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Situ Gintung Dam Controversy, Rebuilt or Removed?

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ABSTRACT

On the dawn of March 27, 2009 all of a sudden Situ Gintung Dam in South Tangerang, Banten, Indonesia was being headline on the media allover the world. A 10-meter high earthen dam breached with almost 100-dead toll brings us to a controversy, whether it will be rebuilt or removed. As compare to the situation in the US where around 60 small dams were scheduled for removal in 2008 alone, mostly due to no-longer-served its intended purpose and/or in order to restore its ecological integrity by restoring the free movement of fish and other aquatic organisms.
This paper discusses thoroughly the complexity of issues to be considered and the decision-making process to be taken for both possibilities.

Keywords
Situ Gintung Dam controversy; rebuilt or removed; considerations.

1. BACKGROUND INFORMATION

The exact figure of dams allover the world is uncertain, NRC estimated around 2.5 million dams in 1990. According to the latest update by the USACE National Inventory of Dams (NID, 2009), there are 82,642 dams in the US, and approximately one third of these dams pose a "high" or "significant" hazard to life and property if failure occurs. Over one third of these dams are already fifty years old, and in another ten years, more than 60% of these dams will have reached the half-century mark. The deterioration of aging dams creates a financial burden for dam authorities and safety hazards to those living downstream. According to the National Performance of Dams Program at Stanford University, 1,595 significant hazard dams are within one mile of a downstream city.

In the world's record of disasters due to human technical failures, the 1975 collapse of China's Banqiao reservoir dam in Henan province ranked first, which was in a matter of days, 26 dams collapsed one after another, which resulted in massive flooding in nine counties and one town. The total number of deaths recorded was around 240,000. Note that in China there are 85,160 reservoirs, which a total of 3,486 dams collapsed from 1954 to 2005.

As indicated by International River Network, the cause of failure of various types of dams (earthfill, rockfill, gravity, multi-arch, buttress, arch, tailings dam) were either due to overtopping (35%), piping (38%), structural failure or geological/foundation weaknesses (21%), and others 6%. Referring ICOLD (International Committee on Large Dams) Bulletin 109, the statistics of dam failures worldwide (excl. China & USSR) were dominated by overtopping during operation of fill dams, which were less than 30m high.

After the event on the dawn of March 27, 2009, the aging Situ Gintung Dam in South Tangerang, Banten, Indonesia contributed to the statistics of devastating dam failures with almost 100-dead toll, hundreds of victims and missing people. On March 31, 2009, the Directorate General of Water Resources, Ministry of Public Work, has come up with a recommendation to build new check-dam more upstream in order to preserve reservoir function.

According to World Commission on Dams, the consensus among river ecologists is that dams are the single greatest cause of the decline of river ecosystems, since by design dams alter the natural flow regime. Dams also require ongoing maintenance, and can have significant economic impacts on dam authorities, the surrounding community and society in general.

Therefore, despite the long history and importance of dams, there is a growing awareness to remove them. Decommissioning or removal of dams has primarily taken place in the US and Europe, and the trend is likely to go worldwide. Dam “decommissioning” means the deactivation of a dam project’s principle functions and may include: dismantling power generating equipment, permanently opening dam gates, partial breaching of earthen structures, or complete and permanent removal.

The American Rivers organization has documented approximately 750 dam decommissioning since 1912, with the pace picking up to between 20 and 50 each year for the last 10 years. Currently in the United States, more dams are being removed than built. In the year 2008 alone, there were 64 dams removed or scheduled to be removed.

The situation in the US Dam Removal Cited reasons for removal (American Rivers et al., 1999):

- Environmental — 43%
- Safety — 30%
- Economics — 18%
- Failure — 6%
- Unauthorized structure — 4%
- Recreation — 2%

Influencing public opinion can be a lengthy and difficult process, since many groups are involved in dam removal decisions. Scientific information about the benefits and drawbacks of dam removal should be used as the basis of decision making. Dam removal is becoming a new socio-politico-scientific endeavor.

Several tools exist to assist communities and decision makers in evaluating the option of removing a dam. This paper discussing two decision-making guides for dam retain or removal; and exploring the possibility to employ the guidelines for Situ Gintung case.

