４. 発表要旨集

4. Abstracts and Presentation slides

Session 1

“Crisis Management and Reducing Risk from Disasters in Indonesia”

Countermeasures for Erosion and Sedimentation Problem in Upper reach of Brantas and River bed Degradation in Middle Reach of Brantas and Porong

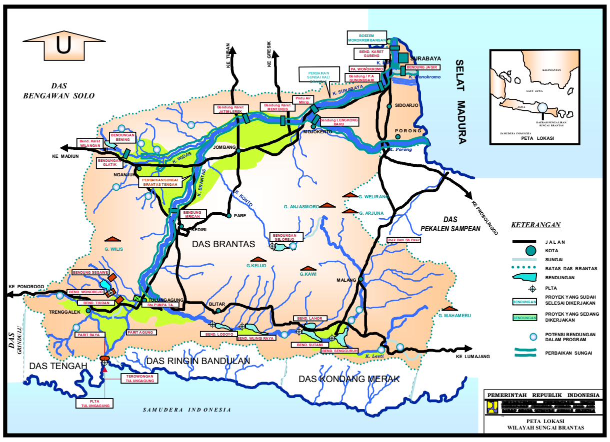
Mr.Sugiyando

Brantas River Office, Ministry of Public Works

COUNTERMEASURES FOR EROSION AND SEDIMENTATION PROBLEM IN UPPER REACH OF BRANTAS AND RIVER BED DEGRADATION IN MIDDLE REACH OF BRANTAS AND PORONG

SUGIYANTO
BRANTAS RIVER BASIN OFFICE
DIRECTORATE GENERAL OF WATER RESOURCES
MINISTRY OF PUBLIC WORKS

MAP OF WATER RESOURCES POTENCY AT EAST JAVA



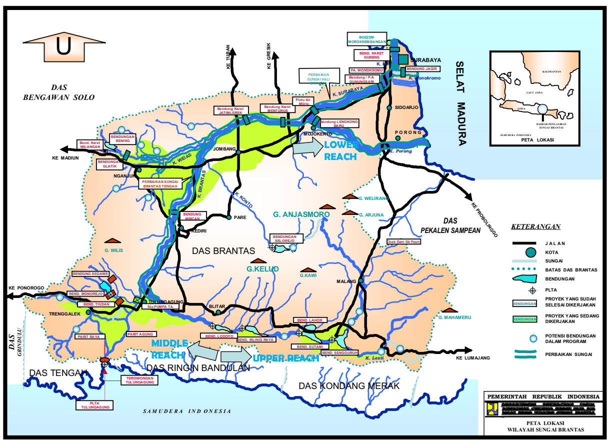
BRANTAS RIVER BASIN
(11.800 km^2)

Devided into 3 reaches :

- Brantas Upper Reach
  From Mt. Anjasmoro to Lodoyo Dam
- Brantas Middle Reach
  From Lodoyo Dam to New Lengkong Barrage
- Brantas Lower Reach
  From New Lengkong Barrage to River Mouth

BRANTAS RIVER :

- The River with 320 km length
- There is a Mt.Kelud Volcanic Area that contributes a large volume of Sediment into the Brantas River
- The six dam reservoirs were constructed from seventies to eighties at the upper and middle reaches, i.e. : Sengguruh, Sutami, Lahor, Wlingi, Lodoyo and Selorejo Dams
- Since completion of the dam construction works sediment accumulation in the dam reservoirs has significantly reduced their original storage capacities

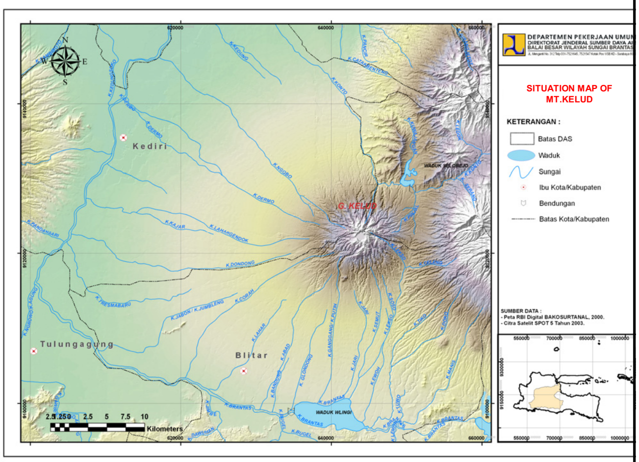


THE ACTIVE VULCANOUS OF MT.KELUD

- Brantas R. characterized by clockwise watercourse centering on around Mt.Kelud
- In Twentieth (20th) century erupted 5 times (1901; 1919; 1951; 1966; 1990), produced 90 - 320 million M^3 of ejecta per eruption
- One of sediment sources in the middle Brantas River Basin (pyroclastic flow & ash fall deposits)
- After raining, it deposites are conveyed to the down stream

THE ACTIVE VULCANOUS OF MT.SEMERU

- Located at the catchment boundary (eastern)
- Vulcanic materials entering into the Brantas main stream are relatively small (mostly to the Pekalen-Sampean River Basin)



EROSION AND SEDIMENTATION PROBLEM AT UPPER REACH

Due to nature caused :

- Vulcanic deposit erupted by Mt.Kelud and Mt.Semeru
  Causing of large amout of vulcanic debris on mountain slopes and deposition of fine vulcanic materials (easy to move)
- Devastation of mountain slopes
  Causing of erosion from erosive lands

⇒ Causing of sedimentation in reservoirs of sabo structures and dams

EROSION AND SEDIMENTATION PROBLEM AT UPPER REACH

Due to man caused :

- Construction of Sabo Structure
  Causing of aggradation of upper and degradation of lower river bed
- Construction of dams (Sengguruh, Lahor, Sutami, Wlingi and Lodoyo)
  Causing of sediment flow blocked by dams
- Construction of Sand Bypass Channel
  Causing of increment of sediment discharge

DEGRADATION PROBLEM AT BRANTAS MIDDLE REACH AND PORONG RIVER

Due to man caused (only) :

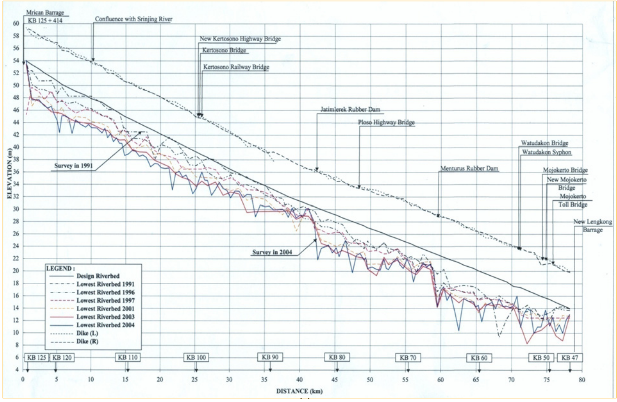
- Dredging by river improvement project (1980 - 1985)
  Causing of decrement of sediment flow from upstream
- Construction of Weirs (Mrican, Jatimlerek, Menturus)
  Causing of sediment blocked by weir
- Sand Mining
  Causing of removal of river bed

⇒ Causing of degradation of River bed

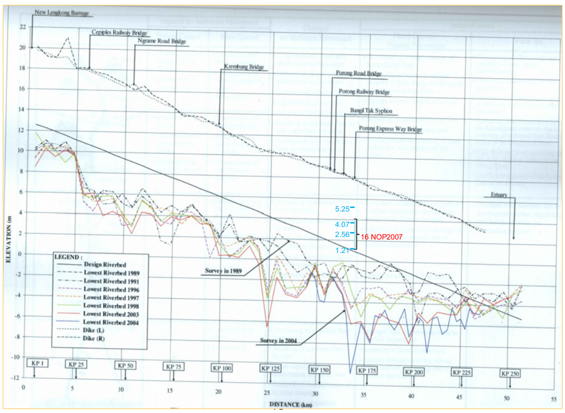
MUD FLOW PROBLEM AT PORONG RIVER

- In 29 May 2006 the mud crater appeared at Sidoarjo District, about 1.7 Km right side of the Porong River
- Because there is no other way to flow the mud into a certain location, finaly the mud is released to Porong River
- Its releasing causes the problem of decrement of flood flow capacity in the Porong River

