Session 4

“Sediment Yield and Sedimentation in Reservoirs”

Countermeasures for Sedimentation in Wonogiri Multipurpose Dam Reservoir

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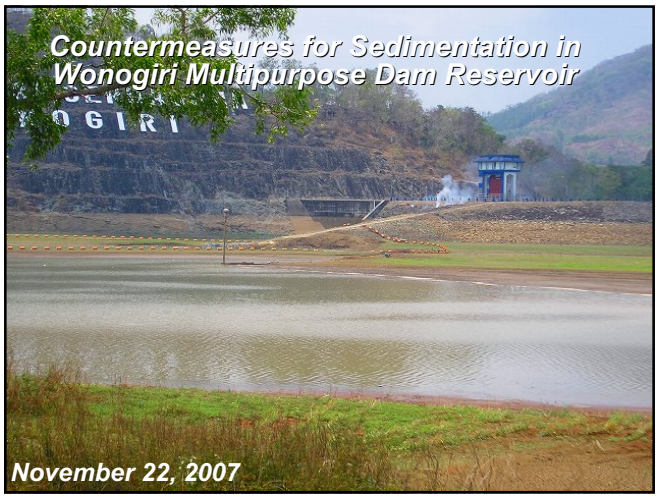
(Bengawan Solo Large River Basin Unit



I. Feature of Wonogiri Multipurpose Dam

- Based on Master Plan Bengawan Solo River Basin by OTCA (JICA), 1974
- Construction complete in 1982 funding by OECF (JBIC)
- As a multipurpose dam
  - Flood Control (4 000m^3 – 400 m^3)
  - Irrigation 23.200 Ha (30.000 Ha)
  - Hydro Power Installed Capacity 12.4 MW
  - Tourism
  - Fishery

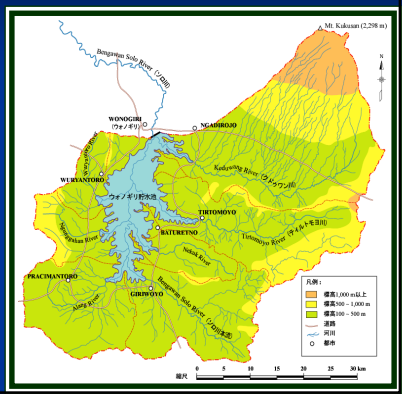

Wonogiri Multipurpose Dam

Features of Wonogiri Multipurpose Dam

- Dam Type : Rockfill
- Dam Height : 40 m
- Crest Length : 830 m
- Catchment Area : 1.350 km^2
- Reservoir Area : 90 km^2
- Gross Storage Capacity : 735 juta m^3
- Effective Storage Capacity : 615 juta m^3

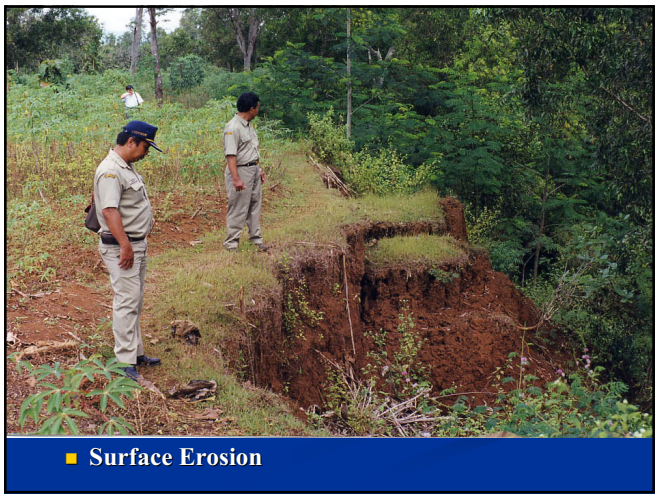
Condition of Multipurpose Wonogiri Dam
Catchment Area