2. THE DECISION-MAKING MODELS FOR DAM RETAIN OR REMOVAL

Influencing public opinion can be a lengthy and difficult process. Many groups are involved in dam removal decisions; local residents, citizens groups, local government, state government agencies, federal government agencies, businesses and environmental groups. Opponents to dam removal raise concerns such as the effect on property values, recreation, and town identity, while proponents of dam removal raise concerns such as public safety, the cost of maintaining an aging dam, and water quality problems created by dams.

Based on previous work by Stephanie Lindloff, River Alliance of Wisconsin, ten common concerns about dam repair and removal are the following: (1) "If the dam is removed, the river will turn into a mere trickle or even dry up"; (2) "We'll have more flooding problems"; (3) "All that will be left are stinking mud flats"; (4) "If the dam is removed, who will own the 'new' land?"; (5) "If the dam is removed, wildlife habitat will be lost and wildlife will suffer"; (6) "Will property values be affected?"; (7) "Who will pay for the dam's repair or removal?"; (8) "The dam has historical value"; (9) "Dam removal will introduce exotic and/or disease species"; (10) "I've heard you can get sick because of dam repair or removal".

There are several tools exist to assist communities and decision makers in evaluating the option of removing a dam. The following are two tools from two reliable sources, which already approved to be powerful, namely:

- "Exploring Dam Removal: A Decision-Making Guide". A joint project report written by American Rivers and Trout Unlimited for dam removal and river restoration work in 2002.
- "Dam Repair or Removal: A Decision-Making Guide". Document prepared based on a project funded by the Wisconsin Department of Natural Resources and in part by University of Wisconsin-Madison Institute for Environmental Studies.

2.1. Exploring Dam Removal: A Decision-Making Guide Developed by American Rivers and Trout Unlimited (AR & TU)

In exploring whether a dam should be removed or retained, the considerations are structured as follow:

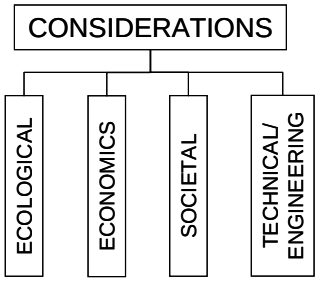


Figure 1: Consideration Structure of AR & TU Decision-Making Guide

Considerations that should be addressed and the bottom line of each issue are summarized in the following table:

Table 1: Considerations, Issues and Bottom Line of AR & TU Decision-Making Guide

	Issues	Bottom Line
ECOLOGICAL CONSIDERATIONS	A. Upstream Flow and Habitat	Will the restored river and riparian habitat upstream outweigh the loss of impounded habitat?
	B. Downstream Flow and Habitat	Is dam removal necessary to restore natural flows to the river? Do the benefits of restored flows outweigh the impacts on species that prefer unnatural flows?
	C. Fish and Wildlife	Is the net impact of dam removal on fish and wildlife populations positive or negative?
	D. Passage and Movement of Fish and Other Species	Will dam removal improve safe passage of migrating fish and movement of resident fish and wildlife? Is dam removal necessary to accomplish this? Can dam removal be done without enabling the spread of undesirable species?
	E. Sediment Movement	What is the current net impact of the accumulated sediment on the impoundment and downstream habitats? How will sediments released during dam removal impact the riparian and riverine habitats in the short and long term?
	F. Water Quality	Will dam removal have a net benefit on water quality, taking into account both short-term and long-term impacts and benefits?
	G. Riparian Areas	Will there be a net gain in the amount and quality of riparian habitat as a result of dam removal?
	H. Wetland Areas	How will the wetlands gained by dam removal compare in amount, type, and

