經濟部

Strategy on Shihmen Reservoir High Turbidity

Water Resources Agency, Ministry of Economic Affairs

2009/10

經濟部水利署

WATER RESOURCES AGENCY

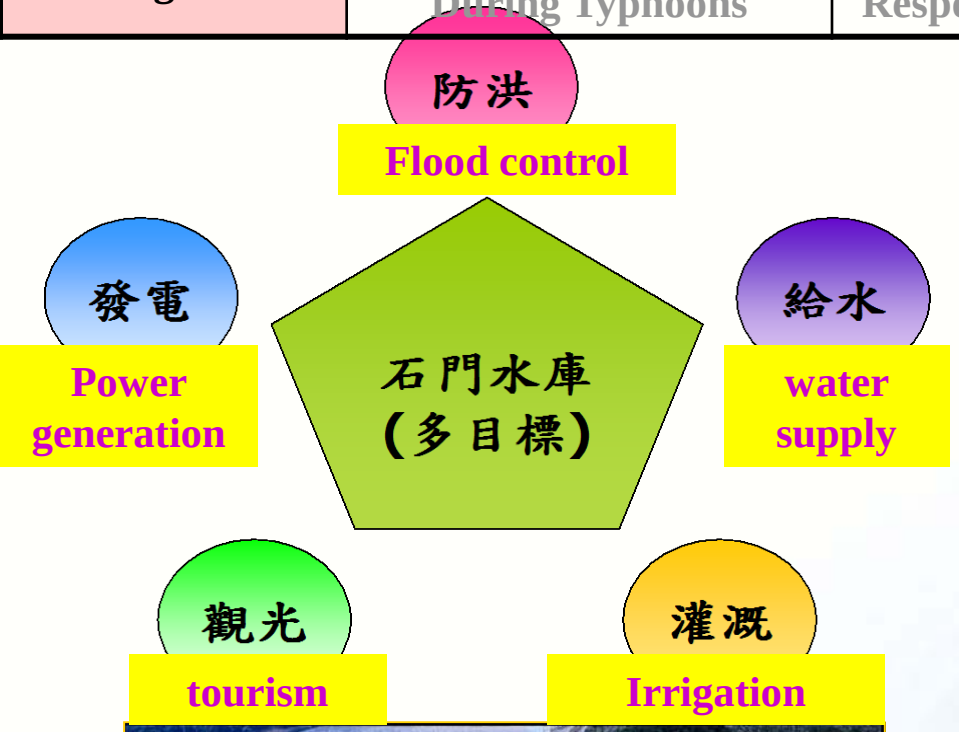
Presentation Outline

- Background
- Raw Water Turbidity During Typhoons
- Emergency Response Measures
- Rehabilitation Programs
- Concluding Remarks

❖Location of Shihmen Reservoir

❖石門水庫重要設施位置圖

〔Location of Shihmen Reservoir's major structures〕



- The Shihmen Reservoir started in May 1963 to store water.
- It is a multi-Purpose Project for irrigation, power generation, water supply, flood control and tourism.
  - **Drainage Area: 764.4km^2**
  - **Average annual run off: 1.9×10^{9}m^3**
  - **Reservoir Volume**
    - **Initial: 3.09×10^{9}m^3**
    - **Current: 2.09×10^{9}m^3**
  - **Water Demand: 1.0×10^{9}m^3**

Project Functions

❖Water supply

- ❑ The reservoir supplies water for Taipei and Taoyuan through Shihmen, Longtan, Danan, Bansin and the Pingzen purification plants.

❖Irrigation

- ❑Irrigation areas under Taoyuan and Shihmen Agriculture Association about 36,000 hectares.

❖Power generation

- ❑Shihmen Power Plant of about 214,000,000 kwh per year, and Ixing Power Plant about 169,000,000 kwh.