- Total Area : 1.350 km^2
- Keduwang River : 426 km^2 (32%)
- Tirtomoyo River : 206 km^2 (15%)
- Bengawan Solo River: 200 km^2 (15%)
- Agricultural 80 %
  Forest 13%

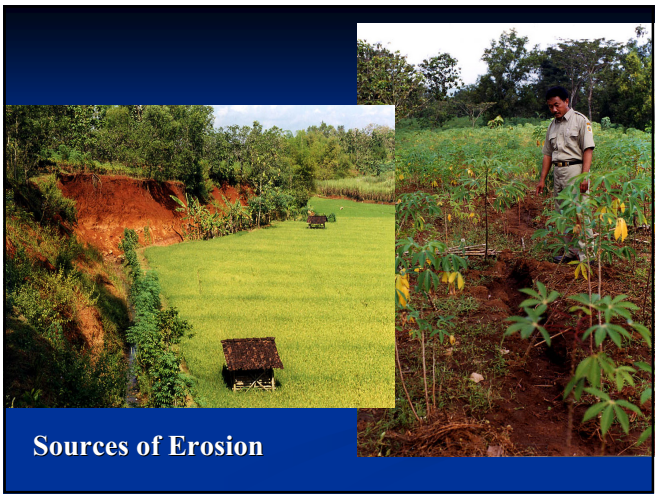


- Agriculture land with steep slope, high potential erosion
- Erosion caused by bad cultivation

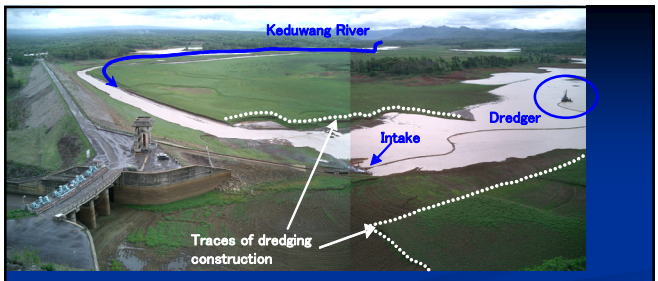
- Surface Erosion



- Surface Erosion



Sources of Erosion



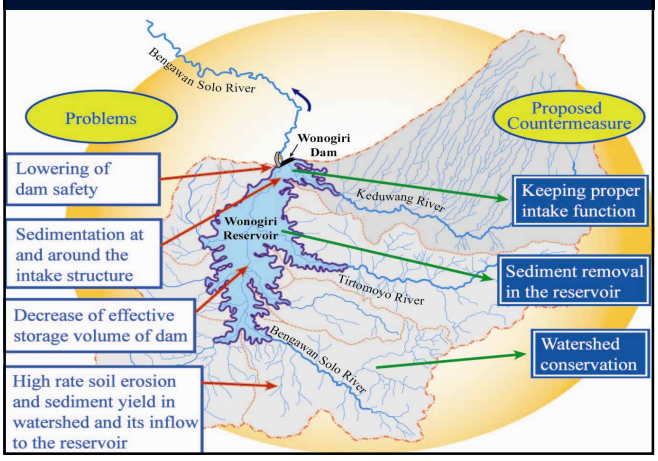
Multipurpose Wonogiri Dam(Dried session)
Dredging in November 2003.

Dam Sedimentation
Sediment Material in front of intake is silty clay

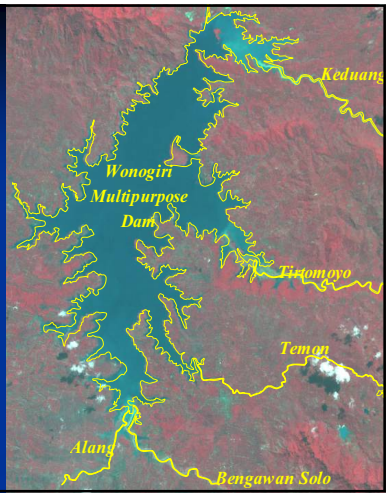
- Waterflow with sediment from Keduwang River in wet session (brown color)