	Issues	Bottom Line
		habitat value to the wetlands lost by dam removal?
	I. Location of the Dam within the Watershed	Will dam removal significantly enhance the river's ecological values, given the location of the dam relative to other dams in the watershed?
ECONOMIC CONSIDERATIONS	A. Dam Owner's Costs and Benefits	Are the long-term costs of operating and maintaining the dam less or more than the costs of removing the dam? Do any benefits of the dam need to be replaced, and if so, by whom?
	B. Societal Costs and Benefits	Are others in the community responsible for any additional costs and benefits of maintaining or removing the dam?
	C. Recreational Costs and Benefits	Will dam removal positively or negatively influence community revenues from recreation?
	D. Environmental Costs and Benefits	Do the net environmental costs (or benefits) of keeping the dam outweigh the net environmental costs (or benefits) of removing the dam?
	E. Property Values	Will dam removal positively or negatively affect property values adjacent to the stream? Will these effects, if any, be short or long term?
	F. Distribution of Costs and Benefits	Who benefits the most from retaining/removing the dam? Who bears the costs for retaining/removing the dam?
	G. Availability of Funding for Dam Repair or Removal	What funds are available to pay for dam maintenance/repair or removal?
SOCIETAL CONSIDERATIONS	A. Community Understanding of the Dam, the River, and Dam Removal	Do the decision-makers and other concerned parties have sufficient information to make an informed decision about dam removal or dam retention?
	B. Service(s) Provided by the Dam	Does the dam provide any services? Are these services as valuable as the services provided by a free-flowing river? If yes, can these services be provided through alternative means?
	C. Who Benefits From and Who Bears the Costs of the Dam	Who benefits from and who bears the costs of the dam? Who will benefit from and who will bear the cost of a restored river?
	D. Community Sentiments Toward the Dam and the River	How do community members feel about the dam? About the river? About dam removal?
	E. Historical Role of the Dam	Does the dam have true historical value, and are there ways to commemorate the historical value without keeping the dam?
TECHNICAL/ENGINEERING CONSIDERATIONS	A. Feasibility of Repairing and Maintaining the Dam	
	A1. Safety Repairs or Upgrades	If the dam is unsafe, will dam removal cost less than repairs and ongoing maintenance? Are repairs to the dam prohibitively expensive?
	A2. Repairs or Upgrades to Continue Efficiently Providing the Dam's Intended Uses	If expensive upgrades are needed to maintain the dam's services, is it more cost effective to remove the dam and find alternatives to replace those services?
	A3. Mitigation of the Dam's Environmental Impacts	If environmental mitigation measures are needed, is it more cost effective to keep the dam and mitigate for its environmental impacts or remove the dam?
	B. Feasibility and Design of Dam Removal	
	B1. Obtaining Dam Removal Permits	Will permitting requirements affect the design, cost or feasibility of the removal? Are there permitting requirements for dam
	B2. Protecting Against Environmental Impacts	What steps must be taken to eliminate or minimize the environmental impacts of the dam removal?
	B3. Managing Sediment	Is there a feasible method of managing the sediment behind the dam?
	B4. Removing Structures	What is the most cost effective and environmentally sound dam removal method?
	B5. Protecting Infrastructure	Are there structures that will have to be stabilized, retrofitted, or relocated if the dam is removed?
	B6. Restoring the Channel	Does the new river channel need to be actively designed or can the river naturally find its own channel?
	B7. Restoring Recovered Land	Will the recovered land need to be actively re-vegetated?

To see the complete checklist questions and toolboxes, one should consult "Exploring Dam Removal: A Decision-Making Guide" in <http://www.americanrivers.org/>.

2.2. Dam Repair or Removal: A Decision-Making Guide Developed by Wisconsin Department of Natural Resources (WDNR) and University of Wisconsin-Madison (UWM)

The document "Dam Repair or Removal: A Decision-Making Guide" is a main reference for The Water Resources Management workshop (WRM) 2000, which is a regular part of the curriculum of the Water Resources Management graduate program at the University of Wisconsin-Madison. The workshop is conducted based on five modules in the document, and involves an interdisciplinary team of faculty and graduate students in the analysis of a contemporary water resources problem.

