The Talo Dam Project

Projet de Mise en Valeur Des Plaines Du Moyen Bani

By:

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Executive Summary

As the World Commission on Dams Executive Summary has noted: "At the heart of the dams debate are issues of equity, governance, justice, and power." This report focuses on these issues in light of the Talo Dam Project [1], highlighting the concerns of various stakeholders and affected populations. Based on available evidence, we believe that the project should not move forward, or at the very least not do so until all of the recommended measures and transformational changes outlined below have occurred.

Our concerns with the project can be divided into three distinct geographical regions: the target area, the upstream area, and downstream. Each region has distinct issues and interests that need to be considered separately, as well as in relation to each other, and as a whole. Numerous stakeholders are involved in varying capacities in the project, including the African Development Bank, Government of Mali, local communities, and larger civil society – consisting of local, regional, and international actors. The main body of the report focuses on concerns raised by each of the above stakeholders in addition to concerns identified by the Clark Research Team.

Significant topics inadequately considered by the AfDB can be summarized as follows:

Project Concerns:

- Calculations of total cost vs. total benefits from the project are incomplete and need to be reconsidered. Total costs should include the loss of downstream agricultural, grazing and fishing and the loss of 11,000 hectares of grazing lands in the target area. Climatic variability such as low rainfall will likely reduce projected outputs. Additionally, there are concerns over distribution of benefits. Who will gain and who will lose, and how will total benefits be spread among community members?

- Similar irrigation schemes have failed in Mali due to poor management and coordination. That this project largely follows the model of failed predecessors raises serious concerns about its

[1] The AfDB's reference to this project as a weir rather than a dam is misleading. Based on international standards on dam height and reservoir capacity this project is a "large dam" and we refer to it as such.

prospects for success. The 1997 EIA describes the project as the most complex irrigation project in Mali, yet no investment has been made in building the capacity to manage and maintain the project. Local, regional, and national responsibilities, as well as accountability, are unclear.

- The AfDB states that only 6% of the Bani River will be diverted annually for irrigation in the target area. From our hydrological analysis, we find that number misleading, as up to 20% of the river will be diverted while the reservoir is filling during the rainy season. This will deprive downstream communities of much-needed floodwaters at a critical time for rice and agricultural production. Furthermore, the occurrence of a dry hydrological year (i.e. a year with minimal precipitation) would significantly increase the impact of the reservoir on surrounding and downstream communities and ecosystems.

- The 1995 EIA suggested that up to 15,500 people could face relocation in the submersion area. To alleviate this problem, they suggested building an eighty-kilometer dike following the left bank of the reservoir. The 1997 EIA, commissioned by the AfDB in response to 1995 findings contained a new survey of topographical and hydrological data from the left bank of the upstream area. This study found that only one village was at serious risk of flooding, and as such the AfDB need only build a thirty-five kilometer dike along the left bank of the Bani upstream from dam to Wori. However, from the 1997 Agrer EIA, we believe the potential flooding of villages further upstream due to hydrological changes brought about by the dam still exists, and as such a contingency plan for these villages should exist. Such a plan would provide resources or assistance in case of flooding or undesired changes in agricultural activities.

Project Omissions:

- Environmental and socio-economic impacts of this project on the downstream area were completely excluded in all stages of project design and planning. The cost/benefit analysis completely neglected all downstream effects. AfDB and WCD guidelines clearly dictate that downstream communities must be considered in project conception and design.

- The project documents fail to adequately consider ecological and systemic impacts. The transformation of a seasonal river into a continuously flowing river will radically transform the riparian ecosystem. Generations of families, flora and fauna depend on the annual rise and fall of the Bani. The Bani River is a part of the larger Niger Inland Delta region. As the Niger's major tributary, the Bani River is a part of larger system, and cannot be viewed in isolation.

- Alternative development strategies were not considered at any point during project planning. The WCD has highlighted the importance of exploring alternative irrigation and development strategies. There is no evidence that alternatives to the dam were considered by the AfDB or Government of Mali.

