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INTERACTIONS OF ENVIRONMENTAL ASSESSMENT AND COASTAL ZONE MANAGEMENT: BILI-BILI DAM CASE

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ABSTRACT

The development of Bili-Bili Dam promises some benefits as well as flood control, providing water supply for irrigation, fishery, clean water, and for electrical power. This research aims to identify how far environmental information is considered on this dam construction. The lack of environment information consideration will cause a necessary extra cost for environment damage recovery.

INTRODUCTION

In 1976 the coastal city if Makassar (formerly called Ujung Pandang), South Sulawesi, Indonesia, suffered from a serious flood. Two thirds of the city of 646,868 people was underwater (over 35 km^2) with the total damage estimated at 450 million rupiahs (CTI 1994). A 1978 study of the Lower Jeneberang River that flows through the southern part of Makassar suggested building a dam to stop the flooding.

The purpose of this research is to look at what information was used, its completeness, and when it was used in the decision to built the multipurpose Bili-Bili Dam on the Jeneberang River. In looking at the completeness of the environmental information, the study evaluates the actual (post development) impact of the dam on the river and coastal area.

LITERATURE REVIEW

This research takes a watershed approach as its framework for analysis. A watershed is defined as the land area drained by a river or stream, system of connecting streams, such that all water within the area flows through a single outlet. Paembonan (1997) describes a watershed as an ecosystem that consists of three interrelated and interacting subsystems; protection subsystem, production subsystem and multipurpose subsystem. Production uses of the watershed have to be balanced with protection and multiple uses.

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For example when water is the product and is used for irrigation or domestic use, pollution controls must be put in place (protection) in order to protect these uses. Translating to sustainable development (defined as "meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987 p. 8) the three subsystems must be kept in balance for the long term. In the case of the Jeneberang River watershed, development of one product (flood control) has to be balanced with the multiple uses of the river and watershed (irrigation, sand and gravel mining, domestic water supply, hydroelectric power generation, fisheries and recreation) while protecting the watershed ecosystem including the coastal zone. The Director General of Irrigation for Indonesia has stated his goal "one river, one planning and one management." The planning for the entire river basin is a more complex planning effort than designing a single project. Finding the balance is difficult (Linsley 1979).

Planning is an essential task for water resources development and is part of the process to find the balance. Linsley (1979) defines planning as the orderly consideration of the project from the original statement of the purpose through evaluation of alternatives to the final decision on the course of action. Planners provide several alternatives to the decision-makers enabling them to choose the optimum one, balancing the multiple purposes of the watershed. "Water resources development may be small or large, simple or complex, serving one purpose or several, but it should provide the facilities to accomplish the optimum development of the related physical resources" (USDIBR 1973).

In construction planning, the first step is political, recognizing the need for the project, followed by a technical analysis of feasible alternatives (Linsley 1979). An economic study of costs and benefits as well as studies of social impacts, environmental impacts and financial feasibility is also developed as aids to the decision-making. The result is usually a multipurpose project in order to balance complimentary and conflicting objectives (Richards 1982; Chia 1991).

Water resources development is expected to meet various requirements for water by varying the quantity and quality of supply, control of excess water, and conserving the quality and quantity by modifying the time and place of use of these supplies according to the need of a plan (Clark 1977; Linsley 1979). Water resources are traditionally developed by building dams, reservoirs and other installations along the river. Such projects interfere with natural processes causing impacts to the environment in the upper stream and to the downstream sections including the coastal area. Because of these consequences water resources policy-makers need to understand the relationship between the watershed and the coastal areas. Development activities modify the land area resulting in a high potential for adverse effects on estuarine water system. This occurs by modifying the runoff patterns and thereby reducing the capability of the land to store the regularize the releaser of rain water from the watershed and to cleanse it en route to the coastal zone (Clark 1977; Maragos et al. 1983). Understanding these relationships intuitively, Emperor Yu of China, 1600 BC is reported to have said, "To protect your rivers, protect your mountains." (www.wildlife.org/main.html 2000).

Dams have been placed on every type and size of flowing rivers to store water to compensate for fluctuations in river flow and for hydroelectric power generation. Cairrns (1992) reported that in the US more than 200 major dams were completed between 1962 and 1968. According to the 1982 inventory of nonfederal dams conducted by the U.S. Army Corps of Engineers, major dams constructed in the world decreases from more than 2,000 per year in the 1960's to about 1,240 per year during the 1990's. The International Commission on Large Dam (ICOLD) reported that nearly 1,200 dams with the height of at least 15 m (defined as a huge dam) were under construction at the beginning of 1994 (McCully 1996).