Considerations of dam retain or removal is structured as follow:

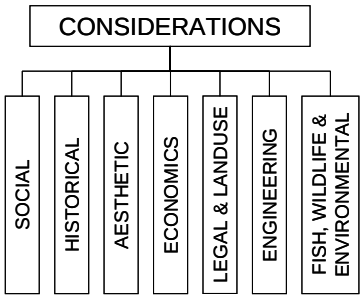


Figure 2: Considerations Structure of WDNR & UWM Decision-Making Guide

The outline of considerations, issues and checklist questions of WDNR & UWM Decision-Making Guide is summarized in the following table:

Table 2: Considerations, Issues and Checklist Questions
WDNR & UWM Decision-Making Guide

	Issues	Checklist Questions
SOCIAL	• Community attitudes • Process of decision-making	• What is the social value of the dam and the impoundment? • What are community attitudes toward the dam? • What type of decision-making process will be used for deciding whether to remove or repair the dam?
HISTORICAL	• Historical facts • Historic preservation options	• What is the history of the dam? • Are historical community events hosted at the site? • Is the dam's historical value primarily through association with an adjoining building or structure (for example, a millhouse) versus the impoundment?
AESTHETICS	• Aesthetic concerns • Possible changes in the scenery • Options for enhancing visual appeal	• What are the community's primary aesthetic concerns? • How will the environment of the area change with our decision to repair or remove the dam? • What opportunities exist for enhancing the look of our community as a result of our decision to repair or remove the dam?
ECONOMICS	• Costs – Construction costs – Safety and liability cost – Operation and maintenance costs • Property values – Benefits – Recreational benefits – Environmental benefits • Funding	• What is the cost of repairing or rebuilding the dam? • What is the cost of removing the dam? • If sediment is an issue, what is the cost of addressing the sediment that has accumulated behind the dam? What if the sediments are contaminated? What is the cost of properly disposing the sediment? • Are property values expected to increase or decrease in the surrounding area if the dam and pond are around for another several decades or if the dam is removed? • What funding sources are available to cover construction costs and costs of operation and maintenance with repair or removal?
LEGAL & LAND USE	• Historical overview of legal regulation on dams • Legal definitions • Repair/removal issues • Role of the Regulatory Commission • Land ownership identification: Dams and flooded lands	• What are the important regulatory considerations? • Who owns the dam? • What are the important land use considerations if the dam is repaired or removed? • What happens to the land submerged by the impoundment if the dam is removed? Who will own the land?
ENGINEERING	• Dam safety and hazard classification • Flood studies • Structure assessment and analysis • Emergency Action Plan • Sediment management	• What is a dam safety inspection? How often does the dam owner need to perform it? • What is the size, type, age and safety condition of the dam? • What is the hazard ranking of the dam (that is, how much potential damage could be caused if the dam were to fail)? • Does the dam provide flood protection? Does the dam meet necessary flood standards? What is the flood passage capacity of the dam? • Would the dam survive maximum headwater conditions (impoundment filled to the top)? Is it possible to see sliding, overturning or foundation failure (such as cracks, holes, crumbled sections, and so forth)?
FISH, WILDLIFE & ENVIRONMENTAL	• Fish/wildlife communities • Effects on fish and other aquatic wildlife habitat • Effect on wetlands • Species of concern • Watershed, water quality, and groundwater	• What is the quality of habitat in the impoundment? Upstream? Downstream? • What is the amount and type of lake or pond habitat that would be lost through dam removal (for example, how many acres of warm-water fishery? How many acres of waterfowl habitat)? • What are the amount and type of reconnected river habitat that would be gained through dam removal? • How would dam removal/repair affect wetlands? • Are the species affected by dam related activities species of concern? Are there endangered species present?

To see the complete checklist questions and toolboxes, one should consult Water Resources Management Practicum 2000: "Dam Repair or Removal: A Decision-Making Guide", in <http://www.ies.wisc.edu/research/wrm00/>.

2.3. Decision-Making Process

A well designed decision-making process can address safety, economic, and environmental concerns and also satisfy the desire of community members and other stakeholders to participate actively in shaping the future of the dam and related natural resources in their community.

The experiences of numerous Wisconsin, USA, communities that have faced the decision-making whether to remove or retain suggest that designing and adhering to a well considered collaborative decision-making process can significantly reduce the conflicts.