Profil Transition of the Brantas Middle Reach



Profil Transition of the Brantas Lower Reach



COUNTERMEASURES AGAINST THE PROBLEMS

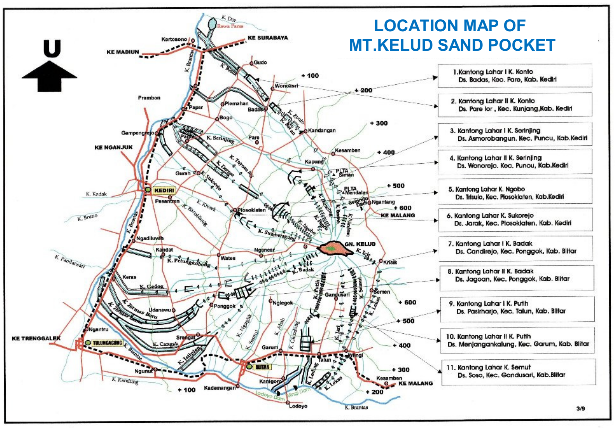
UPPER REACH:

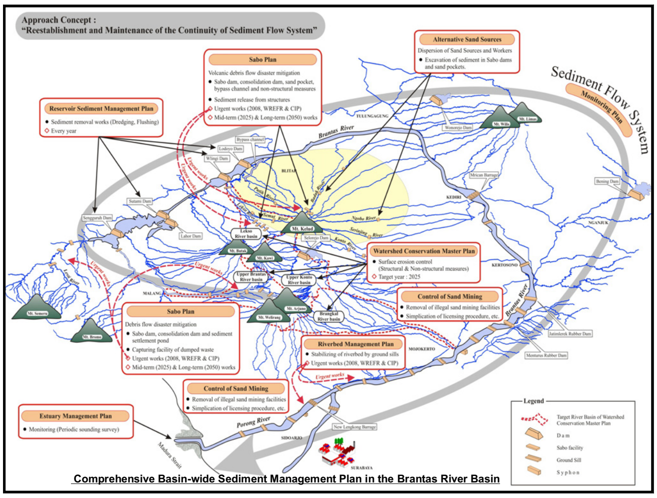
- Watershed conservation in the upper Brantas River and the Lesti River Areas (including community impowerment)
- Storage of sediment by sabo structures
- Dredging of sediment in dam reservoirs
- Utilization of sediment in sabo facilities and dam reservoirs
- Bypassing and flushing of sediment
- Monitoring of sediment movement

COUNTERMEASURES AGAINST THE PROBLEMS

BRANTAS MIDDLE REACH AND PORONG RIVER :

- Flushing of sediment in upstream section of weirs
- Control of sand mining affects to river structures
- Supervision of sand mining (location, volume)
- Monitoring of sediment movement (including monitoring of sand mining)
- Control of sediment tractive force in river (groin, foot protections, ground sills)





THE END

THANK YOU

Structural measures of sediment management in Mt.Merapi area

Mr.Chandra Hassan

Research Institute for Water Resources

STRUCTURAL MEASURES
OF SEDIMENT MANAGEMENT IN MT. MERAPI AREA

By
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Research Centre for Sabo (*Balai Sabo*)

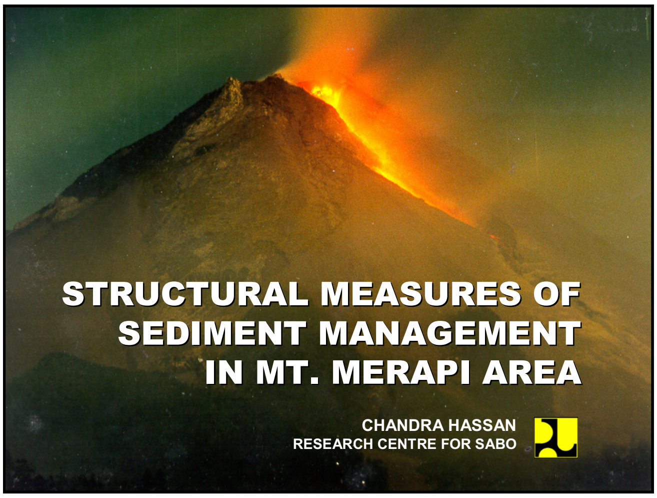
SYNOPSIS

At present many active volcano is in risk conditions. The disaster caused by volcanic eruption are categorized as primary disaster by direct eruptions of volcano and secondary disaster by lahar flows. The last eruption of Mt. Merapi in 2006, producing million cubic meters of volcanic debris which can potentially be generated as lahar disaster or volcanic debris flows.

Measures of sediment management in Mt. Merapi area are applied through structural and nonstructural approach. Structural measures is very unique and applied along its tributaries which is usually steep and often nonuniform slopes. This implies to highly varies of river discharge. With regard to conditions under which lahar flows occur, the implementation of structural measures of sediment management in Mt. Merapi area depending upon the triggering factors. In other words, prerequisites for the occurrence of lahar flows must be recognized well. The source of sediment supply, the zones to be classified, and the size of sediment which is consists of very wide range of sizes. The magnitude of sediment particles ranges from boulders of 3 meters or more weighing several tones down to very finely grained materials. Consequently, the sediment in volcanic mountain rivers consists mostly of a mixture of different particle sizes.

In Mt. Merapi area, where recent fall of ash have occurred, low precipitation can often trigger lahar flows, because river bed sedimentation is supplied constantly. Structural measures also affected by other reasons such as damming that occurs frequently as the result of valley banks collapse. Other than these, it is also influenced by river bends, change of channel width, and location of apex point. Therefore, structural measures of sediment management in Mt. Merapi is unique, because lahar flows are considered to occur under complicated relationship between the amount of rainfall, materials to be conveyed, gradient of the channel, ecological features, and rheological behaviour of the flows.

Keywords : volcano, mountain river, lahar, disaster.



MAP OF INDONESIA

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Tectonic Plates

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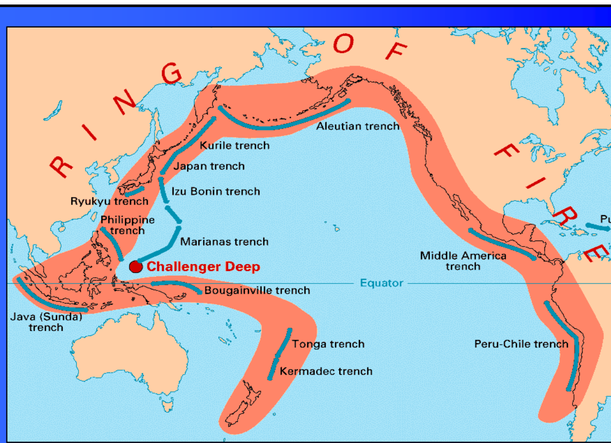

The world's ring of fire

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NUMBER OF ACTIVE VOLCANOES
IN INDONESIA

NO.	ISLAND	CLASS A	CLASS B	CLASS C	NUMBER
1.	Sumatera	11	12	6	29
2.	Sunda Straits	1	0	0	1
3.	Jawa	21	10	5	36
4.	Sunda Kecil	21	3	5	29
5.	Banda Islands	8	1	0	9
6.	Sulawesi	6	2	5	13
7.	Sangir Talaud	5	0	0	5
8.	Halmahera	6	1	0	7
		79	29	21	129