- (*Urgent Dredging for Sedimentation*) by JICA Grant Project in 2001-2004
- The Study on Urgent Countermeasures for sedimentation in the Wonogiri multipurpose dam reservoir by JICA Study in 2004-2007

Master Plan Scheme



Current Issues of Wonogiri Reservoir Sedimentation



Inflow of Sediment into Reservoir
(Normal H.W.L. 136.0 m)

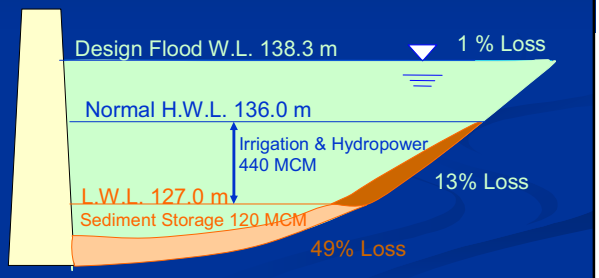
Inflow of Sediment into Reservoir
(L.W.L. 127.0 m)

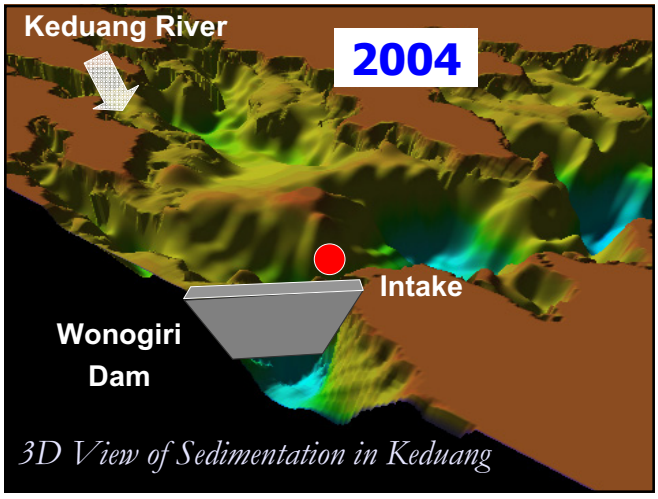
The Reservoir Capacity is Decreasing Now.