❖Flood control

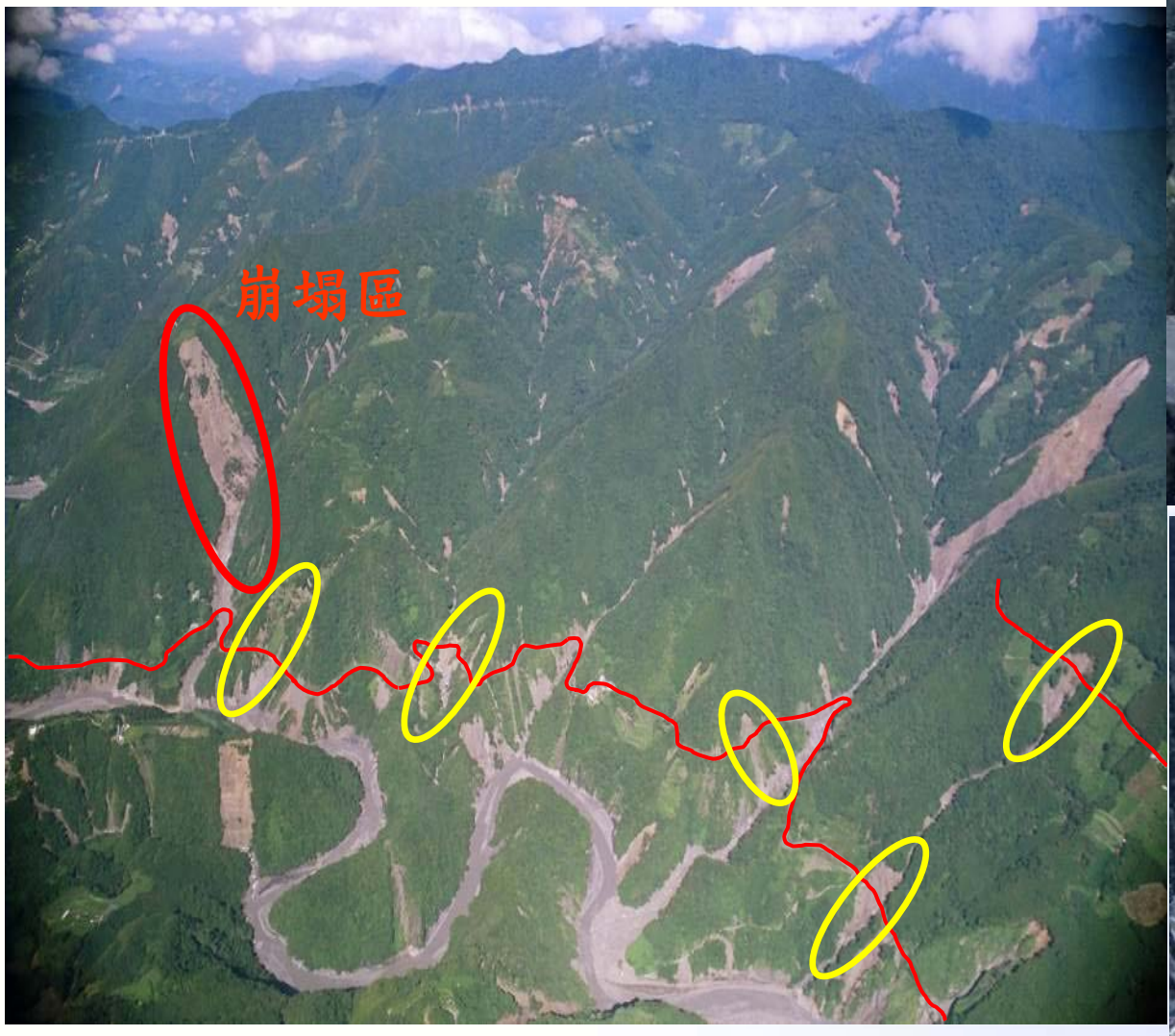
- ❑ Reduce PMF inflow of 14,500cms to outflow of 13,800cms.
- ❑ In the recent 5 years (2003 ~ 2007) reduced peak inflow by about 22% and delay the peak discharge timing by approximately 3 hours.