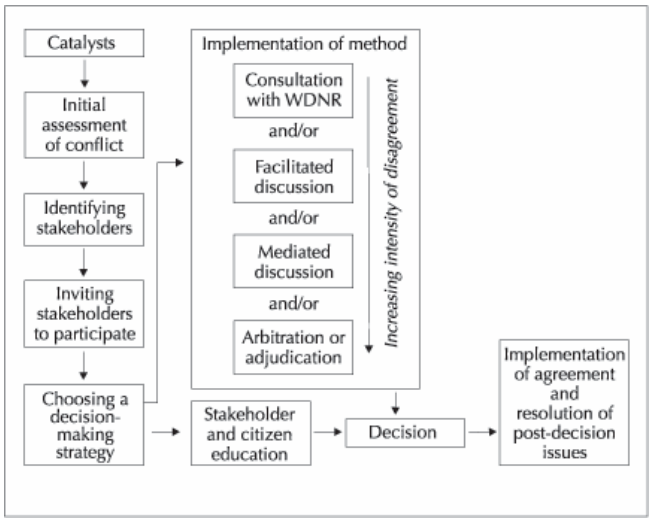


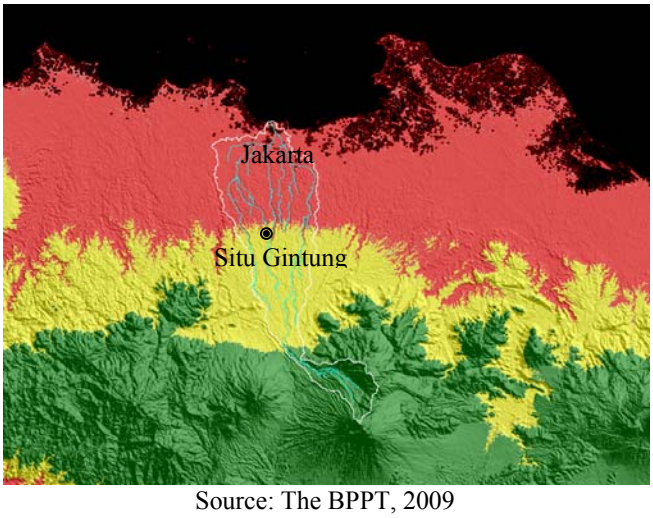
Figure 3: Principal components involved in designing and implementing an appropriate decision-making process.

3. THE SITU GINTUNG CASE

3.1. Situ Gintung Disaster Feature

Situ Gintung Dam was built during the Dutch occupancy in the year 1932-1934. The condition before the dam break was already degraded. The originally 31 Ha reservoir with 10m depth, currently (before its burst) only around 21 Ha left with the depth ranging from 3 to 4 meter.

Located in the vicinity of Jakarta, the storage capacity of the Situ Gintung reservoir diminished gradually within 76 years, mainly due to the pressure of urbanization.



Source: The BPPT, 2009

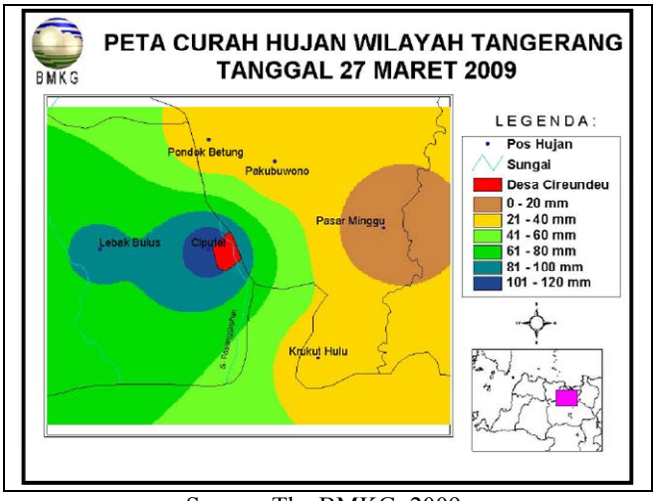
Figure 4: Location of Situ Gintung Dam.

Based on 1:25,000 Earth Imagery Map, the 2008 land use distribution of the catchment area of Situ Gintung reservoir is dominated by housing (39.70%) and farmland (22.80%). The total catchment area is just around 112.50 Ha.