Reservoir Loss of Capacity

WONOGIRI DAM
Crest of Dam
EL. 142.0 m

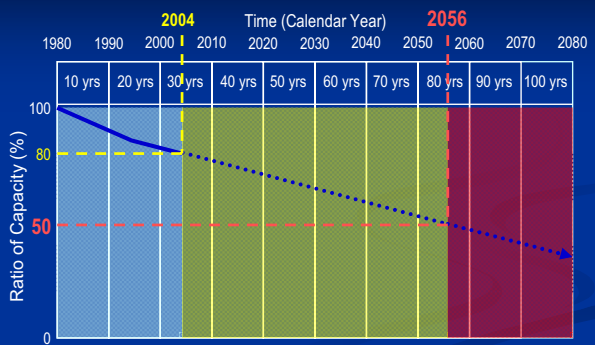
From 1980 to 2005



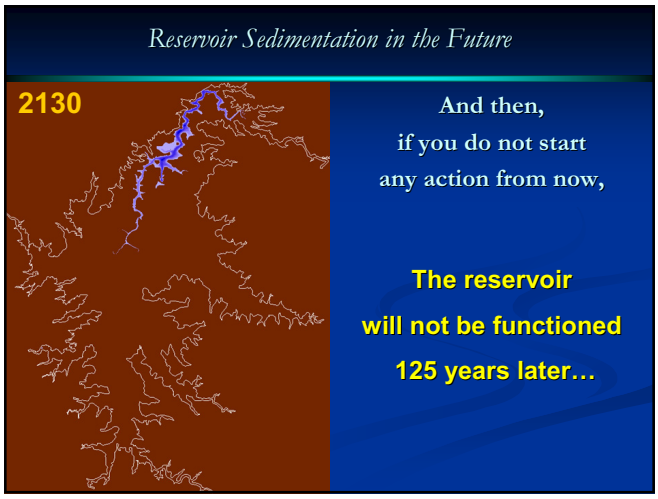


3D View of Sedimentation in Keduang

Simplified Lifetime Projection



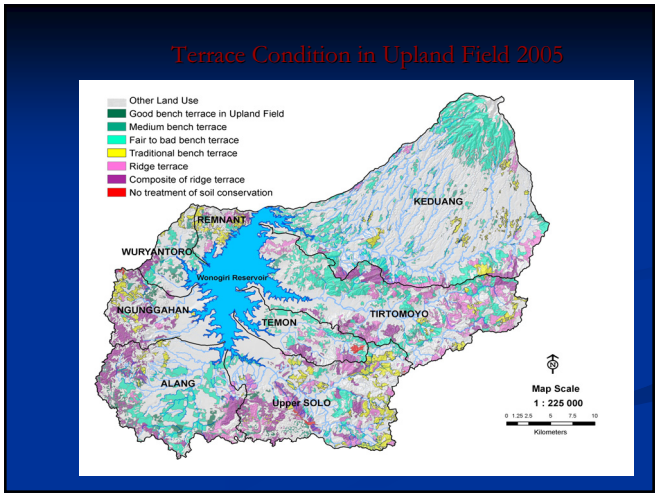
Wonogiri will lose Half of Capacity
below N.W.L 136.0 m by year 2056.

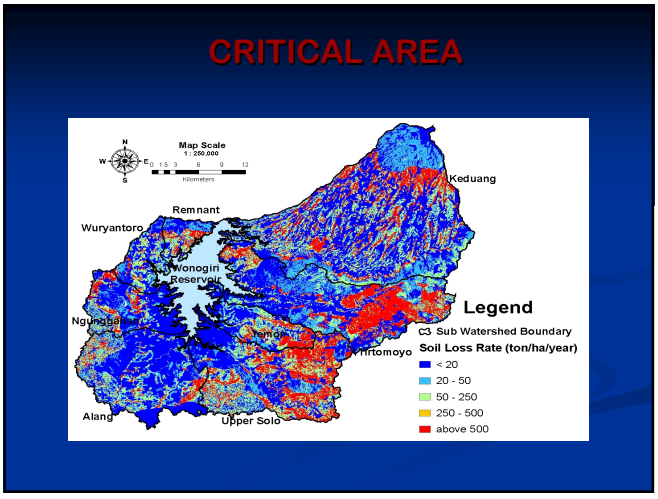

Reservoir Sedimentation in the Future
2130
And then,
if you do not start
any action from now,
The reservoir
will not be functioned
125 years later…

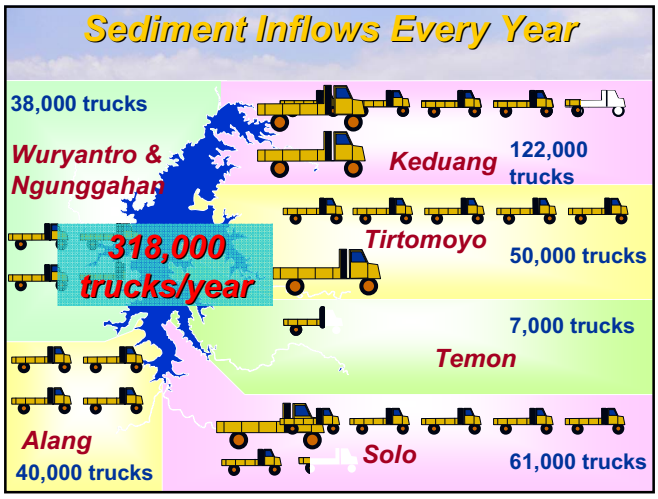

Garbage Problem
at Intake
Dec. 2004
Jan. 2004


Garbage Inflow from Keduang River
09/12/2006
21/12/2006


What Kind of Sediment Material Deposited ?
Geological Section of Solo River
(EL.m)
25
Sediment Materials are Composed
Mainly of Silt and Clay.