❖Tourism

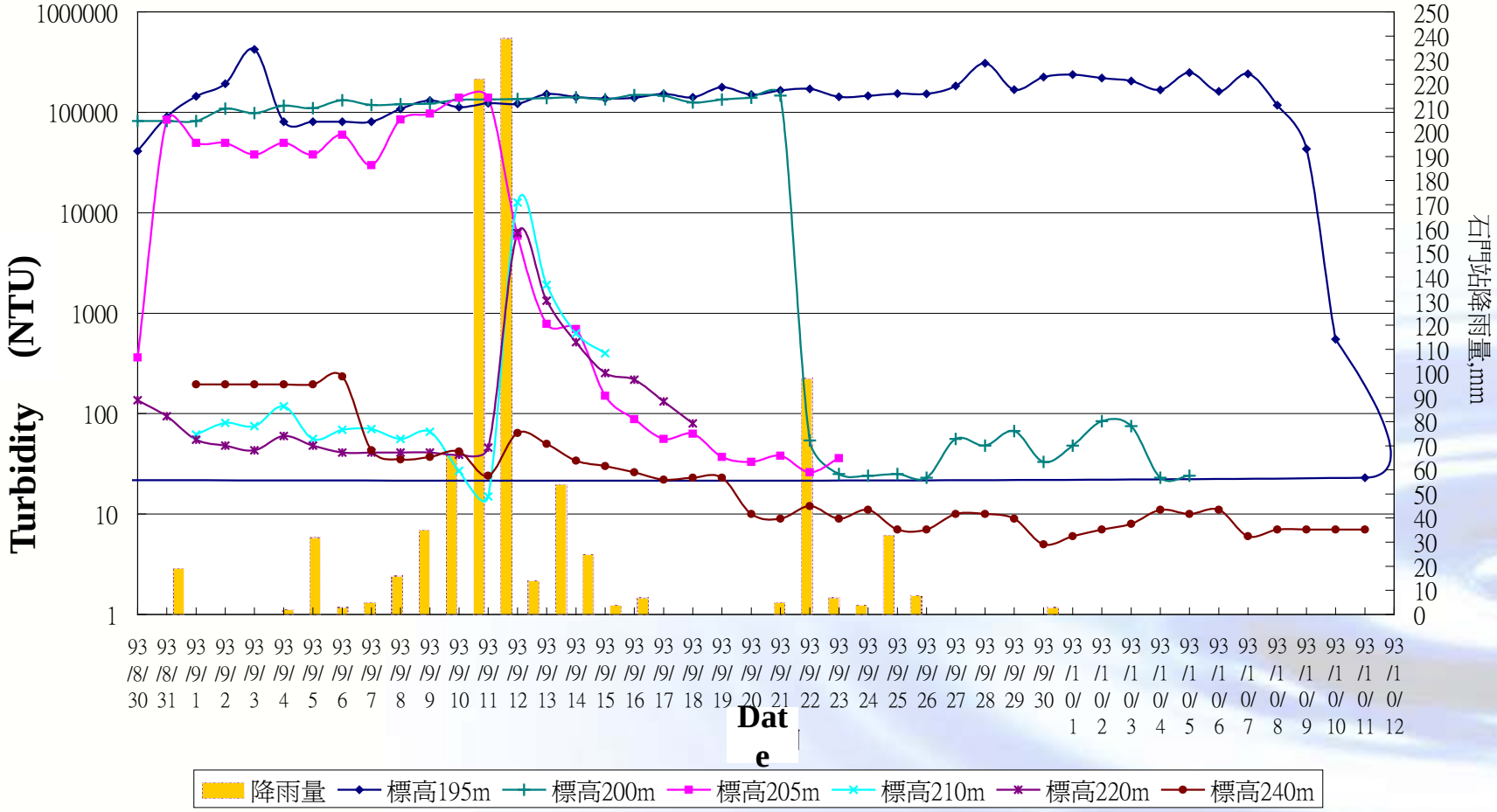
- ❑ From 2005 to now, the reservoir and its surrounding has become a popular tourist spot in northern Taiwan. The annual tourists to the reservoir surpasses 1,000,000 people.