Based on available evidence and documentation, our research team cannot support the assertion that this project is an appropriate development strategy. In our judgment, the following information is needed:

1. An Environmental Impact Assessment and socio-economic study focusing on the downstream area (from the dam to Mopti).

2. An Environmental Impact Assessment focusing on potential effects of the Talo Dam on the greater Niger Inland Delta.

3. A revised cost-benefit analysis of potential losses that includes both downstream and upstream costs or losses, in addition to projected project benefits.

4. A comprehensive hydrological study taking into account the amount of water to be diverted from the Bani River, including losses due to factors such as evaporation. This study must consider climatic variability and not solely rely on yearly averages.

Two obvious conclusions are of considerable consequence. First, consultations with affected communities were far below current international standards of acceptability. Local communities, especially those downstream, were not invited nor encouraged to participate in the design and planning of this project. This failure is contrary to the policies of the African Development Bank, and ignores World Commission on Dams guidelines. Second, the failure to explore alternative irrigation strategies raises questions about the appropriateness of the Talo Project. Had these issues been included from the moment of inception, the Talo Dam project would have greater credibility.

The Bani River is constantly in a state of change. Every year it overflows its banks and transforms the Niger Inland Delta into a vast floodplain. At least a half a million people of diverse cultural backgrounds, migrating birds, and fish all depend on it. The entire riparian ecosystem lives according to its rise and fall. Drought and climate change are already affecting the river, as its flow is decreasing every year. The Talo Dam, at 5 meters high and 700 meters long will change the river in new and uncertain ways. The AfDB ought to conduct a more thorough review of environmental and socio-economic impacts before proceeding with this project.

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I. Introduction

This report was prepared by team of independent researchers at Clark University. Our task was to conduct a thorough review of data available on the project, the Bani River and the Niger Inland Delta region, and to review knowledge generated from previous dam projects. To do this, we reviewed AfDB documents, Malian government reports, independent environmental impact assessments, local media and community groups, and scholarly resources. We believe the project will impact three distinct areas: upstream, the target area, and downstream, and have arranged our concerns accordingly. We then synthesized the available material to create a cost-benefit analysis of the Talo Dam Project. We also include a section describing how applicable AfDB policies and World Commission on Dams (WCD) guidelines were not adhered to. The final section contains our concluding thoughts and recommendations. With respect to logistical and technical aspects of the project, we believe that certain necessary steps must be taken in the project design and planning before we could concur that the project is a viable development strategy. Finally, we conclude with a statement on the necessity of local participation in project conception and design, and the significance of its exclusion in the Talo Dam project.

The Niger Inland Delta is unique and irreplaceable region in Africa. The value of a floodplain ecosystem in a semi-arid zone bordered by vast desert cannot be underestimated. A river with seasonal floods needs to be examined in a different light than one with a constant flow of water, especially in relation to the human-river relationship and levels of groundwater. The flow of the Bani is decreasing every year, and as it continues to do so, its water becomes an increasingly valuable resource. Because of this, in addition to examining the project components, local participation, AFDB policies and international dam guidelines, we believe it is of highest importance to take into account the distinctive nature of this environment in the project planning.

II. Summary of the AfDB and Malian Government's Proposal

The section that follows is based upon documents from the African Development Bank: *Memorandum: Rapport d'Evaluation: Mali: Programme de Mise en Valeur des Plaines du Moyen Bani – Phase I-*, and Malian government's Resume: *Programme de Mise en Valeu des Plaines du Moyen Bani*.

Abstract:

The purpose of the *Middle Bani Plains Agricultural Improvement Project* is to increase agricultural production in 65 villages of the administrative Circles of San and Bla in the Segou region of Mali, through the construction of a dam and accompanying irrigation infrastructures on the Bani River near the town of Talo. Recently approved for funding by the African Development Bank (AfDB), it is scheduled to take place in two phases with an interval of 10 years, both phases intending to bring more than 20,000 hectares along the San-Douna strip of the southern bank of the Bani into production, comprising of 16,000 hectares for rice cultivation, 4750 hectares of pastureland, and 490 hectares for fisheries. Coincidental to the project will be the undertaking of other initiatives in the area, including

agricultural extension, new rangeland management schemes, improvement of a local road, and development activities such as literacy and health, focusing on women.