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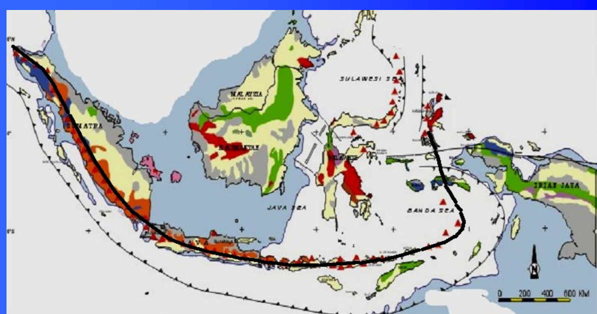

VOLCANIC BELT IN INDONESIA

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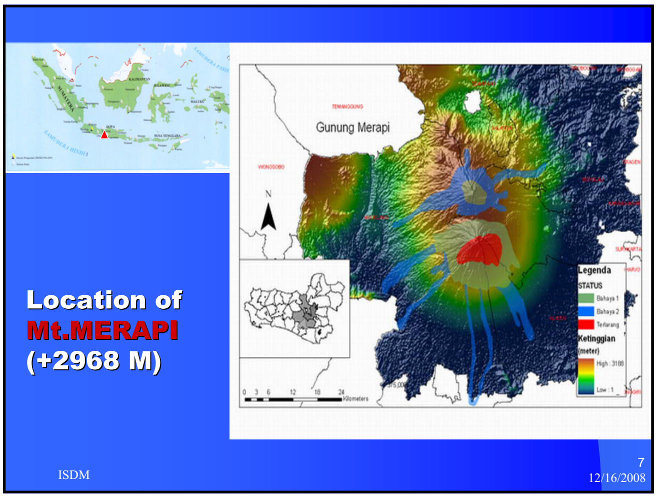
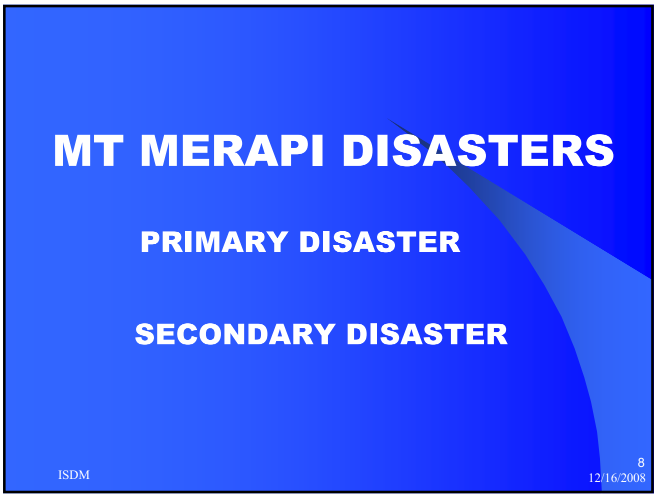

Location of
Mt.MERAPI
(+2968 M)
Gunung Merapi
Legenda
STATUS
Ketinggian
ISDM
7
12/16/2008


MT MERAPI DISASTERS
PRIMARY DISASTER
SECONDARY DISASTER
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8
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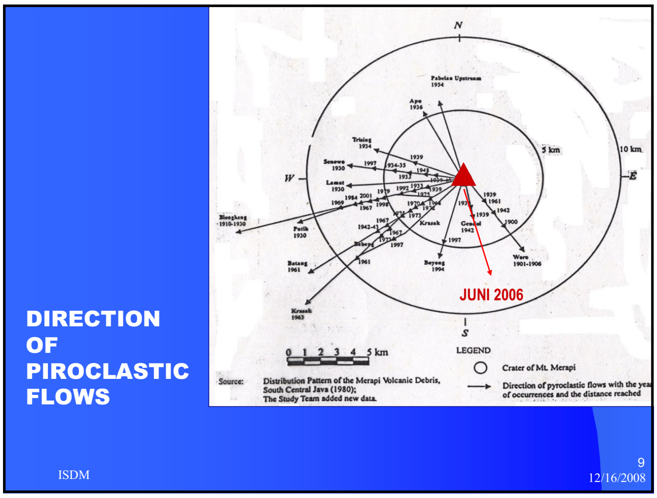
DIRECTION
OF
PIROCLASTIC
FLOWS
N
W
E
S
5 km
10 km
JUNI 2006
LEGEND
Crater of Mt. Merapi
Direction of pyroclastic flows with the year of occurrences and the distance reached
Source: Distribution Pattern of the Merapi Volcanic Debris, South Central Java (1980); The Study Team added new data.
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9
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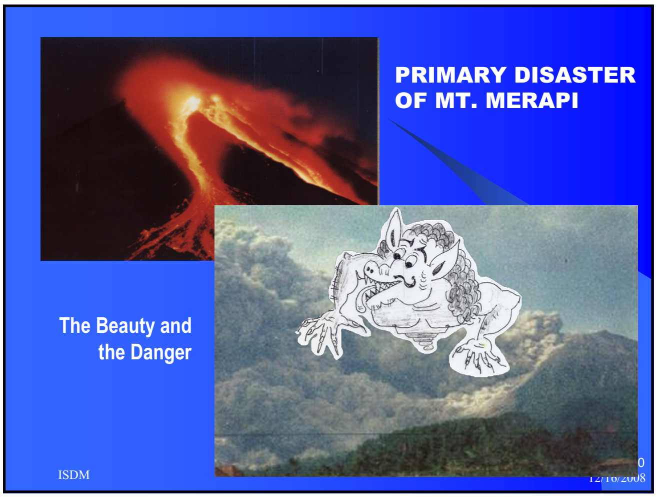
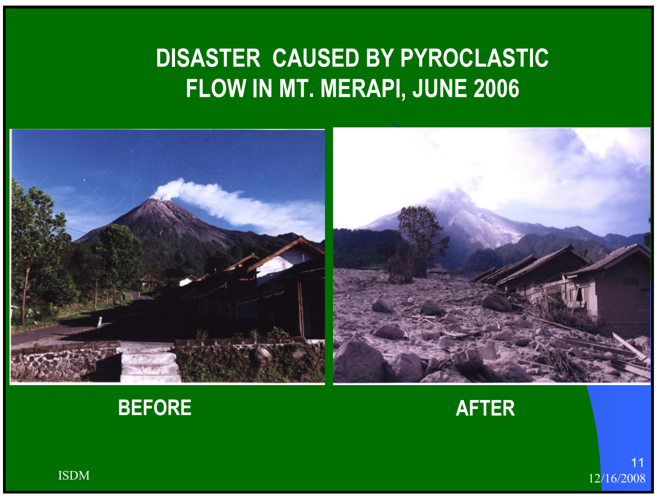
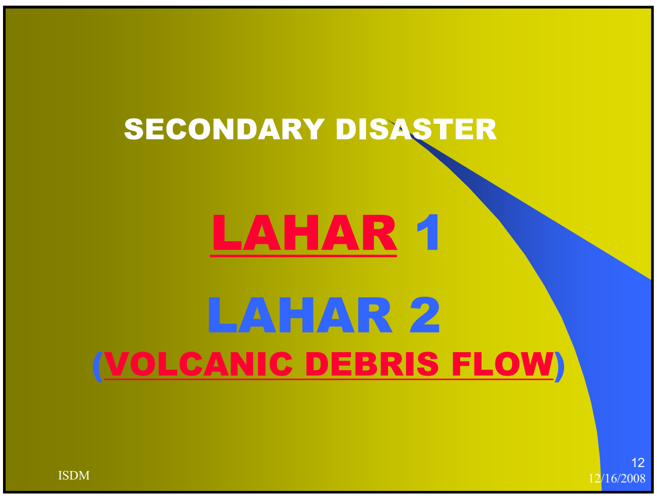