Reasons for Increasing Turbidity

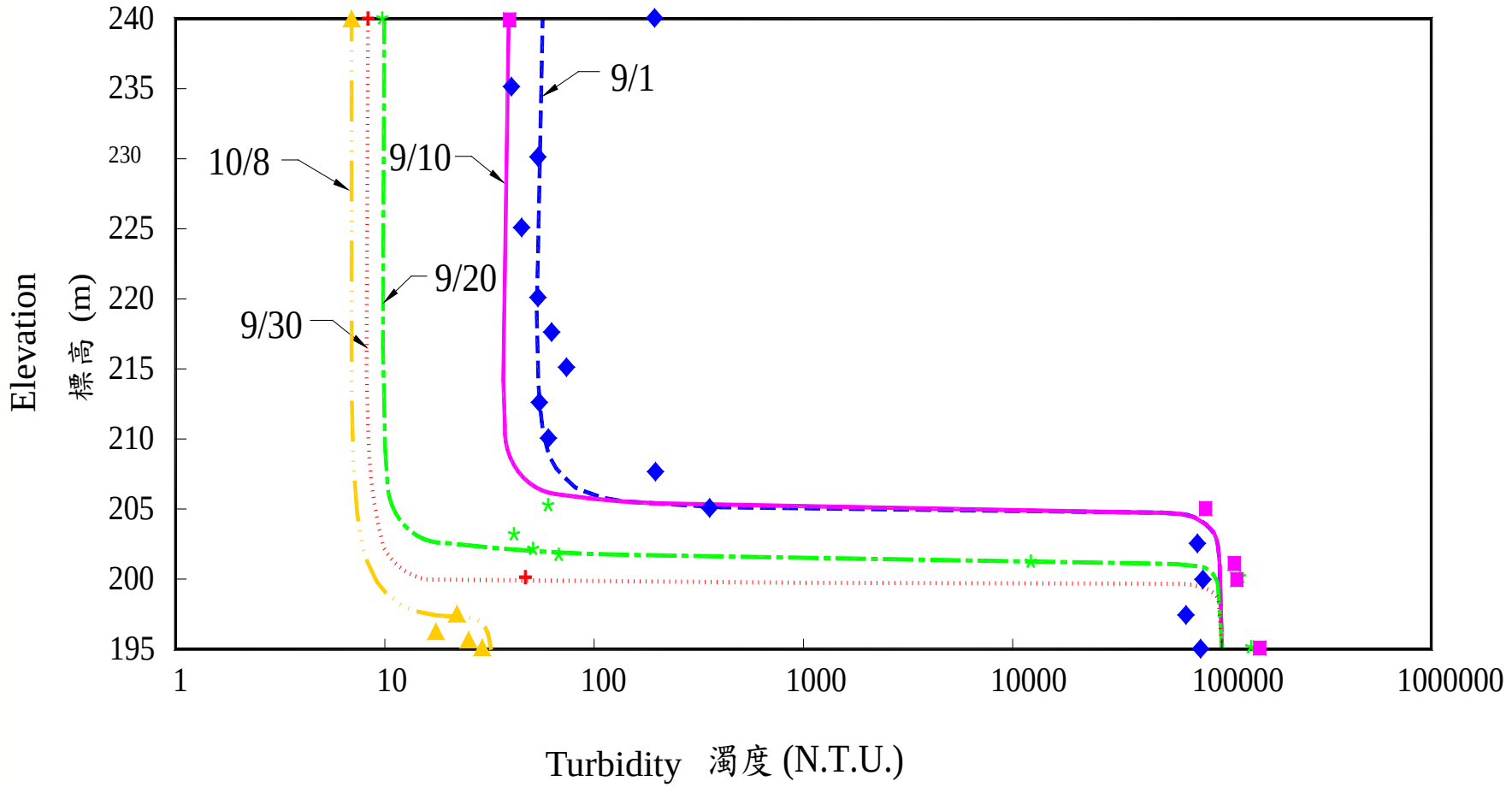
- Increase in rainfall intensity during typhoons
- Poor geological conditions in catchment area
- Steep terrain conditions in catchment area
- Excessive road widening programs
- Over development of the catchment area
- Outdated flood release and water purification facilities
- 1999 Chi-Chi earthquake