Project Name: Middle Bani Agricultural Improvement Project, or
Projet de Mise en Valeur Des Plaines Du Moyen Bani

Target Area: 65 villages (population uncertain), located in the San and Bla Circles of the Segou Region (63,500 people).

Total Projected Cost: $26.89 million.

Principal Lenders: African Development Bank - $18.49 million, or 73.52%
Organization of Petroleum Exporting Countries (OPEC) – $4.4 million (16.36%)
Remaining costs covered by Government of Mali.

Borrower: Government of Mali.

Agencies of Execution: Ministry of Rural Development and Environment
National Direction of Rural Infrastructures

Background and Reasons for Project:

As in much of the Sahelian region of West Africa, Mali has experienced climactic change during the last 20-30 years in the form of decreased precipitation, resulting in increased aridity and drought in many areas. The Segou region, part of the semi-arid zone of the country, has been affected as its rivers and tributaries, including the Niger and Bani Rivers have seen marked decreases in volume, especially following the summer rainy season when the rivers' higher water levels rivers typically inundate large floodplain areas. Lower levels and duration of annual flooding, in turn, directly affect the quality and extent in terms of hectares to which traditional flood-recession agriculture, largely rice cultivation, can be practiced along the Niger and Bani Rivers, and the Niger Inland Delta region as a whole. Variations in the two rivers' hydrology also have effects on the pastoral, agro-pastoral, and fishing livelihoods in this area, of which a substantial part of the Mali's population and agricultural production depend.

Lower volumes of flow of the Bani River, yearly as well as during annual flooding, has been observed too have been particularly acute (Ballo, Lae). Consequently, annual floodwaters are no longer able to reach many areas formerly farmed in the San and Bla Circles of the Segou region, along the southern bank of the Middle Bani, curtailing agricultural production. According to the 1997 AfDB Report, these losses worsened the economic situation of the Segou and San areas, leading to high levels of emigration to other areas of Mali (1.1.2). As a result, during the 1980's dams were proposed along the Bani River at Djenne and Talo to respond to this dilemma.

The purpose of the dam near Talo, a town located just upstream from San, was to raise the level of the river sufficiently at the location of the reservoir so that water to flow through irrigation networks to the formerly flooded areas, enabling the restoration of agriculture. Initial feasibility studies were carried out in 1988, with the African Development Bank paying visits in 1989 and 1994, the following of which an Environmental Impact Assessment (EIA), was carried out at the Bank's initiative in 1995. The EIA was carried out by the Danish firm Hedeselskabet. Lack of sufficient information including recent topographical and hydrological data at the time of the assessment, resulted in a follow up study being carried out at the Bank's request. This study, carried out by the Belgium firm Agrer, considered the risks of flooding to villages above the dam as minimal, as well recommending the addition of a sluice gate to the dam in order to enable to the release of a controlled flow of water downstream.

Project Objectives:

The objectives of the Talo Dam Project, as per the AfDB's 1997 Evaluation Report, are the following:

1. *Increased Agricultural Production:* This fits into Mali's overall goal of greater food security, especially in terms of increasing national sufficiency in rice production and reducing imports. Production aims for after the 1st phase of the project are 14,000 tons of rice and 760 tons of meat (2.3% and 0.8% of 1998 national production respectively), resulting from the irrigation of 7,850 ha, comprised of 4,750 of rice and 2,470 of bourgou pasture. After completion of 2nd phase, 20,300 ha will be irrigated, with 16,030 ha of rice, 4,290 of rice, and 490 ha of fisheries.

2. *Creation of Permanent Rural Employment:* Among the population, those directly benefiting are those who will receive parcels of land (1,600 individuals will be allocated 2.8 hectare plots in the first phase of the project), as well as unspecified others who will use or have access to the new pasture areas and fisheries. Others are to indirectly benefit from employment or commerce in target area due to the increased agricultural production, or proposed development activities.

Project Components:

The project objectives require the implementation of the following major actions: (Clark team comments are in italics)

1. Construction of a dam at Talo:

The AfDB asserts that the structure should not actually be considered a dam, but a *weir*, as the definition of a weir is simply a wall built across a stream or river to raise the water level upstream, with water flowing over the top and continuing downstream. However, based on guidelines established by the World Commission on Dams, the structure actually falls into the category of 'large dam' based on the size of its reservoir.