PRIMARY DISASTER
OF MT. MERAPI
The Beauty and
the Danger
ISDM


DISASTER CAUSED BY PYROCLASTIC
FLOW IN MT. MERAPI, JUNE 2006
BEFORE
AFTER
ISDM
11
12/16/2008


SECONDARY DISASTER
LAHAR 1
LAHAR 2
(VOLCANIC DEBRIS FLOW)
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12
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TYPICAL LAHAR DEPOSIT AT MT. MERAPI AREA

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DAMAGES AND VICTIM CAUSED BY LAHAR FLOWS

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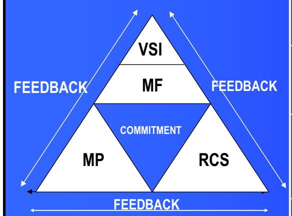
CORE INSTITUTIONS TO HANDLE MT MERAPI DISASTERS



VSI	Volcanology Survey of Indonesia (under Ministry of Mine and Energy)	Monitoring Mt. Merapi activities (primary disasters)
MF	Ministry of Forestry	Conducting reforestation, regreening, and teracing
MP	Merapi Project (under Balai Besar Wilayah Sungai Serayu Opak, DGWRD, MPW)	Constructing Sabo facilities in torrent rivers. (against secondary disasters)
RCS	Research Centre for Sabo (under Agency for Research and Development, MPW)	Conducting research and development of Sabo technology against secondary disasters.
DGWRD	Directorate General of Water Resources Development	
MPW	Ministry of Public Works	

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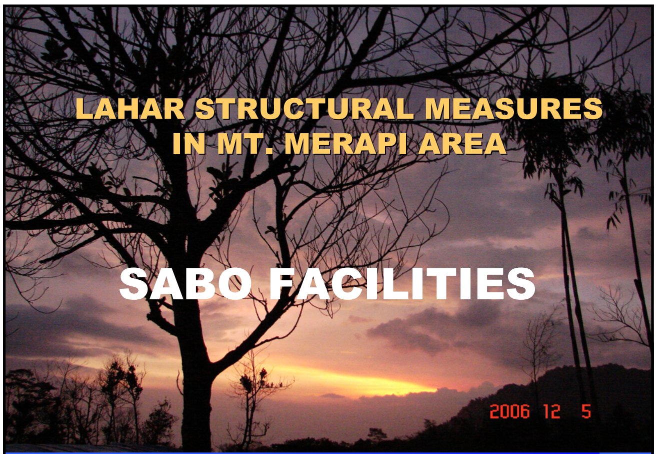

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CONCEPT OF SABO WORKS

- Combination strctural and nonstructural countermeasures
- Collaboration between central government and local government
- Collaboration among government (central and local) with local resident, NGO, etc.

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Basic implementation of Sabo works in Mt. Merapi

- Mt. Merapi is one of active volcano in the world and the most active volcano in Indonesia. It is located in densely populated area in Central Java.
- Frequent eruptions have induced pyroclastic flows due to collapse of lava dome.
- There is intensive rainfall, the loose deposits flow downstream as debris / lahar flow endangering residents live and assets in the down stream.
- The inhabitants at the foothills of Mt. Merapi have suffered from those volcanic disaster.

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Kind of Sabo facilities

- Sabodam
- Training dike/ Dikes
- Revetment

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Multipurpose

- Installation of **intake** on a check dam, consolidation dam and groundsill
- Utilization of check dams, consolidation dams and groundsill as a **submersible bridge**
- Construction of a **bridge over the main dam** of check dam and consolidation dam
- Construction of consolidation dam and groundsill in order to **protect** the bridge and the weir against degradation of riverbed.

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SABO FACILITIES

MAIN MENU → http://localhost/WEB/

LAB MENU → http://localhost/WEB/

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NUMBER OF SABO FACILITIES IN MT MERAPI AREA

NO	NAME OF TORRENT	NOS SABO FACILITIES		CAPACITY (M^3)	
		Sand Pocket	Sabo dam	Sand Pocket	Sabo dam
1	K. Pabelan	2	9	56,205	912,200
2	K. Apu	2	-	364,500	-
3	K. Trising	2	-	288,500	-
4	K. Senowo	3	2	830,800	57,600
5	K. Blongkeng	3	10	515,700	768,900
6	K. Lamat	5	7	69,800	1,656,000
7	K. Putih	5	10	1,428,900	522.700
8	K. Batang	8	1	1,597,000	396,300
9	K. Krasak	2	19	1,003,702	2,811,400
10	K. Bebeng	7	3	2,494,200	216,900
11	K. Boyong	8	41	2,097,300	2,175,826
12	K. Kuning	4	2	1,219,500	24,500
13	K. Gendol	3	12	995,500	548,200
14	K. Woro	-	7	-	111,425

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KINDS OF SABO FACILITIES

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Anchor method to prevent slope failure implemented in West Sumatera.

Sabo dam in Putih river, Mt. Kelud area (East Java) to prevent degradation of riverbed.

Combination Slit Sabo dam with road bridge in Mt. Merapi area (D.I. Yogyakarta)

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Hydroelectric Power station
Sabo dam with irrigation water intake
Sand pocket in Mt. Merapi area
Slit Sabo dam
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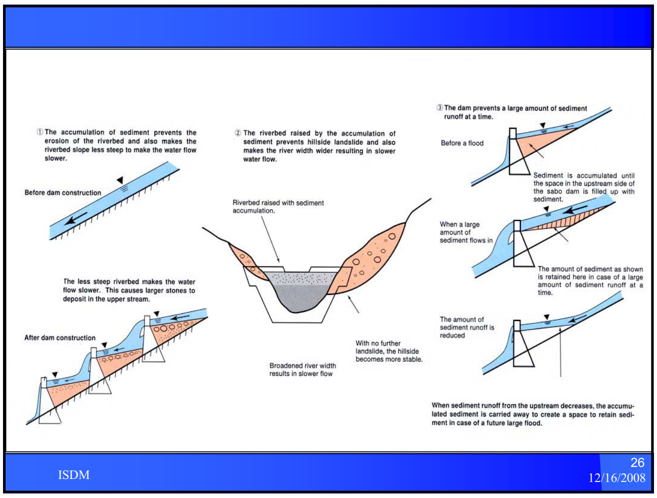

① The accumulation of sediment prevents the erosion of the riverbed and also makes the riverbed slope less steep to make the water flow slower.
Before dam construction
The less steep riverbed makes the water flow slower. This causes larger stones to deposit in the upper stream.
After dam construction
② The riverbed raised by the accumulation of sediment prevents hillside landslide and also makes the river width wider resulting in slower water flow.
Riverbed raised with sediment accumulation.
With no further landslide, the hillside becomes more stable.
Broadened river width results in slower flow
③ The dam prevents a large amount of sediment runoff at a time.
Before a flood
Sediment is accumulated until the space in the upstream side of the sabo dam is filled up with sediment.
When a large amount of sediment flows in
The amount of sediment as shown is retained here in case of a large amount of sediment runoff at a time.
The amount of sediment runoff is reduced
When sediment runoff from the upstream decreases, the accumulated sediment is carried away to create a space to retain sediment in case of a future large flood.
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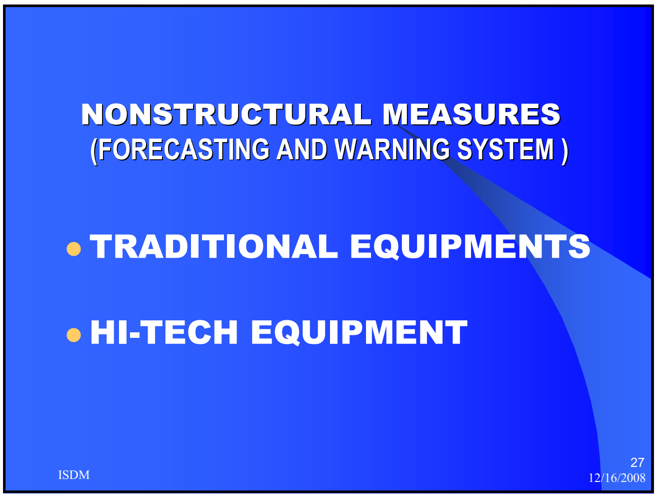