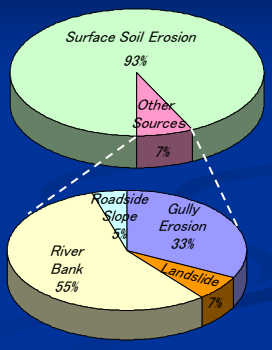

Terrace Condition in Upland Field 2005
Other Land Use
Good bench terrace in Upland Field
Medium bench terrace
Fair to bad bench terrace
Traditional bench terrace
Ridge terrace
Composite of ridge terrace
No treatment of soil conservation
KEDUANG
REMNANT
WURYANTORO
Wonogiri Reservoir
NGUNGGAHAN
TEMON
TIRTOMOYO
ALANG
Upper SOLO
Map Scale
1 : 225 000
Kilometers

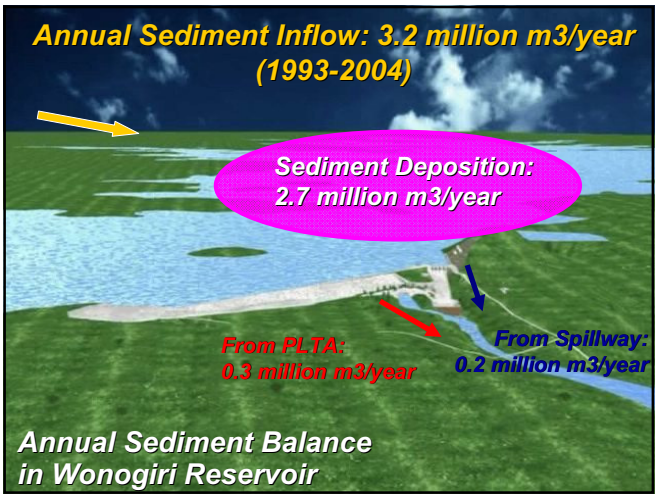

CRITICAL AREA
Map Scale
1 : 200,000
Kilometers
Keduang
Remnant
Wuryantoro
Wonogiri
Reservoir
Ngunggahan
Temon
Tirtomoyo
Alang
Upper Solo
Legend
Sub Watershed Boundary
Soil Loss Rate (ton/ha/year)
< 20
20 - 50
50 - 250
250 - 500
above 500



Annual Sediment Yields by Source

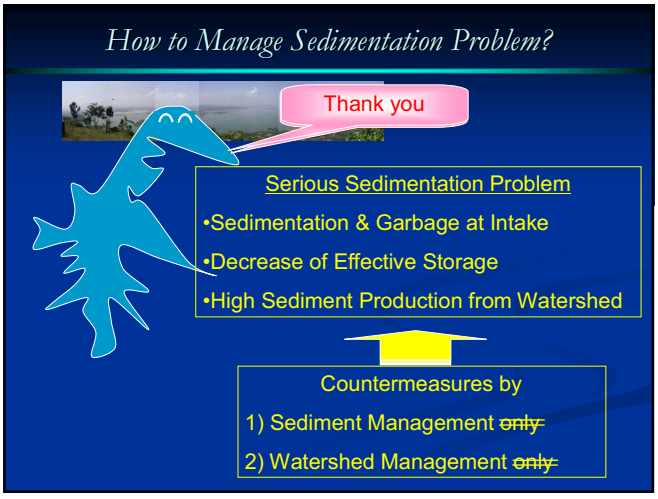
Sediment Source Total: 3,181	Vol. (x1000m³)
▪Soil Erosion	2,949
▪Other Sources	232
- Gully	76
- Landslide	15
- River Bank	130
- Roadside Slope	11





Summary of Sedimentation Issues of Wonogiri Reservoir

- High Sediment Production in the Wonogiri Watershed and Sediment Inflow into Reservoir
- Sediment Deposits and Garbage at Intake
- Decrease of Effective Storage Capacity