The dam is to be constructed along a portion of the Bani River near the village of Talo (on the left bank just upstream from San), at a location where the river passes over a natural rock abutment on which the dam's foundation will be built. According to the AfDB and GoM documents, as well as a correspondence from the AfDB, dam is to be 295 meters long and 5 meters tall, constructed of reinforced concrete with stone masonry surrounding the passage to metal release valve of the sluice gate. The sluice gate, which can release 10m3 of water downstream and control the level of the reservoir, is to be set into the lower portion of the left side. The reservoir is to hold a capacity of 175.6 million cubic meters, with a surface area of over 29 million square meters, and affect the level of the Bani at full capacity following the rainy season as far upstream as Douna.

Charts at the back of the GoM document, based on the 1997 study by Agrer, show various hydrology management schemes for the Talo Dam, which show that water will pass over the top of the Talo structure during the wet season when the reservoir is full, roughly from early September to January. During a two-week period in January, no water will flow past the dam, after which controlled amounts ranging between 5 and 10 million cubic m/s will be released, depending on the scheme (there are four), via the sluice gate until mid-August. At his point, again, no water will flow past the dam for at least another week, or until the reservoir is full.

2. Installation of the necessary irrigation network:

A 19 kilometer long main canal will bring water from the reservoir to four main areas: Woloni, Tounga, San West and Center, and San East. The necessary irrigation infrastructure for the first two areas, Woloni, and Tounga, is scheduled be completed by the end of the first phase of the project, while construction of irrigation systems for San West, Center, and San East will occur during the second phase. 350 hectares of land (250 upstream and 100 downstream) will be irrigated using totally controlled irrigation, in contrast to the controlled submersion method to be used in other areas of the project. Other than identification of the main areas, or *casiers*, to be irrigated, as well as descriptions of the main and secondary canals supplying water to these areas, there is little detailed elaboration in the AfDB document as to irrigation regimes in these respective areas. The material composition of all irrigation infrastructures, with the exception of the various intakes and gates throughout the system is to be of earth (GoM: 3.3.2A). This is significant in that considerable amounts of water could be lost to infiltration, and it increases the importance of regular maintenance and servicing of the structures in order to prevent erosion and them becoming clogged up by biological matter, the latter of which also contributes to water loss. There is no consideration in the documents as to amounts of water lost either to transport costs or due to evaporation in the reservoir and irrigation structures.

3. Rehabilitation of Fields and Allocation of Parcels to Locals:

According to the AfDB and GoM, 4,750 ha of irrigated land will be divided into 2.8 ha plots to be allocated to 1,600 locals for the cultivation of rice during the first phase of the project. The areas must be prepared and rehabilitated, as many areas have not been in production due to the effects of the drought. The Hedeselskabet 1995 EIA mentions that 11,300 hectares of current grazing areas will be lost due to the allocation and cultivation of these areas (III.2.2.1). AfDB and GoM documents do not indicate exactly to whom these plots will be allocated, nor by what criteria the beneficiaries chosen (for example, if they were formerly farmers, or have the relevant skills/knowledge, etc.). The documents make it clear that substantial amounts of fertilizers will be needed, in addition to pesticide usage, because of poor soil quality in the production areas, which will require considerable amounts of training and supervision as many farmers have little or no previous experience with using them.

4. Cultivation of 4,750 ha of rice, 2,470 ha of pastureland, and 380 ha of fisheries by the fifth year:

These are the amounts of area envisioned to be in production by the end of the project's 1rst phase, or after the initial five years. The remaining 11,280 ha of rice, 1820 ha of pasture, and 100 of fisheries would be put into production by the end of the 2nd phase, or after 10 years. The National Direction of Rural Infrastructures henceforth will have the responsibility of watching over and managing the dam and irrigation schemes, while interaction with the local population will occur through organized, village associations. The CMDT, or *Compagnie Malien de Developpement de Textiles*, noted as having a history of involvement in the Segou region boosting agricultural production (mainly cotton), is envisaged to play an active role in the project by working with target communities. There is little or no mention of the credit and inputs farmers will need to effectively put their plots of rice into production, and the extent to which village associations exist or encompass villages in the target area. How the *bourgou* fodder-production areas will be allocated and used, and by what institutions governed is not specified. There is also scant information about what types of fisheries will be built, where, and who will benefit.

