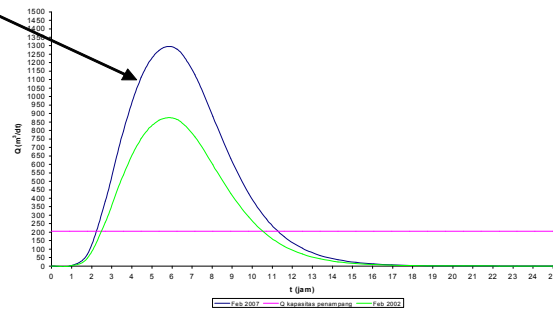
February 2007's Flood (Februari 2007)



Catchment Area of Ciliwung Tengah



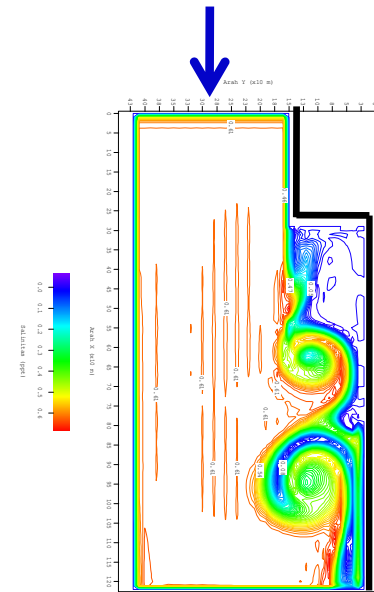
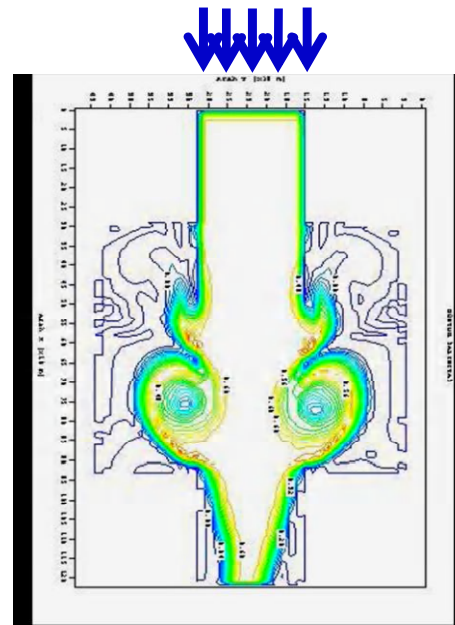
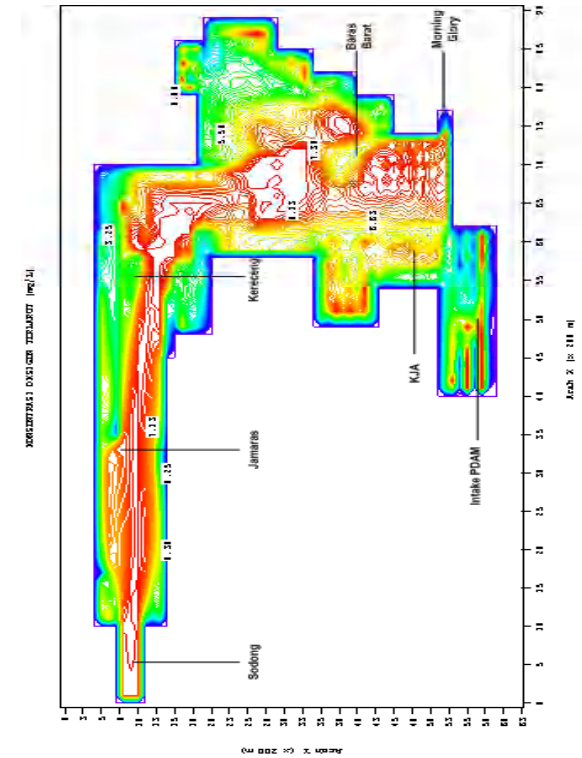
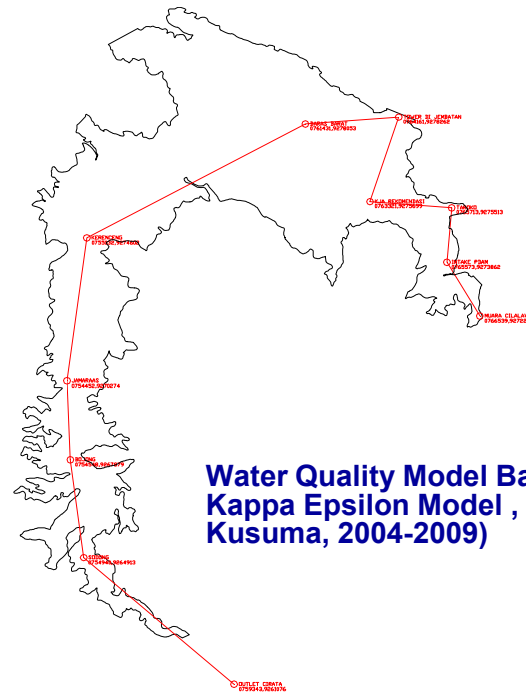
Hidrograf Banjir Sub DAS Ciliwung Tengah