At the beginning of the 20th century, dams were popular because they promised abundant cheap power, wealth, and food security. At the beginning of the 21st century, dams are unpopular because of the resulting impacts on the ecology of rivers and coastal waters. It is also because many dams, now a century old, are beginning to fail, raising additional concerns and costs (Jobin 1998).

The main environmental impacts from a dam and reservoir are:

1. the upstream change from river valley to reservoir;
2. changes in the morphology of downstream riverbed and banks, delta, estuary, and coastline due to altered sediment loads,
3. changes in downstream water quality as measured by temperature, nutrient load, turbidity, dissolved gases, and concentration of heavy metals and minerals, and
4. reduction in biodiversity due to blocking the movement of organisms (i.e. fish) as well as trapping nutrients in the reservoir which impact quality of zooplankton and resulting changes in aquatic life species diversity. For example, an 80% reduction in the discharge into the Indus River because of dams in Pakistan and India killed almost all the river delta mangroves McCully 1996). The World Bank has leant large sums of money to countries throughout the world to build large dams and only recently has

begun to see that this form of development is not necessarily good for the people in those countries (Leopold and Dunne 1978).

Dams have been highly effective in controlling flood waters immediately downstream. However, dams have resulted in the flooding of thousands of hectares of land including towns, villages and prime agricultural lands. Three Gorges Dam on the Yangtze River in China will require resettlement of more than a million farmers and villagers. The Aswan Dam in Egypt on the Nile River provided benefits to some farmers and has been a major source of electric power. But the water covered priceless archeological sites, destroyed fishing ponds, eroded riverbanks, and altered nutrient and sediment balances. It has led to changes in the Nile Delta because the normal silt load deposited in the delta has stopped (Leopold and dunne 1978).

As part of the decision-making process in deciding whether and where to build the dam, an environmental impact assessment (EIA) in undertaken. The purpose of an EIA is to fully disclose to decision-makers and the general public the short term and long term environmental impacts that will occur as a result of undertaking the project. The EIA should be developed as part of the iterative process of deciding on, and planning and designing a project. Alternative solution should be proposed to the problem being solved and the environmental impacts of those different alternatives analyzed in order that the alternative with the least impact can be chosen. If there are unavoidable impacts mitigations are created and made a part of any cost benefit study that is done for the project.

In the United States, the 1970 National Environmental Policy Act, required that major federal project affecting the environment an environmental impact statement has to be written. The statement has to be made available to the public for comment and the lead agency is required to respond to the comments before making the final decision on which alternative will be chosen for implementation. Alternative actions considered include the no action alternative of continuing the status quo.

In Indonesia, EIA [Analisis Mengenai Dampak Lingkungan (AMDAL)] was enacted as Act 4, 1982. Section 16 "ketentuan-ketentuan pokok pengelolaan lingkungan hidup" is the base law of environmental management. The law was implemented by governmental regulation was renewed by PP no.51 in 1993 and PP no. 27 in 1999. The general guidelines [kerangka acuan (KA)] states that all projects with a significant impact on the environment requires an Environmental Impact Study (EIS) [Analisis Dampak Lingkungan (ANDAL)].

A unique ecosystem, where the land and sea interface is the coastal zone; a region that continually changes. The transfer of fresh water, nutrients, temperature, sediments, organic matter and pollutants from the land can extend seaward while intrusion of seawater can extend inland (Chia 1991). There are numerous components of the coastal ecosystems that must be safeguarded, e.g. vegetation along the shoreline, estuarine bottoms, shellfish beds, and the breeding, nursery, feeding and resting habitats of many aquatic species. In addition, the basic dynamic processes must be maintained – water circulation, nutrient input, dissolved oxygen, salinity and sunlight penetration of the water. Only after these vital basic processes and components are identified and their vulnerabilities to disturbance known, can an effective management program be developed (Ketchum 1992, Clark 1977).

Sand may be supplied to beaches from headland erosion, river transport, and offshore sources. If the sand supply is reduced because of reduced river sediment transport, the beach may become undernourished; shrink and shoreline cliff erosion is accelerated to make up the balance. This process by which beaches are reduced or maintained can be caused by a sediment imbalance between sources (rivers and headland erosion), the rate of long-shore transport along the coast, and the sediment sinks (Kondoff 1977).

In the United States coastal zone management is governed by the 1972 Coastal Zone Management Act (CZMA) in which Congress explicitly called for balancing environmental and economic concerns. The CZMA was amended in 1990. The states hold the primary responsibility for planning and implementing comprehensive coastal land-use management plans and the federal role is to coordinate the development of programs that are compatible not only with statewide goals, but also regional and national values (Ducsik 1971).