5. Rehabilitation of the Cinzana-Talo-Katiena road:

A road, connecting Cinzana to Talo via Katiena is to be repaired and improved using the $4.4 million in OPEC funds. From Katiena to Talo, the road will exist on top of the dike that will extend from Katiena to Talo, passing near Wori. Though the AfDB document does not elaborate on the purpose of the road, it is assumed that will help reduce isolation of the target area and improve market access.

Additional actions:
In addition to these actions, other activities are planned to coincide with the project, including the following:

- Agricultural extension activities – *Few specifics are given about what activities will take place, by what agency, or if the CMDT will be involved*

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- New rangeland management schemes – *A local committee is supposed to help formulate a new rangeland management system, but whether such a system will work within the framework of existing systems, or require the imposition of a new one. It is also not clear what role government agencies will play.*

- Reforestation of 150 ha – *The responsible agency is not specified, nor the areas to be reforested or their status afterwards as either government lands off limits to locals, or village wood lots.*

- Development activities carried out with the local population, focusing especially on women – These activities fall in the areas of literacy, health education, and sanitation improvement. *The implementing organization is not identified, nor are the actual projects and their purpose.*

Summary of 1995 EIA

The AfDB commissioned Hedeselskabet (Danish Land Development Service) to conduct an environmental impact assessment on the project in 1995. The report is primarily concerned with potential impacts of the dam on upstream communities. They confirmed that there are risks associated with this project, such as water pollution, increases in water-borne diseases, and the need for a high level of coordination in operating the irrigation schemes in the target area. The assessment concluded that most of these risks could be minimized or avoided if the necessary precautions specified in the report are taken.

However, examining upstream areas and the potential for flooding of nearly twenty villages and their land, the EIA stated that construction of the dam might necessitate the relocation of 15,500 people, or in the least would require building a dike along an eighty kilometer stretch of the left bank of the Bani from Talo to Douna. The report determined there was a need for highly detailed topographical data on the left bank of the Bani.

Summary of 1997 EIA

The 1997 EIA, produced by Agrer, a Belgian firm, was commissioned in response to uncertainties raised by the 1995 EIA. This report focused on gathering more detailed topographical data on the left bank above the dam, and analyzing it with hydrological and socio-economic data. The report complied a large amount of hydrological data, from which it designed management schemes for control of the Talo dam. It also examined the viability of the irrigation schemes and long-term socio-economic benefits.

The report concluded that measures needed to protect upstream areas on the left bank were minimal-namely a 25 kilometer dike from the Talo dam to Wori. Areas further upstream might benefit from flooding, but would have to take any protective measures at their own initiative. The report concedes that previous experiences with controlled submersion irrigation in Mali (Segou and Mopti) were problematic due to poor management, organization and maintenance. However, these problems can be avoided through clear definition of the roles of both the state and local communities in the management and

maintenance of irrigation infrastructures. The report believes that if the project is successful in achieving the intended increases in agricultural production that long-term benefits will outweigh production investment costs if

Timetable:

The above components of the project were to be implemented according to the following timetable in the 1997 AfDB report:

Activities/Action	Implementing Agency	Beginning Date	Duration
Approving of Loan	African Development Fund	December 1997	
Signing of Loan	ADF/Malian Government	January 1998	
Nomination of Director, Forming Of Program Execution Team	Malian Government	January 1998	6 months
Disbursement of Loan	ADF	March 1998	
Preparation of 1rst annual Program Budget	Program Execution Team	June 1998	1 month
Recruitment of Organizations for Assessments and other Studies	Program Execution Team	June 1998	6 months
Dam Construction	Private Enterprise	October 1998	Until June 2002
Irrigation System Construction	Private Enterprise	January 1999	Until June 2002
Cultivation	Program Beneficiaries	July 2002	
Termination of Program		December 2002	

Current Status:

In a recent correspondence from the AfDB, it appears that the loan for the project was approved by the AfDB and Malian National Assembly in 1998. Detailed engineering plans were carried out in 1999, with bidding plans completed in February of 2000. It is anticipated that contracts will be awarded in the spring of 2001, and construction will subsequently begin. In correspondence from the AfDB March, 2001, Wilhemme Johnson notified us that the construction of the dam would not begin until the final version of our report had been received and reviewed.