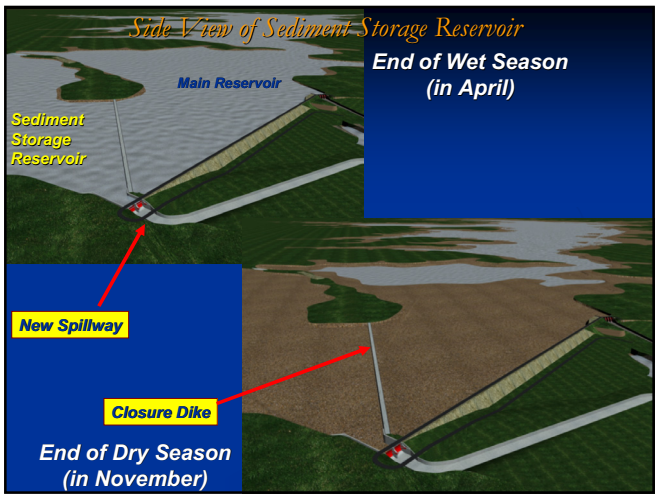


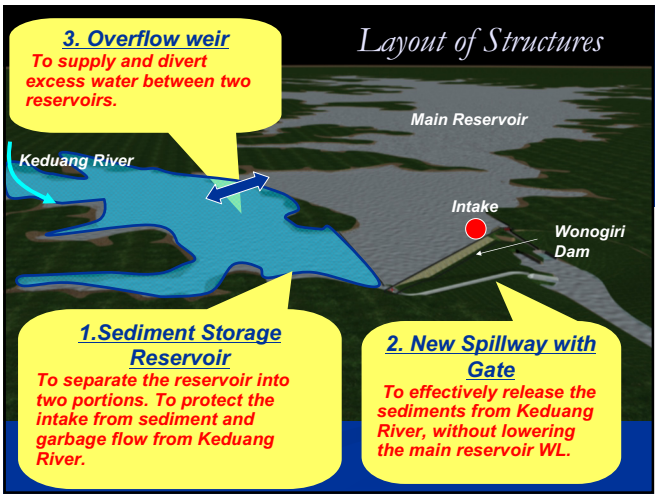
Urgent Measures

- *Target:* Sediment and Garbage Inflows from Keduang River
- *Purpose:* Reduce, Remove and Release Sediment and Garbage Inflows

Structural Measure: Sediment Storage Reservoir to Keep Proper Function of Intake

Non-structural Measure: Watershed Management in Keduang Catchment to Reduce Sediment Production and Inflow