NONSTRUCTURAL MEASURES
(FORECASTING AND WARNING SYSTEM)
TRADITIONAL EQUIPMENTS
HI-TECH EQUIPMENT
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TRADITIONAL EQUIPMENTS
Sound test of traditional equipments
Figure 11. ARRANGEMENT OF TRADITIONAL EQUIPMENT FOR WARNING SYSTEM
Proposed location of bende or kentongan.
Coverage of each bende or kentongan
Boundary of hazard area
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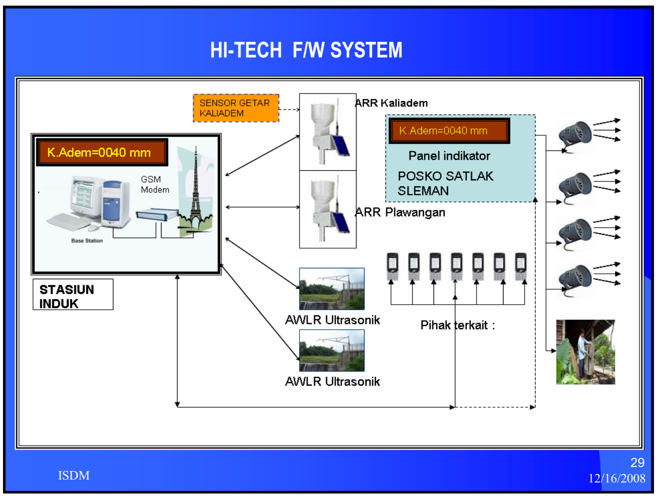

HI-TECH F/W SYSTEM
SENSOR GETAR KALIADEM
ARR Kaliadem
K.Adem=0040 mm
GSM Modem
Base Station
STASIUN INDUK
K.Adem=0040 mm
Panel indikator
POSKO SATLAK SLEMAN
ARR Plawangan
AWLR Ultrasonik
Pihak terkait :
AWLR Ultrasonik
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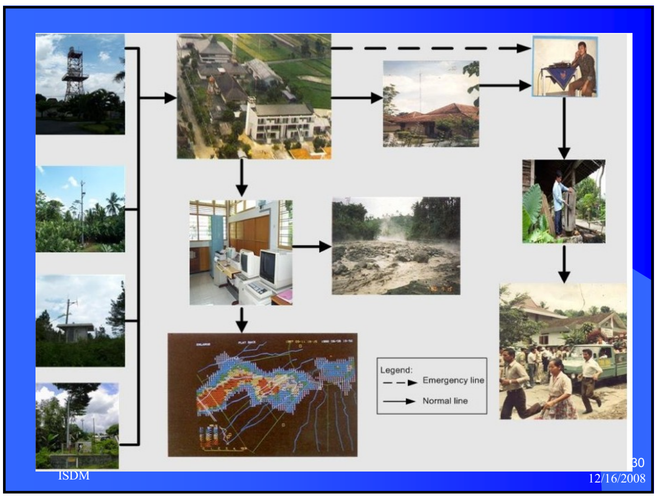

Legend:
Emergency line
Normal line
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SOCIALIZATION

Socialization to the resident in disaster prone area to explore participatory of the people on lahar disaster mitigation activities.

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RESEARCH ON SABO

- Effectivity of Sabo dam to cope with sediment flow into the reservoir.
- Effectivity of Gorong-gorong type of Sabo dam to trap the lahar consist of leftover three trunk.
- Implementation of Sabo dam with the SPAM method.
- Development of traditional F/W system against lahar disasters
- Development of F/W system using celular devices.
- Development of simple warning equipment for landslides.
- Making NSPM for Sabo works

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CONCLUSIONS

- Indonesia is subject to many different natural hazard or **disaster prone area** (129 active volcanoes, earthquake belts, rainy monsoon that cause annual floods and landslide,droughts,tidal waves, etc).
- **Lahar disaster** are mostly happen triggering by mechanism process of water, soil and together with human activities.

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CONT.....

- In IMt. Merapi area the sediment related issues might dealing with management for mitigation of negative impacts or lahar disasters so called SABO. An integrated aspect of socio, economic and culture with introducing **Sabo technology** recently is being a strategy subjected to the community in the lahar disaster prone area of Mt. Merapi.
- To enhance human resources on lahar disasters mitigation, education for **community based awareness** are introduced.

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CONT......

- Sabo technology have been implemented successfully in Mt. Merapi area and it has given advantages to the people who live in disaster prone area, but utilization of Sabo facilities which are potentials for other purposes to be integrated on lahar disaster management will continue be optimized **to support rural development program.**
- Securing the safety of communities by best synthesizing **non-structural and structural measures according to the local condition**, trough collaboration between the local communities and the government organization.

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RECOMMENDATIONS

- A systematic approach in collaborating manner through several activities in an integration system of structural and non structural aspect should be implemented and **supported by the community and stakeholders** , whereas a strategy of bottom-up approach and raising awareness of the people should be realized in a suitable way.

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RECOMD…..
Facing the new era at present, it is necessary to have re-orientation in Sabo technology with the recent trend of basic infrastructure development, to promote public partnerships. New orientation of Sabo technology will not only focusing to the safety of human life and infrastructures in lahar hazard area, but also consider to secondary utilization of facilities. Multi purpose is a basic function to reduce the damage caused by lahar disasters during or after occurrence and to improve rural living standard during normal live.
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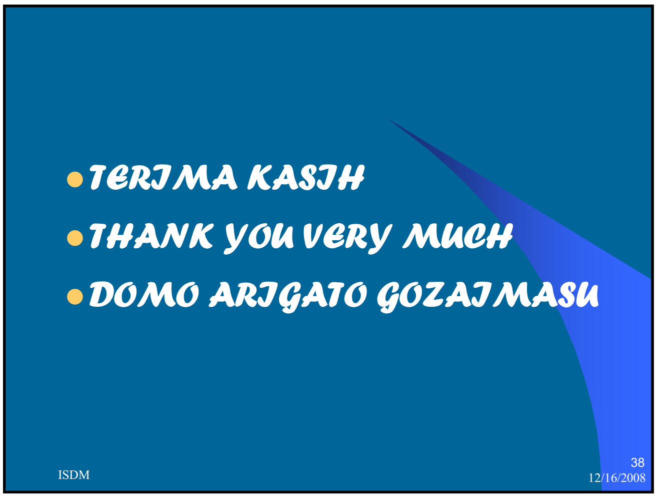

TERIMA KASIH
THANK YOU VERY MUCH
DOMO ARIGATO GOZAIMASU
ISDM
38
12/16/2008

Study on Estimation of Mesoscale Maximum Precipitation In Brantas River Basin by Using Rainfall Observation and Numerical Simulation

Dr. Satoru Oishi

University of Yamanashi

Study on Estimation of Mesoscale Maximum Precipitation in Brantas River Basin by Using Rainfall Observation and Numerical Simulation

Satoru OISHI (University of Yamanashi, JAPAN)
Hideaki TAKAHASHI (University of Yamanashi, JAPAN)
Kengo SUNADA (University of Yamanashi, JAPAN)

For flood control which consists of countermeasure by construction and management of land use, it is a basic approach to determine a basic flood protection plan. Then, a planned rainfall amount should be estimated by following the flood protection plan. Effective estimation for rainfall amount can be obtained when the maximum rainfall amount at the concerned region has been well known. Moreover, the worst scenario which occurs when it rains more than planned rainfall amount can be suggested and the risk can be estimated. The maximum rainfall amount is defined as Probable Maximum Precipitation (PMP). PMP is also defined as "Maximum rainfall amount which can be theoretically and physically explained at a certain period of time and area" (Hansen 1982). Therefore, it is impossible to observe the rainfall more than PMP under the ordinal condition.