Source: The BPPT, 2009.

Figure 5: Catchment Area of Situ Gintung Resevoir.

The BPPT (The Agency for the Assessment and Application Technology) has conducted analysis concerning the trigger of Situ Gintung dam failure. Most likely the reason of dam burst was manifold, but the weakest point of the dam was its aging spillway structure. Piping through the spillway crack, and high intensity rainfall brought the dam to collapse.



Source: The BMKG, 2009.

Figure 6: Rainfall Distribution on March 27, 2009.

According to the BMKG, the total area-rainfall on the preceding day was 113.20 mm.

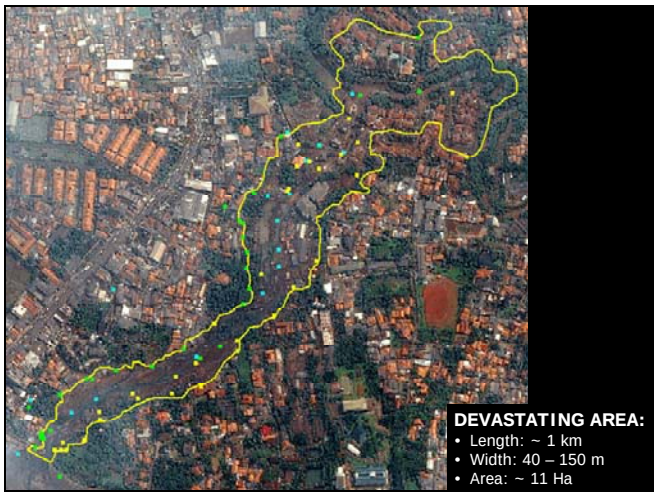
Although the Situ Gintung dam failure was not the one and only catastrophic event due to human technical failures, the number of dead-toll, hundreds of victims and missing people was indeed very massive in comparison to i.e. the

collapse of Teton Dam in Idaho, USA, where a 90m high dam burst with 'only' 11 dead-toll.

Source: KOMPAS/WISNU WIDIANTORO, 2009
Figure 7: Situ Gintung, Situation Aftermath, March 27, 2009.

The dense housing complexes which occupied floodplains immediately downstream of the dam actually should have never been allowed to be there. People who have chosen to build houses and decided to live there should have known about the regulation and also the most important, about the potential hazard.

The scale of devastating hazard area covered around 11 Ha with 1km in length and 40-150m in width. Within minutes 316 permanent and semi-permanent houses were torn down and billion of rupiahs losses were obvious.



Source: The BPPT, 2009
Figure 8: Devastating Area Downstream of Situ Gintung Dam

3.2. Proposal of Post-Disaster Management

Technical Properties of Situ Gintung Dam/Reservoir can be summarized as follow:

- Dam: ca. 200m-length and ca. 7m-height.
- Appurtenances: one 5mx1.5m spillway and two intakes
- Function: originally for irrigation, then converted into conservation facility utilized for recreation and fisheries.
- Downstream channel: ca. 2m-width channel, tributary of Pasanggrahan river, floodplains occupied by dense housing complexes.

The Directorate General of Water Resource (DGWR), Ministry of Public Works has come up with three options of long-term post-disaster management as summarized on the following table:

Table 3: Proposal of Long-Term Post-Disaster Management

First-Option	Second-Option	Third-Option
Reconstruction alternatives/scenarios: a. Dam location alternatives: - rebuild at the same spot (alternative 1); - relocate more upstream (alternative 2). b. Select the best fit dam-type. c. Reorganize land usage upstream and downstream area of the dam, in line with the existing regulation; and consider the risk factors of dam safety. d. Enhance the post-construction management approach (dam/reservoir authority, operation and maintenance of dam and reservoir)	Dam decommissioning through: - reorganization of previous reservoir area usage and also the downstream part of the dam; - river revival; - usage of previous reservoir area as public and/or recreational facilities; and cultivation of greenbelt area as aquatic buffer.	Combination of First- & Second-Option by constructing new lower check-dam and its appurtenances more upstream (alternative 2) in order to preserve reservoir function in the form of river-channel (hence smaller) storage. The reservoir serves as conservation facility, which should followed by: - reorganizing the land usage upstream and downstream area of the dam, in line with the existing regulation; and consider the risk factors of dam safety. - enhancing the post-construction management approach (authority, operation and maintenance of dam and reservoir) - utilizing the previous reservoir area as public and/or recreational facilities; and cultivating greenbelt area as aquatic buffer.