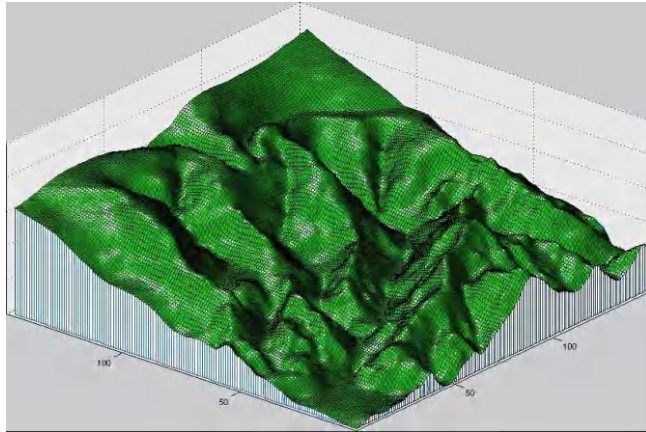
Estuary dam as the best alternative solution for raw water, flood, soil subsident, sea instrusion, sea level rise (MSB Kusuma, 2006)

Flood Related Problem : Reservoir Water Quality Model

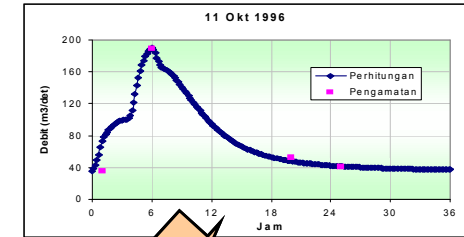
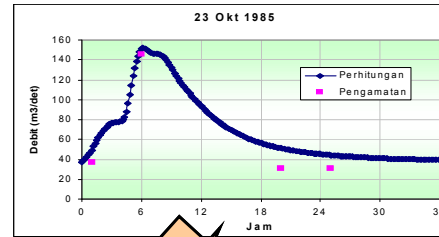
STASIUN	KONSENTRASI OKSIGEN TERLARU T (mg/L)
Parungkalong	4.00
Sodong	2.45
Bojong	2.13
Jamaras	8.43
Kerenceng	5.15
Keramba	7.30
Cilalawi	6.24
PDAM	7.46
Taroko	7.37
Baras Barat	7.59
Dam	8.45



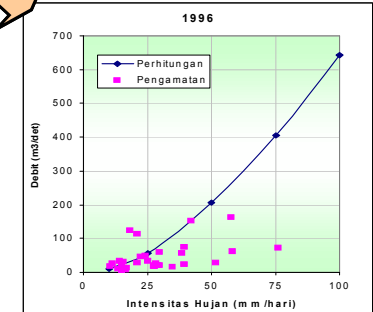
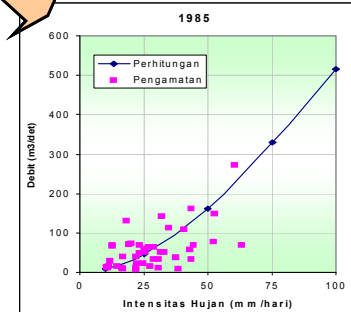
Flood Related Problem : Rainfall-Runoff Model



Hidrograph



Calibration



**Correlation
Rain-Discharge**

Development two dimension model for rainfall runoff model to improve flood and erosion hydrograph (MSB Kusuma, A Kuntoro, Farid, M Bagus, 2004-2008)