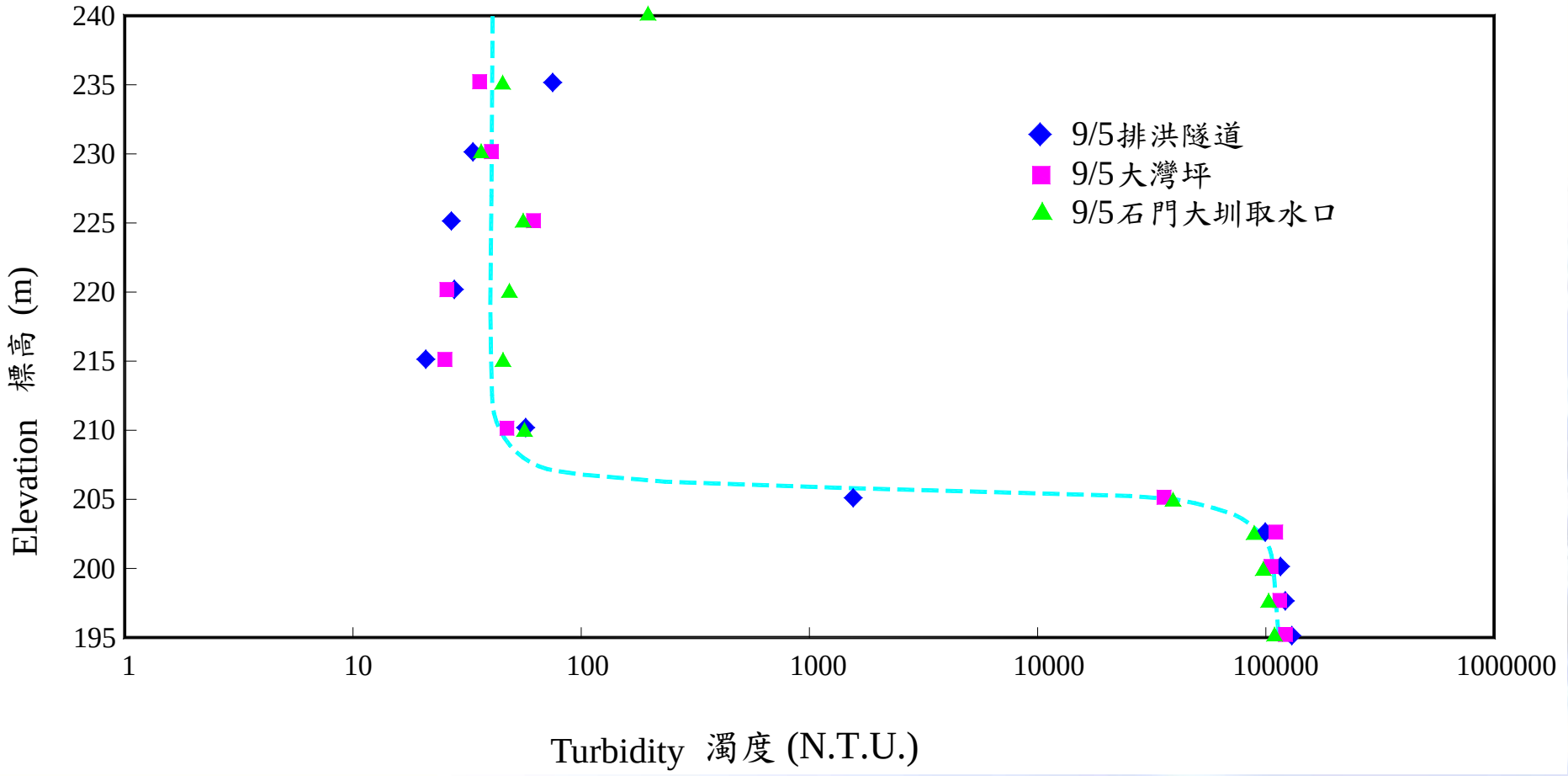
Heavy rainfall caused land slides in catchment area.