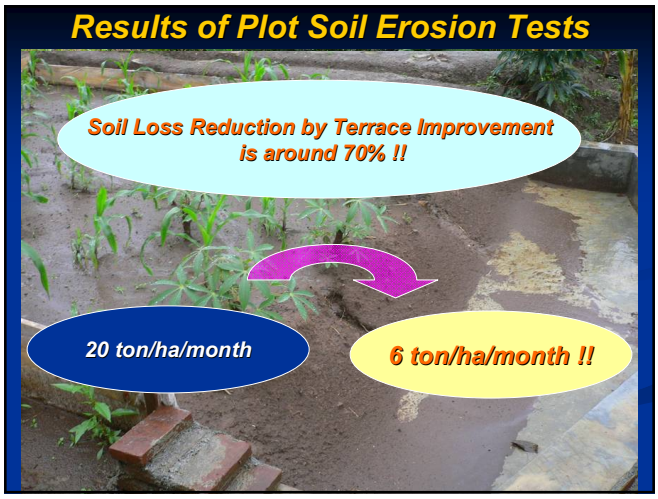




Sediment Release of Sediment Storage Reservoir

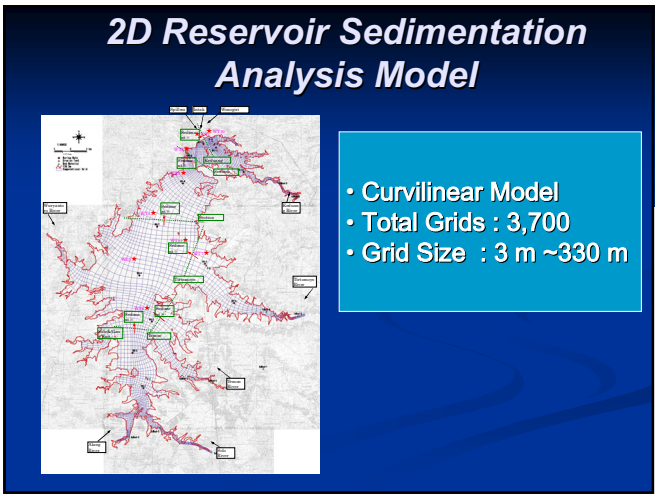
- *Almost all of the sediment inflow from Keduang River will be completely retained in the Sediment Storage Reservoir.*
- *Sediment flushing and sluicing will be made without releasing water stored in the main Wonogiri reservoir*
- *Sluicing (sediment routing) will minimize sediment deposition in the Reservoir during floods.*
- *Flushing will release sediments that have already deposited in the Reservoir by use of natural river power inside the Reservoir.*

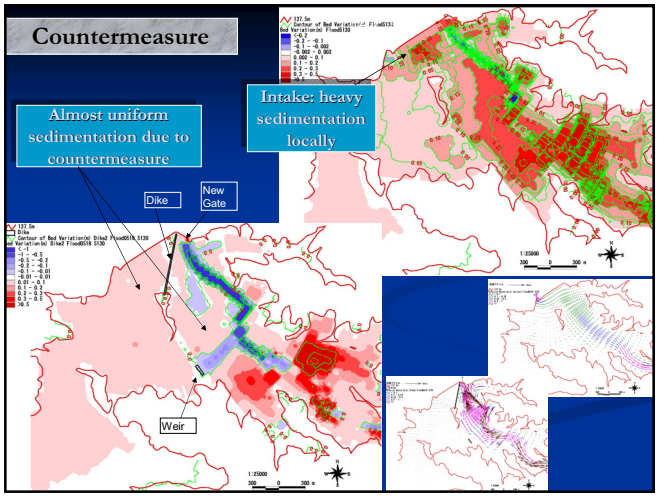
Various Terraces in Wonogiri Watershed

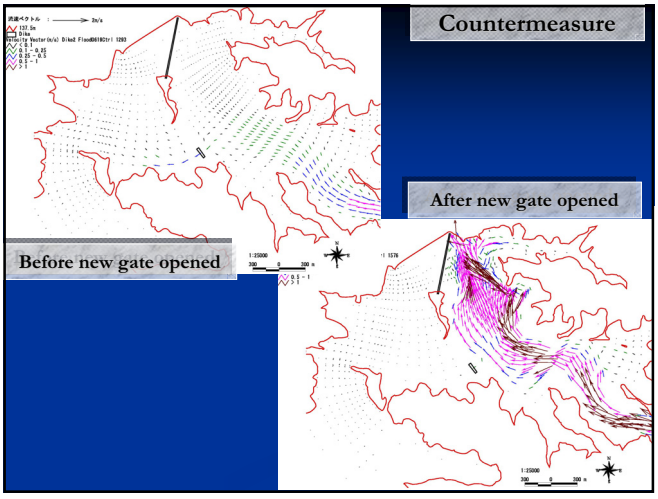

Results of Plot Soil Erosion Tests
Soil Loss Reduction by Terrace Improvement is around 70% !!
20 ton/ha/month
6 ton/ha/month !!