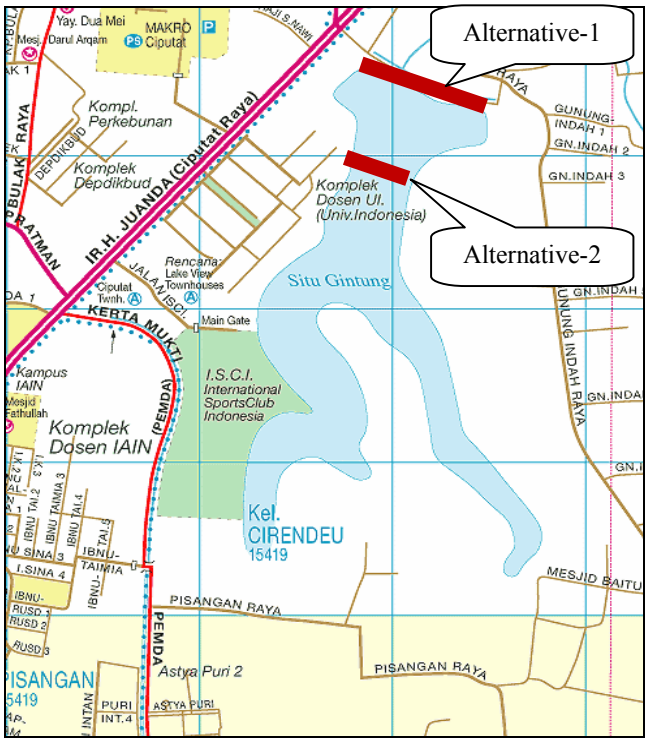
Source: The DGWR, Ministry of Public Work, 2009.

Table 4: Dam Location Alternatives

	Alternative 1	Alternative 2
Dam height	15m	5m
Dam lenght	270m	170m
Inundation area	214,000m^2	161,500m^2
Storage	3,210,000m^3	807,500m^3
Spillway	5x1.5m	5x1m

Source: The DGWR, Ministry of Public Work, 2009.

The dam location alternatives are presented on the following figure.

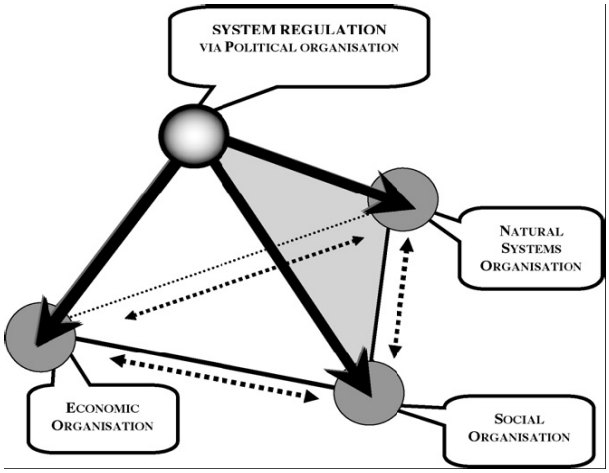


Source: The DGWR, Ministry of Public Work, 2009.
Figure 9: Dam Location Alternatives.

Just within four days after the disaster, on March 31, 2009, to be precise, the DGWR has decided the Third-Option as the most viable one.

4. DISCUSSION

To bear in mind the "Four Spheres" Prism of Sustainability (O'Connor, 2006), there were perfect match to both decision-making guides discussed earlier.



Source: Michelle Graymore, et.al., 2008.
Figure 9: "Four Spheres" Prism of Sustainability.