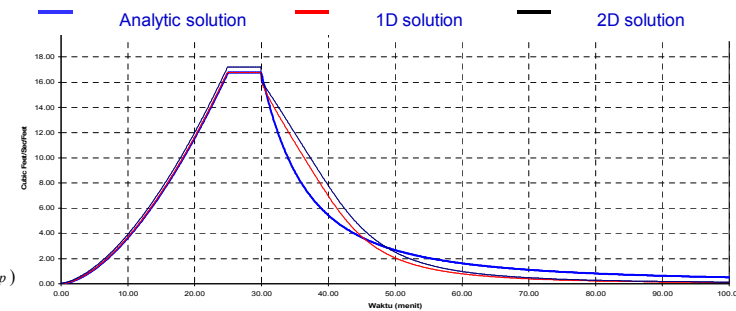
$$I_0 = h_{\text{rer}}$$

$$\alpha = \frac{1.49}{CM} \sqrt{S_0}$$

$$t_p = \left(\frac{L}{\alpha I_0^{m-1}} \right)^{1/m}$$

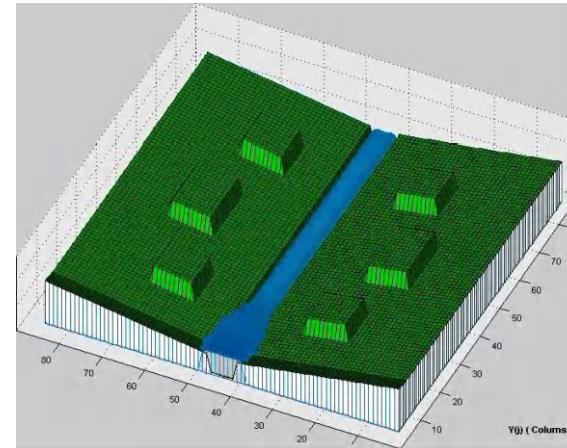
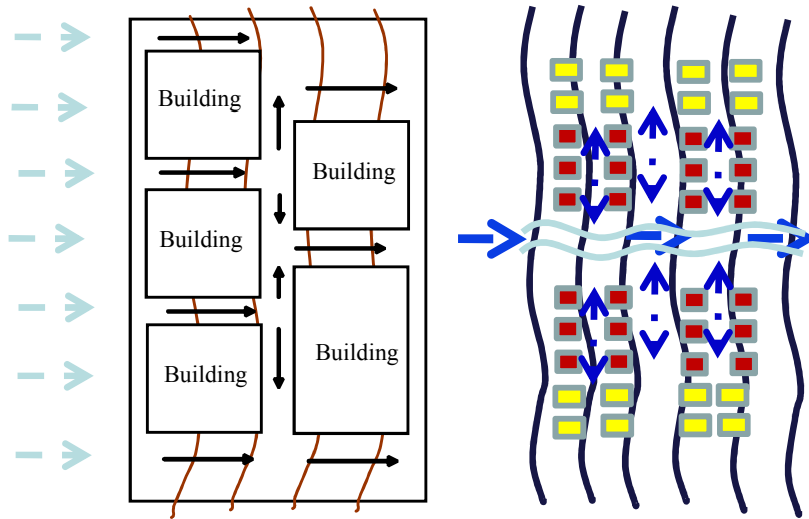
For $t > t_p$:

$$L = \frac{q}{I_0} + mq \left(\frac{1-\frac{1}{m}}{\alpha} \right)^{\frac{1}{m}} (t - t_p)$$

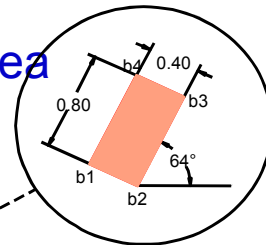


Hydrograph of the analytical solution obtain from the equation above compare to the simulation result at the lower part of the terrain (outlet)

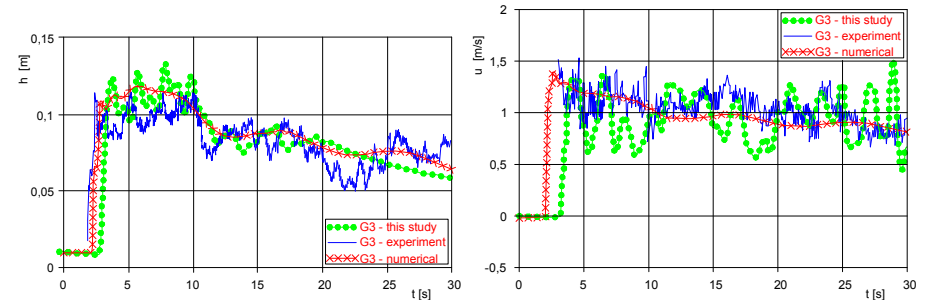
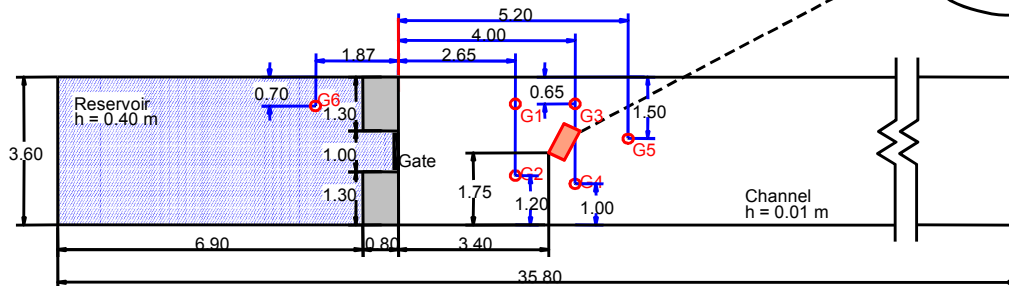
Flood Related Problem : Flood Propagation Flow in Urban Area



Medium to high complexity urban area



Development two dimension model for flood propagation in urban area to improve flood index (MSB Kusuma, M. Farid, M Bagus, E Soewono, Hang tuah, M Cahyono, 2004-2008)



Soares Frazão et. al., (2002), MSBK (On going 2010)

Conclusion

Better solution required to maintain the support of Citarum River to the most productive area such as Jakarta, Bekasi and Karawang as these area are very important to the success of MDG2010 in Indonesia

Better solution could only be achieved if the following effort are taken

- improvement on data base system and assessment tools
- improvement of stakeholder contribution
- Jakarta flood and water requirement is a part of the problem that should be solved where incentive and disincentive concept could be apply
- Roadmad of flood development

Thank You