III. Project Concerns

Concerns raised about the Talo project derive from the Clark research team, the 1995 and 1997 EIAs, local communities, and the African Development Bank itself. We have organized these concerns into three geographical areas: the target area, upstream and downstream. Each section below contains a description of these concerns. Please refer to the conclusion for a summary of recommendations on alleviating certain of these concerns.

A. Project Concerns: African Development Bank

1. **Target Area**: The following are stated risks and concerns by the AfDB in their 1997 Evaluation Report (with Clark team comments in italics):

   - Variability of climactic conditions, especially in the timing of annual precipitation, could lead to losses of up to 30% of "floating" rice crops, in the frequency of once every five years. (4.5.1)

   - Delays in implementation of the second phase of the project (4.5.2). *Completion and operation of 2nd phase irrigation schemes are necessary in order for the project to be considered profitable in terms of the capital invested in construction of the dam.*

   - Effects of chemical fertilizers and pesticides on water quality, requiring strict precautions and legislation governing their usage (4.8.5).

   - Potentially adverse effects on water and soil quality, as well as flora and fauna (4.8.5).

   - Negative effects on human health, requiring new dispensaries and epidemiological studies (4.8.5). *The reasons for negative impacts on human health are not explicitly stated, but with the possibility of adverse effects on soil and water quality, and the probability of increased incidences in malaria, schistosomiasis, and river blindness due to the presence of standing waters, the implications are clear.*

   - Competition between different production systems in the target area, for example, between farmers and pastoralists seeking access to water and land for their animals.

   - Management capacities over water in irrigated areas, and whether irregularities in flooding would occur, as well as the utilization of ill-suited crop varieties.

   - Ability of farmers to sell their crops for a profit, considering existing price incentives, illegal importing of rice, lack of credits, and isolation of several areas.

   - Lack of participation by the population in the conception and implementation of the project, and the continual existence of private irrigation schemes in peri-urban areas.

   - Potential conflict between existing and new land tenure systems that the project will aggravate, as well as lack of secure land tenure on the part of the farmers. *It is worth noting that the AfDB refers to existing agro-sylvo-pastoral resource management systems as " anarchic", which seems to indicate a desire to replace them with new schemes. A strategy to do so, however, is what may in reality lead to anarchy.*

   In response to these risks and concerns, the following arrangements were included in the project proposal:

   - Dikes are to be built on the right bank of the river (Fani-Talo-Wori) to protect villages from flooding. An additional dike to protect Woloni was determined to be unnecessary by the study completed in July of 1997. (4.8.5)

   - Legislation concerning the use of chemical fertilizers and pesticides is to be passed by the Malian government, and a system of Integrated Pest Management (IPM) adopted by the project. (4.8.5)

- The responsibility to safeguard against potential adverse effects on water and soil quality, and flora and fauna, is to be confided to the National Program for Environmental Action (PNAE).

- Potential Human Health problems are to be addressed by the building of additional dispensaries and health centers in the target area, as well as the carrying out of continued epidemiological studies. (4.8.5)

- As for the possibility of overgrazing of flooded areas, the Malian government and local authorities will set up rules concerning grazing, and reforestation of 150 hectares will occur around target villages. (4.8.5)

In addition, the AfDB set the following conditions that were to be met by the Malian government in order for both initial and full disbursement of the loan:

- Create an autonomous Program Implementation Team charged with execution of the project (7.2).

- Nominate a Director and Staff for the aforementioned team (including a Manager, Agronomist, Socioeconomist, Zoologist, and Environmental Technician), which must meet the approval of the African Development Fund (7.2).

- Provide the CMDT with all of the necessary resources to agriculture extension work with inhabitants in the target area and their village association (7.2).