Turbidity Duration Curve at Shihmen Canal Intake After Typhoon Aere



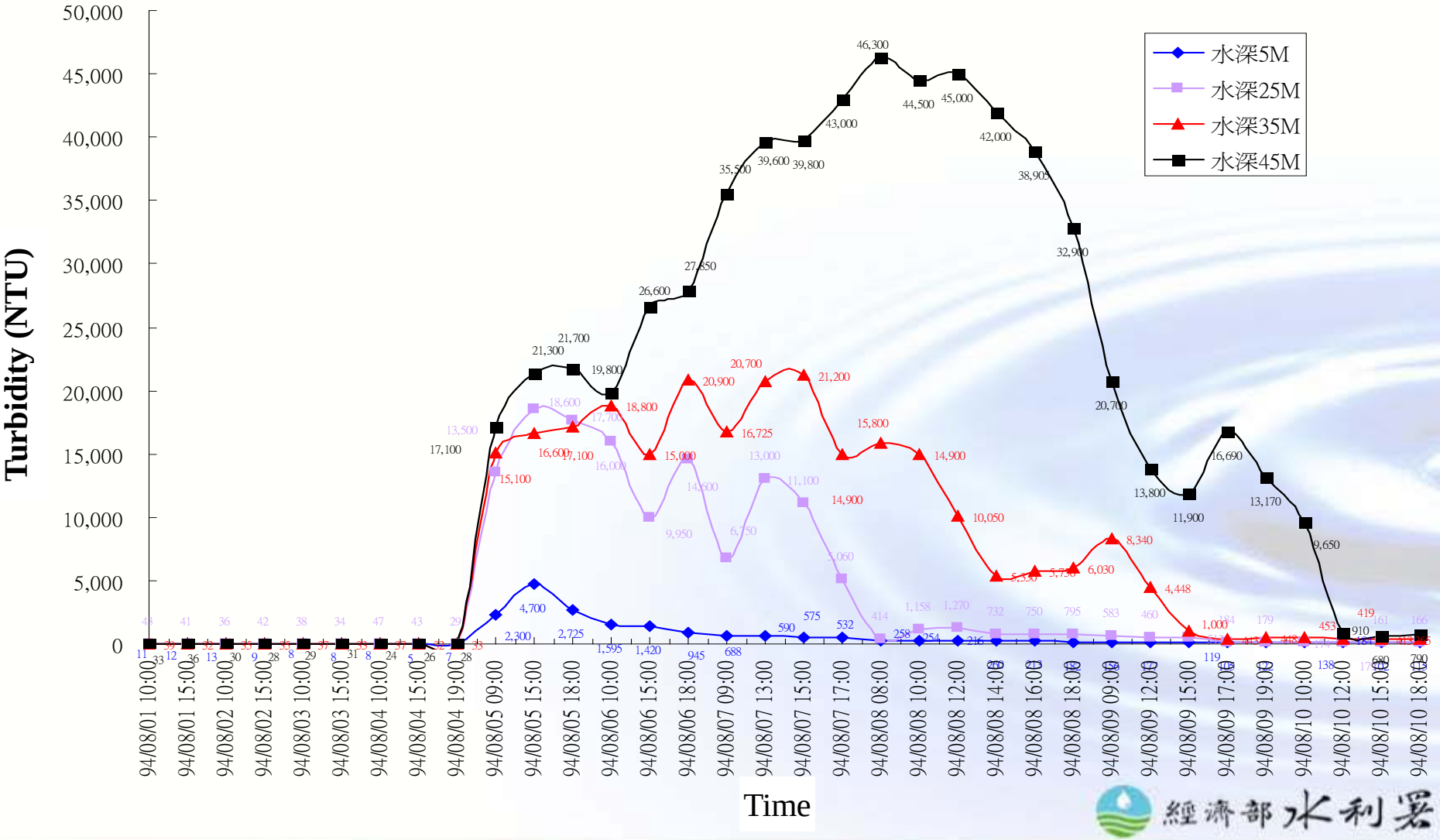
Turbidity Variation at Shihmen Canal Intake After Typhoon Aere



Turbidity Pattern at Different Locations in Shihmen Reservoir After Typhoon Aere

Silt Deposit in Penstock After Typhoon Aere

❖Turbidity During Matsa Typhoon(2005)



Emergency Measures Taken:

- ❑Reservoir turbidity monitoring
- ❑Temporary water supply
- ❑Regional water management and transfer
- ❑Modification in reservoir operation

❖Temporary water supply

(A) Set up exclusive telephone lines for inquiry of water supply situation.

(B) Mobilize 311 water trucks to supply water in the Taoyuan area.

(C) Establish a total of 1,270 temporary water distributing stations.

(D) Distributing mineral water to citizens.

(E) Open water purification plants for public to get water.

❖ Regional Water Management and Transfer

- ❑ Transfer of 200,000CMD to 500,000CMD from Taipei Water Department to the area
- ❑ Increase the output of Danan Purification Plant from 300,000 to 390,000CMD
- ❑ Install a temporary intake for 300,000CMD at the left bank of the afterbay.
- ❑ Install a temporary pumping facility at the dam top for a capacity of 300,000CMD. The capacity of this facility was later increased to 960,000CMD

●石門水庫壩頂抽水工程，抽水機設置排列情形

❖ Modification in Reservoir Operation

- ❑ Increase the operation of low-level discharge facilities for desilting of density current or turbit water and for lowering turbidity in the reservoir