As for the PMP estimation methods, various researches on the approach that have used statistical methods and physical methods have been done up to now. However, most of their target rainfall has longer time scale because the smaller and shorter scale rainfall has been difficult to observe and investigate. However, damage of smaller and shorter scale of rainfall is now increasing especially in urban developed area. Therefore the PMP of relatively smaller special scale and shorter time scale is necessary to estimate for flood control for developed urbanized area.

The purpose of this research is to estimate PMP of the meso-scale. The definition of meso-scale in this study is from 10 minutes to 2 hours, and from point to urban region. The authors have been developed the numerical method using one dimensional cloud microphysical simulation to estimate PMP of meso-scale (Tsuji et al. 1997). This paper propose a method to estimate PMP from rain drop observation which have been performed by one dimensional dopplar radar. In other word, this paper is a way to estimate PMP by atmospheric hydrometer observation. After investigating the mechanism which decide the PMP by profile of atmospheric hydrometer, a method for getting the longer time scale than meso-scale is proposed.

One dimensional dopplar radar has been used in this study. The radar has been developed by METEK cooperation and it has been sold as "Micro Rain Radar" (MRR). MRR uses microwave of 24GHz and MRR can detect the dopplar spectral of the microwave. Microwave is defined basically as electro magnetic wave of 0.1mm to 1m wave length, 300MHz to 3THz frequency. Microwave is widely used for weather radar, however, the weather radar detects the strength of reflected wave only. MRR can obtain rain drop size distribution $N(D)$ by using dopplar spectral then rainfall intensity, total amount of hydrometer in the atmosphere, averaged falling speed are calculated from drop size distribution. The main specification of the MRR is as follows; transform type of FM-CW(F3N), output power 50mV, main angle 2degee (6dB), 31 height step, height resolution 10m to 1000m, average time 10 to 3600sec.

The rainfall intensity (or rain rate) RR[mm/hr], amount of hydrometer in atmosphere LWC [g/m3] and averaged falling speed W [m/s] are calculated by using following equation:

$$RR = \frac{\pi}{6}\int_0^\infty N(D)v(D)dD \tag{1}$$

$$LWC = \rho_w\frac{\pi}{6}\int_0^\infty N(D)D^3dD \tag{2}$$

$$W = \frac{\lambda}{2}\int_0^\infty \eta(f)fdf \Big/ \int_0^\infty \eta(f)dD \tag{3}$$

where, D[mm] is drop size of hydrometer in the atmosphere; $N(D)$[1/m^3/mm], size distribution

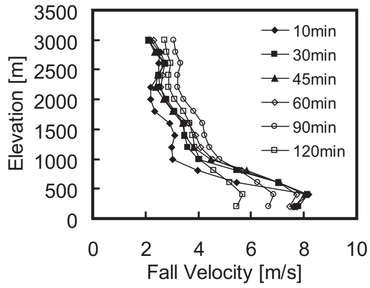


Figure 1: Vertical Profile of Averaged Falling Speed of Hydrometer at Each Time Scale.

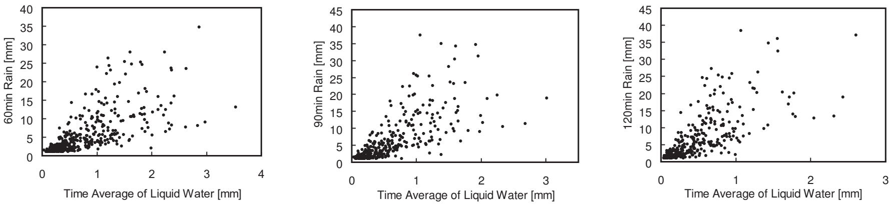


Figure 2: Averaged Hydrometer and 60 minutes(left), 90 minutes (center), 120 minutes(right).

of a hydrometer of a size of D; $v(D)$[m/s], terminal velocity of a hydrometer of D; f[Hz], frequency of dopplar spectum, $\eta(f)$, reflectivity of spectrum of frequency f.

MRR has launched on Jasa Tirta 1 public company in Malang city in Indonesia. The period of the data used in this study was from December 20, 2003 to August 2, 2005. The data from MRR passed the quality check by comparison between rainfall amount obtained by tipping bucket raingauge and MRR , which shows the correlation coefficient was 0.91. However, this study did not use the rainfall amount but investigated the mechanism which defines the PMP by using hydrometer information in the atmosphere.

The result showed that the factor which defines the PMP is different by the temporal scale. The PMP of less than 30d minutes depends on the vertical profile of averaged falling speed of hydrometer. As shown in Figure 1, every, not almost, strong rainfall obtained during the period shows the similar vertical profile of averaged falling speed. Therefore, PMP of less than 30 minutes can estimate the regression line of the vertical profile. On the other hand, Figure 2 shows a strong linear correlation between total amount of hydrometer in the atmospheric column and rainfall amount of more than 60 minutes. It means that the PMP more than 60 minutes can estimate by using total amount of hydrometer in the atmosphere. The amount of hydrometer is now available from satellite image such as TRMM TMI. Therefore, the PMP more than 60 minutes can be estimated by using data of TRMM TMI.

Acknowledgments.

The Reserch was partilly supported by the Ministry of Education, Science, sports and Caluture, Grant-Aid for Young Scientists (B), 16760407, 2004,representative: S.Oishi, and the data observation was supported by Core Reserch for Evolutional Science and Technology(CREST), represetative:Prof.Takara, Kyoto University, in Japan Science and Technology(JST).

Background and Objectives

Asian Monsoon Region

Ratio of Disaster happened in AMR to World Total
Number of Disasters: 40%
Number of Victims: 90%
Total Cost: 50%
Pervent from economical growth

- -Economical Developing
- -Scientific investigation is not enough
- -Scientific observation is not enough
- -Political and Social Problems among Riparian Countries

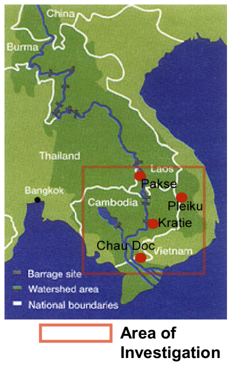
Estimate of Probable Maximum Precipitation, PMP

Analysis of Precipitation Distribution by CMAP

Method

- •Select the day when more than 100mm/day of precipitation has happened
- •Compare the rainfall of CMAP with point precipitation and area averaged precipitation

CMAP (CPC Merged Analysis of Precipitation)
: Monthly averaged daily Rainfall **(mm/day)**
2.5° resolution (6points in the area)
5 days interval



Result •Accuracy of CMAP is reasonable
•Resolution of CMAP is not sufficient

1. 2.5° horizontal: difficult to compare with gauged precipitatio
2. 5days interval: difficult to compare with daily precipitation

Numerical ReAnalysis by using CReSS

Method

- •Select the day when more than 100mm/day of precipitation has happened
- •Compare the rainfall with calculated rainfall by CReSS

CReSS(Cloud Resolving Storm Simulator)

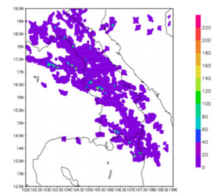
1. **Comparison between observed and calculated Rainfall**
2. **Comparison between calculated rainfall and hydrometer (raindrops in the air)**

Result of ReAnalysis of Rainfall

•CReSS reproduced fine mesh rainfall distribution

•Point rainfall (10km x 10km): big difference between Observed rainfall and reproduced one

Rainfall amount estimation required more accurate reproduction.