The "Four Spheres" Prism of Sustainability can accommodate the complexity of interaction and intertwining nature among the issues. I.e. without doing thorough design procedures is impossible to do the estimation of construction costs, safety and other liability risks, as well as operation and maintenance costs; and without conducting surveillances to stakeholders, is impossible to estimate the benefit of recreation, aesthetic, and ecological, as well as property value. Therefore, the economic consideration is a result of manifold preceding thorough assessment of various considerations.

Further discussion is needed as consequence of choosing the third option of DGWR proposal, among others:

[1] Reorganizing the land usage upstream and downstream area of the dam:
- Do the decision-makers and other concerned parties have sufficient information to make decision?
- What is the land-use classification of the land downstream of the dam? What is the level of development at and below the dam site?
- If the properties will be required to carry flood insurance, are property values expected to increase or decrease in the surrounding area? In the flood zone?
- Are property values expected to increase or decrease with the change from lake to river aesthetics?
- How do community members feel about the dam? What is the current level of support for keeping the dam? Do any local/regional/national officials or anybody else support dam retention? How powerful are they?
- Does the dam have true historical value?

[2] Considering the risk factors of dam safety:
- What is the hazard ranking of the dam? Does the National Dam Safety Program Act affect the dam?
- What will be the impacts of dam failure? What are the costs of dam failure flood insurance? For other liability insurance policies?
- How many properties must carry flood insurance because they are in the flood zone if the dam were to fail? Are there buildings below the dam that cannot be occupied because of the dam break analysis?
- What insurance costs will be avoided in relation to the decision? How many homes, buildings, and other properties will be removed from the catastrophic flood zone and no longer be required to carry flood insurance?
- Is there any Emergency Action Plan (EAP) applies? How does it work?
- Does the dam provide flood protection? Does the dam meet necessary flood standards? What is the flood passage capacity of the dam? Would the dam survive maximum headwater conditions?
- Have floodplain studies been administered previously?
- Would there be a need for design or construction of new appurtenances?
- How will the sediment built up behind the dam be handled? How much sediment would potentially be released downstream? How would it impact the stream?

[3] Enhancing the post-construction management approach (authority, operation and maintenance of dam and reservoir):
- What will periodic inspections of the dam cost to prevent future problems?
- Will the dam have appurtenances that require someone to operate them? How much will dam appurtenances operation cost?
- How often will dredging the reservoir need to be done? How much will it cost?
- Will sediment controls need to be maintained? What does the sediment controls maintenance cost?
- Does the reservoir require vegetation control? What does the vegetation control cost?
- If part of the former reservoir is converted into a park or other natural area, how much would be the maintenance cost?

[4] Utilizing the previous reservoir area as public and/or recreational facilities and cultivating greenbelt area as aquatic buffer:
- What type, location, and extent of existing wetlands created by the dam will be lost? What type, location, and extent of lands could be gained? How will the land gained be managed?
- How many people enjoy the activities on the reservoir? On the river? How much do the people value each activity on the reservoir? On the river?
- Do any businesses rely directly or indirectly on recreation at the reservoir? At the river? What is the economic value of the recreational business at the reservoir? At the river?
- What is the economic value of recreating at a new park or natural area?
- Are recreation businesses currently dependent on the reservoir flexible enough to focus on river recreation?
- What are the recreational opportunities associated with the decision? Are new businesses catering to river recreation likely to be established?
- What impact will the decision have on the watershed? Will surface water quality improve/worsen? Does the dam and impoundment affect groundwater levels in the area?
- Will the recovered land need to be actively re-vegetated?

5. CONCLUDING REMARKS

Making a final decision, whether Situ Gintung Dam/Reservoir should be rebuilt or removed, is not a simple task. There are considerable issues need to be taken into considerations. The "Four Spheres" Prism of Sustainability can accommodate the nature of interrelations and intertwining among the issues.

Once all of the data/information is gathered, many factors should be examined thoroughly and comprehensively, in order to understand the influences on the decision, including:
- The societal, economics and ecological circumstances surrounding the case;
- The complexity of the issues;
- The legal and political context in which a decision must be made;
- The amount of controversy surrounding the decision;
- The impetus for considering all possible alternatives;
- The number, identities, and strength of various stakeholders.
- Etc. etc.

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