- Have in place before December 31st, 1998, a local Development Committee charged with handling socioeconomic problems in the target area, as well as the elaboration and implementation before December 31rst, 2000, of new range management scheme for the area, and a ceasing of pastoral activities in the area of the Talo dam. (7.2)

- Have ready before December 31st, 1998, an Environmental Follow-up Plan, and have begun implementation of a epidemiological study (7.2).

- Have carried out by December 31st, 2000, a study examining how to tax the maintenance costs of the irrigation system, and have taken the necessary measures to implement the tariffs in order to assure the sustainability of the project (7.2).

- Have created a Management Committee and have the necessary collateral (7.2).

- Have a finance agreement with the OPEC countries signed and disbursed (7.2).

2. Upstream:

- Possible flooding of the village of Wori upstream from the dam. (4.8.5). *It was this possibility that led to additional studies being done in 1997 examining the reservoir area after the 1995 EIA.*

3. Downstream:

There is no mention of downstream effects in the AfDB and GoM documents, except passing reference in the GoM document to changes in the flow of the river. Article 3.1.4, states that the dam is work "regulating" water rather than storing it, and that only 1/5 of the flow of the Bani will be diverted during the flood season from the reservoir into the main canal, of which a part will return to the river as drainage. In a Malian newspaper article appearing in 1999, an official responds to downstream queries from the Djenne about hydrological effects by saying that the dam will have no effects except perhaps that floodwaters will reach downstream areas one week later than normal. The official also states that the dam offers an advantage to downstream populations in that water will be released through the sluice gate during the dry season, at which time the river has been known to dry up in some sections before the next rainy season arrives.

B. Project Concerns: 1995 EIA and 1997 EIA

1. Target Area:

- Pollution of both surface and ground waters resulting from the use of pesticides and fertilizers in the target area (IV.11.11.1.1).
- Inability to meet production goals due to poor management and coordination (especially considering difficulties encountered with previous irrigation projects in Mali).
- Loss of 11,000 hectares of grazing area to submersion and rice agriculture (III.2.1).
- Risk of soil degradation: salinization due to lack of inadequate drainage and loss of soil fertility over time (IV.1.2).
- Need for maintenance of irrigation systems and structures, which will be subject to sedimentation and biological growth (IV.1.4).
- Conflicts between rice farmers and pastoralists, as old institutions will be forced to change (IV.2.2).
- Cattle might damage irrigation structures, and likewise be affected by drinking polluted waters (IV.2.2).

2. Upstream

- 20 villages are under threat of flooding on the left bank according to the 1995 EIA, necessitating the relocation of 15,500 people or construction of a 80 km dike from Talo to Douna. The 1997 Agrer EIA concludes only of these villages, Wori, is under threat, and that the dike will need to extend only 30 km from Talo to Katiena (3km past Wori).
- Potential loss of agricultural land due to flooding or higher waters brought about by the reservoir. Again, the 1997 EIA, through topographic and surveys conducted with upstream villages on the left bank dismisses this idea, concluding that these upstream areas could actually stand to benefit from the higher water levels, which could restores some aspects of agricultural production to pre-drought conditions.

3. Downstream

There is no mention of specific downstream concerns in either EIA, although it is noted there will be changes. The detailed, hydrological and topographical studies conducted by Agrer extended only as far downstream as Beneni-Kegny (45 km from Talo). The Hedeselskabet 1995 EIA minimized potential downstream erosion resulting from sediments being trapped behind the dam at Talo, using the rationale that sediments would continue to be carried with floodwaters over the weir when the reservoir is full. This, however, does not take into account the fact that although water will flow over the top of the weir at, or near, the normal volume of

the river when the reservoir is full, there will be considerable time for sediments to accumulate as the surface of the reservoir will extend all the way back to Douna (80 km away). Inability of these sediments to flow over the weir could also have negative effects on downstream agriculture, and lead to shortages of limon, a type of clay used in traditional architecture of the region, such as the Grande Mosque at Djenne. Although the Hedeselskabet report admits there will be downstream hydrological effects, overall it did not elaborate as to what they are, nor propose any preventitive or corrective measures.