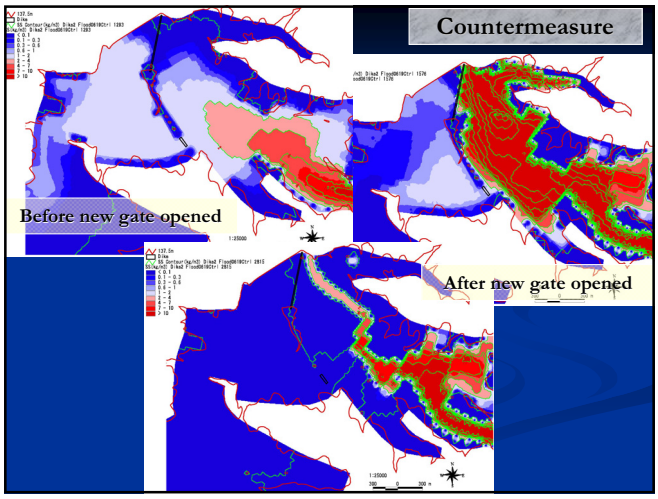

Approach to Watershed Management
Terrace Improvement
Agro-forestry Promotion
Community Based Farmer's Participation into All Process from Planning to Monitoring
Soil Management for Next Generation
Effective Use of NGOs
Proper Incentive to Farmers


Q.1 What's the volume of released sediments and required water?
Experience of Sediment Flushing at Wlingi Dam (May,2004)


2D Reservoir Sedimentation Analysis Model
• Curvilinear Model
• Total Grids : 3,700
• Grid Size : 3 m ~330 m


Countermeasure
Almost uniform sedimentation due to countermeasure
Intake: heavy sedimentation locally
Dike
New Gate
Weir


Countermeasure
After new gate opened
Before new gate opened

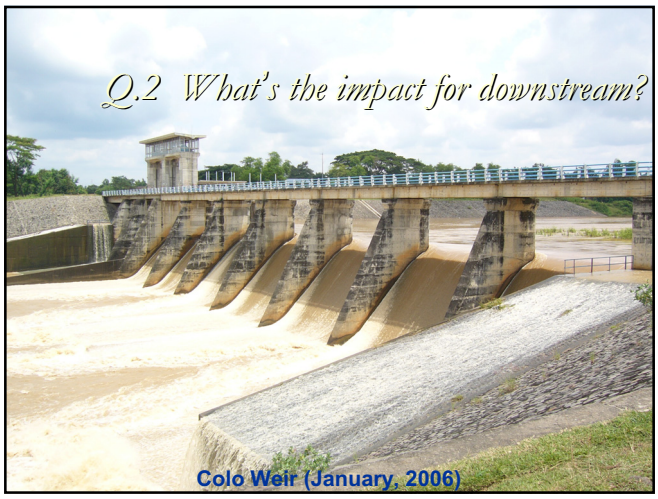


Result of Analysis:

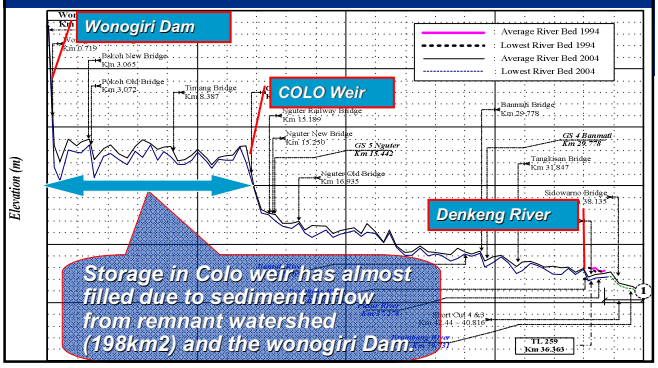
- ***Average of annual sediment releasing is 0.8 million m³/year.***
- ***In Dry years, no water shall be released because of no excess water.***

Million m³

	DRY In 2005	NORMAL In 1996	WET In 1999	Ave.
Mean Annual Inflow	*860*	*1,350*	*1,560*	*1,260*
Spillout	*20*	*495*	*674*	*396*
Sediment releasing	*0.01*	*1.1*	*1.3*	*0.8*



Longitudinal Section of Solo River d/s of the Dam



Characteristics of released sediment from the Dam