In Indonesia, the world's largest archipelagic state with more than 13,000 islands and a 60,000 km coastline, the strong central government is responsible for most of the large development projects, but the 27 provincial governments are responsible for their own coastal area. There is no national coastal zone management act that guides and regulates the cooperation between the national and local government in formulating and implementing integrated coastal zone management programs. Some of the national agencies are stronger, more powerful or better managed and it is these agencies whose interests prevail. However, Indonesia, in its second 25 year national development cycle year plan (REPELITA) has committed to put more emphasis on coastal zone management (BAPENAS 1998).

METHODS

To develop the data for the case study to see if the EIA process and coastal zone concerns were part of the decision-making to solve Makassar's flooding problem, pertinent government documents and those written by consultants were located and reviewed, key persons involved in the process interviewed and major Indonesian laws reviewed. Research traced the general background of the development of the Bili-Bili Dam back to the 1970s.

In order to focus the analysis of the case study, seven major issues in the Jeneberang watershed were followed. These are: flood control, water supply, irrigation, hydroelectric power, fisheries, recreation, and sediment flows.

CASE STUDY

The Jeneberang River is one of the largest rivers in South Sulawesi, possessing a great potential for water resource development. Its headwaters are in the Bawakaraeng Mountains (elevation 2,833 m) and it flows into an alluvial plain near Kampili through the western part of Makassar City and empties into the Makassar Strait (see Figure 1). The river is 75 km long and the watershed covers 727 km2. The citizens of the City of Makassar and Gowa (Kabupaten Gowa) and Takalar (Kabupaten Takalar) counties depend on the river for drinking water and irrigation, but its flow fluctuates widely (59 times) from dry season to rainy season. In 1997, the Jeneberang watershed had a population of 2,878,957 with a 2.9% annual growth rate (JICA 1980). In addition to the floods from the river, its continual load of sediment was being dumped into the harbor in Makassar, requiring dredging and other expensive maintenance.

The dam was built for flood control. Three sites were proposed: Bili-Bili, Pasar Towaya and Jonggoa (JICA 1980). Bili-Bili was selected because it would have the largest reservoir capacity even though the land acquisition costs were higher (JICA 1980).

An earth covered rockfill dam was designed that had a crest length of 1,800 meters and a storage capacity of 362 x 10^6 m^3. The dam is made of three parts, a 42 m high left wing, a 52 m right wing, and a 73 meter high central section (JICA 1982). The reservoir surface area is 18 km2 (CTIE 1996). The detailed design drawings for the Dam were completed in 1988.

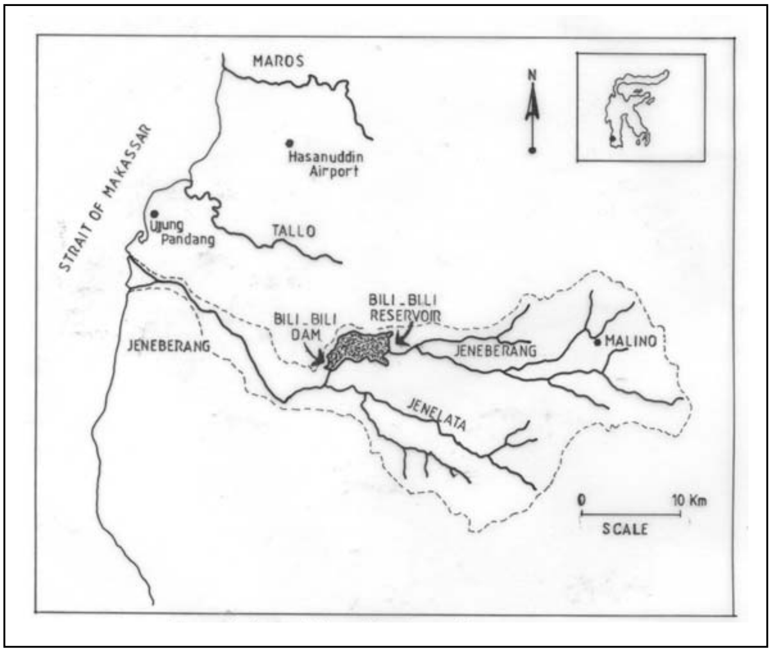

Figure 1. General Map of Jeneberang River and Bili-Bili Dam Location
Source: JICA 1980

The dam was designed for a 50 year life-time based on a sediment flow into the reservoir of 1,500 m3/km2/year, which was revised in 1994 for 1,794 m3/km2/yr. The 50 year design flood was 2,300 m2/sec. The Dam was also designed to send irrigation water to two existing irrigation systems that watered 19,540 ha and that would be rehabilitated. One new irrigation system would be developed adding 5,060 ha of land to be put in production during the dry season. The Dam was also designed to provide 75 gigawatt hours of electricity annually. Figure 1 shows the location of the Bili-Bili Dam.