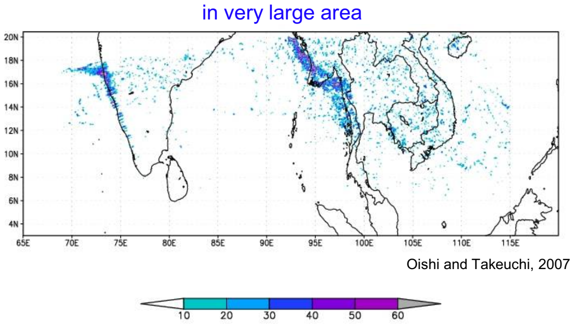


1983.06.26 10:40GMT
Horizontal Resolution : 2500m

Daily precipitation on 1983.06.26 at Pakse: 318mm

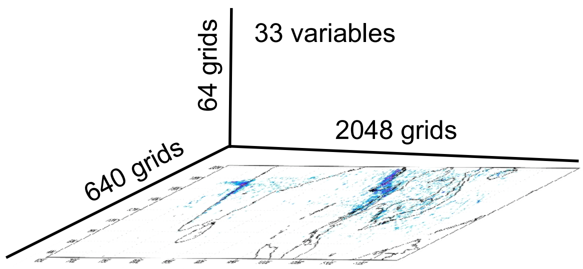
km^2	Average(mm)	Maximum(mm)
10×10	10.26	48.49
20×20	13.85	117.20
30×30	21.86	328.65
40×40	25.31	519.86
50×50	28.47	603.14
60×60	24.69	588.64
70×70	27.39	902.75
80×80	30.37	1113.55
90×90	34.69	1446.00
100×100	36.88	1590.20

in very large area



to consider the sea surface temperature of indian ocean

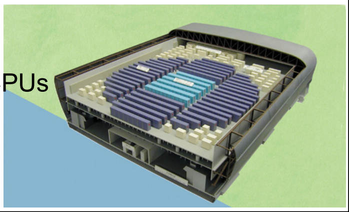
requires large memory



$2048 \times 640 \times 64 \times 33 = 2.76 \times 10^9$ equation/dt

ES: ex-world fastest super computer

124 Node x 8CPU = 992 CPUs



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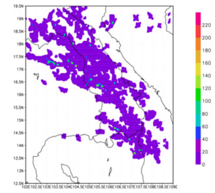

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100×100	36.88	1590.20

PMP estimation by using MRR

PMP ⟷ Microphysical process of raindrop falling

By using Micro Rain Radar (MRR)
One dimensinal radar to detect raindrop size distribution

Hereafter, the research deal with only observed data

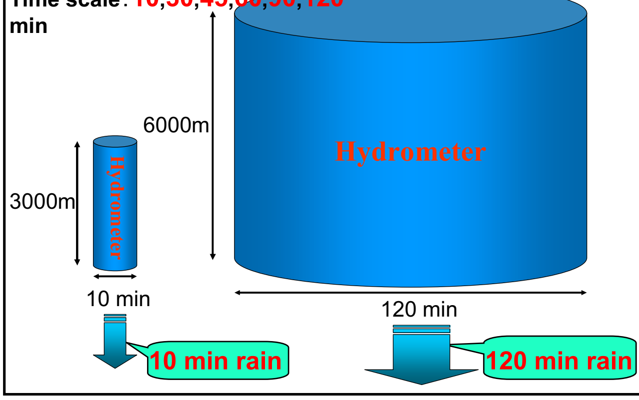
Relationship between observed rainfall amount and

1. **Observed amount of hydrometer in the atmosphere**
2. **Vertical profile of falling speed of hydrometer**

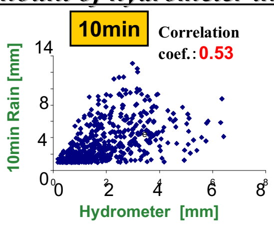
At Malang from December 10, 2003 to August 2, 2005

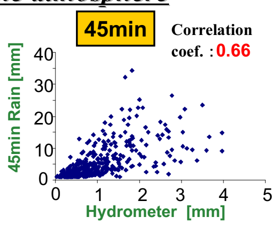
Comparison between rainfall and hydrometer (Jan. 1, 2004～Aug. 2, 2005)

Time scale: 10,30,45,60,90,120 min



Comparison of rainfall amount and amount of hydrometer in the atmosphere



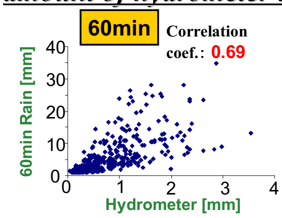


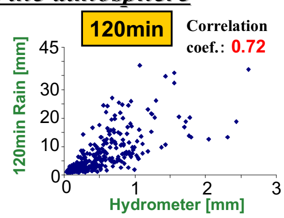
Envelope of Amount of hydrometer : peak point

Hydrometer increase ↛ rainfall become stronger

Shorter than 60 minutes
➡ Rainfall cannot be estimated from amount of hydrometer in the atmosphere

Comparison of rainfall amount and amount of hydrometer in the atmosphere

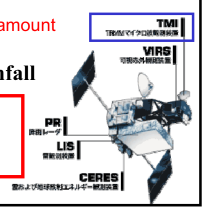


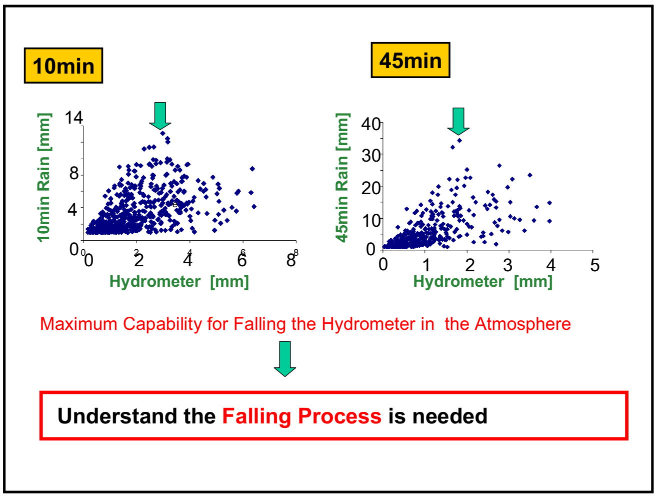


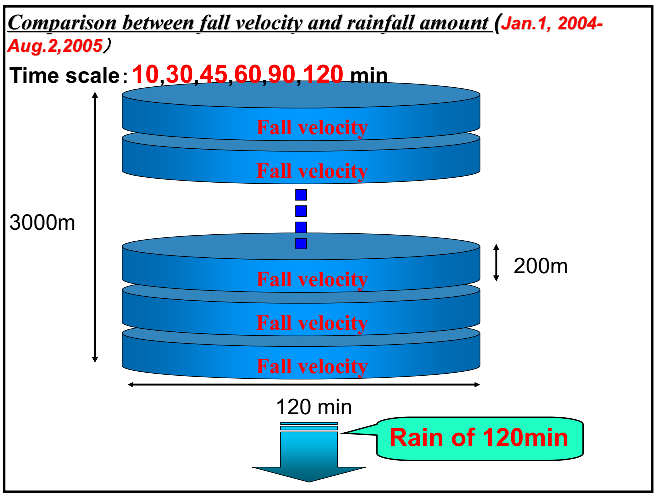
Envelope of Amount of hydrometer : linear with rainfall amount