❖ Summary of Dam Top Water Inake Operation on Typhoon Events

Year	Typhoon	Peak Inflow (cms)	Turbidity (NTU)	Precipitation (mm)	Water Supply Situation	Operation of 960,000 Dam Top Pumping Station (hr)
1996	HERB	6,363	—	790.3	Interrupted 9 days	—
2004	AERE	8,594	208,930	1,042.0	Interrupted 17 days	—
2005	HAITANG	3,199	27,800	510.8	Interrupted 1 day	Pumping 400,000CMD
2005	MATSA	5,166	96,400	846.9	Rotational Supply	Pumping 400,000CMD
2005	TALIM	3,689	46,300	387.6	Supplies water normally	Pumping 400,000CMD
2006	Frontal Rain	818	4,935	—	Normal	16
2007	SEPAT	1,844	5,820	356.2	Normal	26
2007	WIPHA	2,788	21,159	437.3	Normal	80
2007	KROSA	5,300	27,930	670.7	Normal	96
2008	FUNG-WONG	2,039	10,280	273.9	Normal	29
2008	SINLAKU	3,447	9,500	965.2	Normal	124
2008	JANGMI	3,292	8,820	427.2	Normal	67
2009	MORAKOT	1,837	8,112	486.4	Normal	New intake facility operated75hr

Shihmen Reservoir Overall Rehabilitation Programs:

- ❑ Watershed conservation and management projects
- ❑ Dam facility rehabilitation
- ❑ Water supply facility rehabilitations

➢Watershed Conservation and Management Projects

Project	Achievements
(1) Land use management	In Progress
(2) Monitoring of land use, environmental ecology, and disaster prevention	In Progress
(3)Conservation of the watershed	In Progress
(4)Education for conservation and disaster prevention	Continuing Work

➢Shihmen Reservoir Rehabilitation Program

Project item	Status
(1)Upgrade dam top pumping capacity to 960,000 tons	Completed
(2) Repair power plant and PRO	Completed
(3) Backup groundwater water supply for Taoyuan and Hsinchu industrial park	Postponed
(4)Emergency measure for water supply under low reservoir levels	Completed
(5)New reservoir surface intake water supply system	Startup completed
(6)Afterbay improvement, backup storage ponds and man-made lake	Complete planning and in EIA process.
(7) Desilting improvement projects	PRO completed, power plant in progress
(8)New reservoir desilting project	In progress
(9)Investigation, planning, testing and research.	In progress
(10) Construction of hydrology and the water quality monitoring center	In progress
(11) Repair of related facilities and improvement of surrounding environment	In progress
(12)Reservoir sediment dredging	In progress

➢Water Supply Facility Rehabilitation Projects

Project	Status
(1) Improvement of Jianshan Pumping Station	Completed
(2) Upgrading Shihmen Purification Plant Raw Water Storage Capacity to 500,000 m^3	Completed
(3) Exporision of Longtan Purification Plant	In Progress
(4) Water Transfer from Dahan River to Taoyuan	In Progress
(5) Bi-directional Water Supply Between Taoyuan and Hisnchu	Completed

地方說明及民眾參與

國內及國外專家諮商

與社會團體溝通及長官指導

➢執行成果

✓集水區保育--崩塌地處理--砂崙仔

崩塌面積：9.75公頃

執行成果

✓ 集水區保育—野溪及崩塌地治理--蘇樂溪

Concluding Remarks

- The combined effect of large seismic activities, long term reservoir siltation and high rainfall intensity substantially increased the amount of silt inflow into Shihmen Reservoir and changed a traditional reservoir siltation phenomena into siltation plus high turbidity raw water problems. This caused interruption of water supply to general public and affected industrial production.
- To resolve the situation, multiple approaches have been undertaken, including watershed conservation, reservoir desilting, construction of surface intake, regional water management and transfer. The actions taken have alleviated water supply problems since 2005.
- Works are still in progress to further reduce reservoir siltation and raw water turbidity

- Greenhouse effect has cussed a temperature rise of about 1.5℃, and sea level increase of about 20~40 centimeters.
  At the same time, data at Taipei Meteorological Station indicates that for the last 100 years, the annual rainfall has increase 268 mm/year, yet precipitation occurrence has reduced 27.8 days per year. Storm intensity can be expected to increase in the future and global warming is an uncertain factor that must be dealt with.
- Experience gained in Shihmen Reservoir since 2004 may be of value to others, either in Taiwan or else where, in dealing with similar problems.


簡 報 結 束
Thank you for your attention!