In 1988 the contract to write the EIA was signed and the final report reviewed by the Central Government in 1991. An environmental management and monitoring plan was prepared by DGWRD and approved by the Regional Commission of South Sulawesi Province in December 1990 and by the Central Commission for Environmental Impact

Assessment in 1991. The EIA suggested the project and resettlement areas needed protection and improvement, and so required some environmental work be done.

Dam construction began in June 1992 and was scheduled to be completed by the end of 1998, but was actually finished one year earlier, October 1997. The reservoir began filling and reached an elevation of +59.0 m by November 27, 1997.

RESULTS AND ANALYSIS

Appropriate technical information was used to decide to build the dam and to design the structure. One of the key people interviewed revealed that in order to cut costs, the geologic information for the foundation of the dam was collected only every 500 m instead of the planned every 100 m.

The EIA was not used in the decision on which site to choose and was done after final construction documents were completed. The EIA failed to mention a number of problems that developed after the dam was built. For instance, after the river flows were reduced in the downstream sections salt water intruded further into the river and rendered two drinking water intakes unusable. It has been necessary to build a sandsill and rubber dam to control salt water intrusion. Sand mining continued below the dam, but the reduced sediment flow has caused the river bed elevation to decline and threaten the Sungguminasa bridge. The Jenelata River that joins the Jeneberang just below the Dam is the only source of sediment to replenish the sand mining. The EIA also failed to adequately measure the sediment flow from the upper reaches of the river into the reservoir. New calculations done in 1994 put the sediment load at 1,794 m3/km2/year, essentially doubling the sediment flow calculated when the dam was being designed (Dadang 2000). This means that the reservoir has a life of only 25 years, not 50. However, in order to overcome the sediment problems, eleven sand pocket dams and four Sabo dams are being built upstream.

The EIA also looked at the social and economic impact of the dam and projected the need for resettlement of several villages and construction of a section of the major road to Malino. One of the resettlements was not at all successful and the village disbanded. The other at Alur C is built, but the market area appears unused, and the spacing of the houses makes it look less like a village than other settlements in the area. New roadside stands sell fish and bananas to the people who drive by.

As of 2000, the projected irrigation improvements have not happened and the drawings are only now being made for the new system. Therefore the improved rice production is not being realized.

The turbines to generate electricity have not been installed, as of 2000, and therefore there is no electricity being generated. Some of the larger industry in the Makassar region has stopped production, so there is not a big need for the power. Plans are still being made to develop the hydropower, but when it would come on line is uncertain.

A large water purification plant has been built to handle the water from the Bili-Bili Dam and prepare it for the distribution system. However, the plant has not yet started operating. The main water transmission line from the Dam to the water plant is not finished due to some engineering miscalculations. In addition, since the water in the reservoir was allowed to fill up over all the existing vegetation. This has caused a massive amount of biomass to be left underwater that is only slowly decomposing. The resulting anaerobic conditions cause a slight odor of sulfur to be noticeable where the water exits the dam.

One of the economic benefits postulated for the dam and reservoir was the potential for new recreational opportunities close by (within 30 km) to the City of Makassar. New lake-side vacation houses and resorts were projected. As of now, there are no new vacation houses and none seem in the planning stages. Several small roadside picnic areas have been developed which are used on weekends. The dam is a tourist attraction and a source of provincial pride.

The fishing in the region has been changed. Different fish are found in the reservoir than were in the river. The fisherman in the coastal waters report that they have to go further out to sea to find the same fish they used to get closer in (Selintung 2000). They also claim the fish are smaller.

As a result of the dam impounding the sediment previously carried by the river, the river morphology was changing below the Dam. CTI's 1980 report stated that riverbed materials consisted of gravel at the Bili-Bili Dam site and Kampili and fine sand at Sungguminasa. These materials are mined and used for construction in the area. After Bili-Bili dam was built, the sediment load dropped to 19% of what it had been. Formerly, about 80% of the sediment was from upper Jeneberang River and 20% from Jenelata River

(CTI, 1994). In June 1997, the Directorate General of Irrigation reported that a river cut had occurred at 100 m upstream of Kampili Weir, causing the dysfunction of Bissua Irrigation Intake as well as the Bili-Bili Irrigation Intake. Sand mining was also undermining the Sungguminasa Bridge piers.