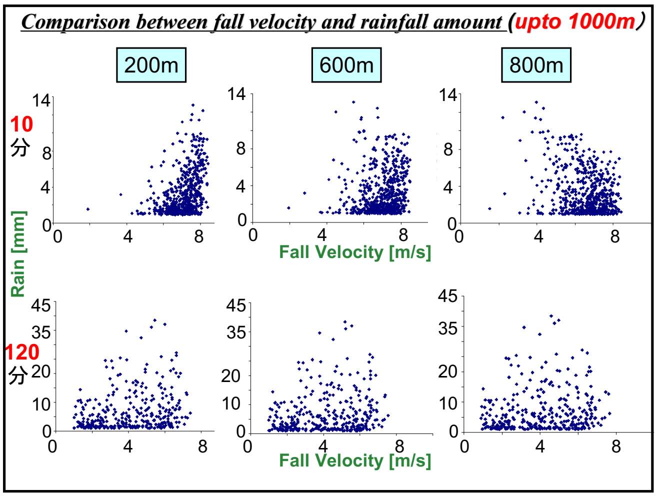
Maximum hydrometer → Maximum rainfall

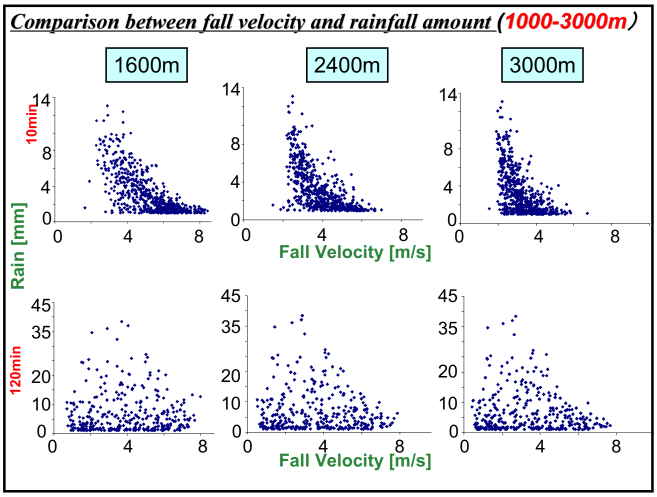
By using hydrometer data of TRMM･TMI ➡ Estimation of PMP

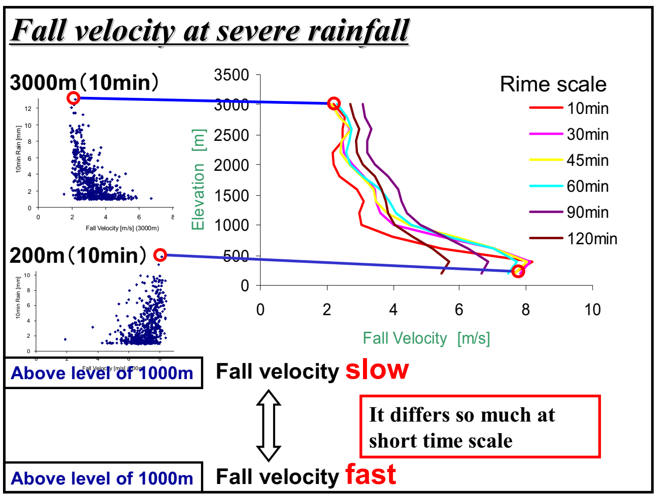


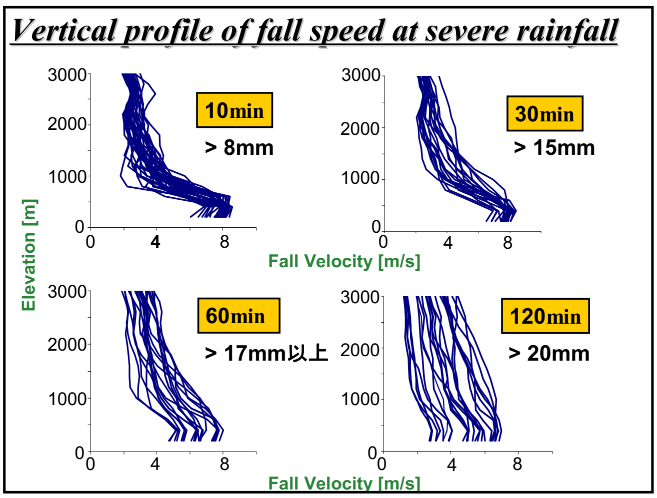

10min
45min
10min Rain [mm]
45min Rain [mm]
Hydrometer [mm]
Hydrometer [mm]
Maximum Capability for Falling the Hydrometer in the Atmosphere
Understand the Falling Process is needed


Comparison between fall velocity and rainfall amount (Jan.1, 2004-Aug.2,2005)
Time scale: 10,30,45,60,90,120 min
Fall velocity
Fall velocity
Fall velocity
Fall velocity
Fall velocity
3000m
200m
120 min
Rain of 120min


Comparison between fall velocity and rainfall amount (upto 1000m)
200m
600m
800m
10分
120分
Rain [mm]
Fall Velocity [m/s]
Fall Velocity [m/s]

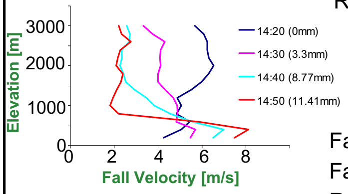

Comparison between fall velocity and rainfall amount (1000-3000m)
1600m
2400m
3000m
10min
120min
Rain [mm]
Fall Velocity [m/s]
Fall Velocity [m/s]


Fall velocity at severe rainfall
3000m(10min)
200m(10min)
Rime scale
10min
30min
45min
60min
90min
120min
Elevation [m]
Fall Velocity [m/s]
Above level of 1000m
Fall velocity slow
It differs so much at short time scale
Above level of 1000m
Fall velocity fast


Vertical profile of fall speed at severe rainfall
10min
> 8mm
30min
> 15mm
60min
> 17mm以上
120min
> 20mm
Elevation [m]
Fall Velocity [m/s]
Fall Velocity [m/s]

Temporal variation of vertical profile of fall velocity

Jan.19, 2004 14:20-14:50



Beginning of rainfall (blue)

Fall velocity above 1000m:**Fast**
Fall velocity below 1000m:**Slow**
Rainfall amount is **little**

Peak time of rainfall (red)

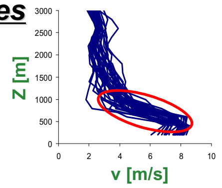
Fall velocity above 1000m:**Slow**
Fall velocity below 1000m:**Fast**
Rainfall amount is **large**

Estimation of PMP of 30minutes

regression line (**400m～1000m**)

$$Z = -Pv + Q$$

$$P = \frac{p}{p_{max}} \qquad Q = \frac{q}{q_{max}}$$

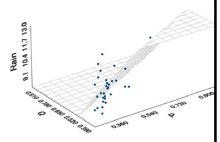


$$Rain = 9.64P - 16.09Q + 14.09 \quad [10min]$$

When Q is smallest, Rain is largest $R^2=0.23$

$$Rain = -22.34P + 13.62Q + 22.27 \quad [30min]$$

When P is smallest, Rain is largest $R^2=0.36$



$$Rain = \begin{cases} \mathbf{0.029p - 0.006q + 14.09} & [10min] \\ \mathbf{-0.044p + 0.003q + 22.27} & [30min] \end{cases}$$

Conclusion for simulation

1. **Comparison between gauged rainfall amount and CMAP estimated rainfall at Mekong river basin**

   •CMAP estimated rainfall was coarse. It could be used for estimating PMP for longer than one month and wider than river basin.

2. **Reproduction of rainfall amount by using CReSS, numerical simulation system**

   •Very fine scale distribution of rainfall was obtained.
   •Rainfall amount estimation was not enough.

   •Observed rainfall mechanism was needed

Conclusion for PMP

3. **Falling mechanism of hydrometer in the atmosphere was investigated by MRR for estimating PMP**

   •Amount of rainfall less than 60minutes related with vertical profile of falling speed of hydrometer.

   •Amount of rainfall more than 60minutes related with total amount of hydrometer in the atmosphere.

   •An equation for estimating PMP less than 30minutes derived from vertifal profile of falling speed.

Acknowledgement

•The authors show highly appreciation to Jasa Tirta 1 public cooperation for permiting to set the MRR on the roof.

•This research was supported by JST and Grant in Aid of Scientific Research from MEXT

Thank you for your attention