The 1996-1997 monitoring report tried to estimate the actual morphological change of Jeneberang River from the data on sand mining and a study of the river cross section. The monitoring report found that a maximum riverbed degradation of more than 7 m and average of 5 m between Sungguminasa Bridge to Kampili Weir occurred in 1994.

Despite the understanding that the changes in sediment load would impact the coastal area, there was no serious effort to look at the impact of the dam on the coastal zone, other than the benefits of no more sediment load to fill in the harbor. Today, the coastal area is changing as a result of the dam. There is erosion of the headlands. At the mouth of the Jeneberang River a sandbar has developed, splitting the river into a north and south branch, and was growing northward from the river at 150 m a year (UPPURP 1989). (Figure 4). The main channel has now shifted to the southern branch as a result of which no sediment is being transported to the Makassar prot area. In 1993 the northern branch of Jeneberang River was closed and converted to a coastal reservoir. The spit at the end of this northern branch stopped growing (Tanjung Bunga), but the southern spit (Tanjung Merdeka) continued to grow. Sakka (1996), in 1996 compared coastal topographic measurements to those in 1989 and found that Tanjung Bunga's coast had been eroded about 70 m toward the land. He predicted that there will be more erosion on the coast and that Tanjung Merdeka will also be affected.

CONCLUSIONS AND RECOMMENDATIONS

Decision-making in Indonesia is primarily oral and based on a consensus model. Older people and one's supervisor are to be respected and there is no open criticism. This means that there is a lack of authentic documentation and memories of the events are fading. The Central Government was the final decision-maker since their financial support was critical. The development of the Jeneberang River fit in with the second Five Year plan. South Sulawesi Governor A.A.Amiruddin played a big role in promoting the project, as did the Mayor of Ujung Pandang, Patompo. Flood control was a major issue. The Dam brings prestige to the province.

The technical information used for decision-making, designing, and constructing the Dam was sufficient. However, the environmental information was not developed (contract signed September 26, 1988) until after the Dam site was chosen (1982) and the detailed design completed (March 1988). Therefore the EIA did not play any role in the decision to build the dam or in its design.

As a result, one could postulate, of the inadequacy of the environmental impact study due to lack of funds and knowledge. A number of additional projects have had to be developed to overcome problems created by the Dam's construction. It has been necessary to build jetties at the river's mouth, groundsill and a rubber dam on the lower reaches of the river to prevent salty tidal waters from entering the potable water intakes on the river, and sand pocket and sabo dams in the upper watershed to trap sediment and keep it out of the reservoir. These projects have added extra costs.

Integrated coastal zone management was not included in Bili-Bili decision-making, design, or construction, even though the Dam was built on a coastal watershed. There is no appointed agency in Indonesia in charge of the coastal zone, rather there is a loosely organized coalition of state and local governments who are suppose to be looking after the area. The result appears to be that no agency was really concerned about the impacts from the Dam or anticipated them. With the resulting loss of sediment load, the coastal area is changing.

The loss of sediment load is also impacting the small companies that dig by hand out of the lower part of the Jeneberang river bottom for construction projects. This has been banned because the river does not replenish the material removed and so the riverbed is lowering, threatening the man-made structures along the river – bridge piers, irrigation water intakes. The government had projected that the sand and gravel companies could move to the upper reaches of the watershed where there is a lot of sediment. But that means owning trucks and other costly big equipment in order to acquire the sand and gravel. Also, the sediment in the upper reaches is very large (picture) and not readily usable by hand methods of gathering and construction.

Losses of sediment and changes in river salinity at the lower reaches have changed the aquatic ecosystem of that reach. In addition, the reservoir now has different fish and water quality issues (eutrophication), that existed before the dam. The project did include a government control area for environmental improvement work that has begun to reforest areas and teach methods of soil conservation. This is an effort to overcome some of the negative environmental impacts.

It is interesting to speculate whether knowing the impacts of the Dam and its opportunities for economic development today, would the Dam still be built. If the environmental impacts, analyzed from a coastal watershed perspective were better understood, how would the project have been different? The EIRR was based on hydroelectric power (not in place), irrigation (no new system or rehabilitated system), additional drinking water (not operating) and flood control (there was another large flood in Makassar after the Dam was built). Not part of the EIRR, but costs nevertheless, the local sand and gravel industry has been impacted and fisherman report having to go further out to sea to catch fish. Five villages were disrupted and about 2,000 people relocated. The drinking water supply was threatened with salty water and had to be protected with a rubber dam. The one benefit, the port is no longer having to be dredged. Were the plans and hopes for economic development oversold? Or, is it an area, now waiting for the economic miracle to happen?

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