C. Project Concerns: Civil Society and Local Community

1. Target Area

Points calling into question the feasibility of the Talo project have been made. The following are main criticisms:

- Uncertain Economic Activities Are Promoted Upstream – While the Talo project will comprise already existing and functioning agricultural and economic activities downstream, it seeks to create new ones upstream with uncertain outcomes. Downstream populations argue that people in the target area not rice farmers, pastoralists, or fishermen by tradition, nor are they experiencing a cereal deficit.

- Controlled Flooding Is a Disqualified Irrigation Technique - The irrigation type of the project, controlled flooding, is a "disqualified technique" as it has already proven unprofitable in other areas tried by the Malian government, such as Segou, Mopti, Niafunke, and Gao, where only 15-20% or total irrigated surfaces are productive.

- The Talo Project Will Spend Too Much On Too Few Beneficiaries - Spending over $27 million, the project will only directly benefit 5,400 people, spending an average of $2,000 per hectare with uncertain results.

2. Upstream

The 1997 EIA documented the position of several chiefs in upstream villages on the building of the dam. While the results were overwhelming positive, more information on the survey techniques utilized and the questions asked need be made available before it can be considered an accurate representation of upstream opinion. Additionally, there were three villages--Kokoun, Goualabougou, Dofounou who expressed concern at losing their dry land agriculture. Regarding the likelihood of this occurrence, there appeared to be an age discrepancy between younger generations opposed to the dam, and older generations who were mostly in favor.

3. Downstream

Objections have been voiced concerning the Talo Dam and Middle Bani Agricultural Improvement Project, concerning its viability as well as the potential socioeconomic and environmental effects it would have on downstream areas of the Bani River and larger Niger Inland Delta region. These concerns have been raised by people living downstream from the project, in addition to other Malian nationals such as journalists, and international actors. Their points of concern regarding the downstream effects of the project can be summarized as the following:

- Incomplete Feasibility Studies - Studies on the socioeconomic and environmental effects of the Talo project ignored the downstream Djenne area and larger Delta region. These areas were not consulted about the project until after the AfDB loan had already been approved and passed by the Malian National Assembly (believed to be March of 1998).

- Loss of Downstream Rice Cultivation Due to Lower Flood Levels - Construction of a dam at Talo would bring out a 30 cm drop in the level of annual flooding, resulting in a loss ratio of 22.5% of areas of rice cultivation downstream. Applying this ratio to the 131,000 hectares of rice paddy in the Circle of Djenne, 30,400 hectares would be lost.

- Delays in Annual Flooding - The Talo Dam would also bring about delays in annual flooding, which alone would compromise 50,000 hectares of rice paddy and 250,000 hectares of pastureland and fishing areas, affecting the not only the Circle of Djenne, but other areas which traditionally use Djenne and the larger Delta area for fishing and grazing.

- Loss of Pasturelands - Areas other than Djenne that would be affected by the loss of the bourgou pasturelands stretch as far as Macina, Tominian, Mopti, Koro, Bankass, Bandiagara, Douentza, and Niafunke. Deprived of their traditional, dry-season grazing areas in the Lower Bani and Inland Niger Delta from January to June, these populations would be forced to find pasture elsewhere, bringing them into conflict with other populations.

- Effects on the Downstream Water Table - Changes in the flow of the Bani, such as lower flood levels, would also lower the water table of downstream areas, affecting populations directly by limiting the availability of potable water (coming mostly from wells), and negatively impacting the cultivation of dry cultures.

- Impacts On the Hydrology of the Entire Inland Delta - As the Bani is an important source of water feeding into the Delta region (responsible for filling more than 30% of Lake Debo near Timbuktu), a drop in its flow would have an impact on the hydrology of the entire Inland Delta, as well as areas downstream from it such as Gao, and beyond (Niger and Nigeria).

- Effects on the Architecture of Djenne - In addition to the livelihoods of its inhabitants and surrounding population being threatened, so also will the history and culture of Djenne be affected, as the complex clay, limon, of which the unique architecture of Djenne is built and maintained (including the Grand Mosque), is likely to be less available. The clay is deposited yearly by sediments carried in the floods.

The following conclusions and recommendations are made by objecting groups:

- Compensation by the Malian government in the form of projects utilizing pumps to access groundwater supplies are not desired, as they already proved unviable in Segou, Mopti, Timbuktu, and Gao. The costs of operating and maintaining the pumps was 3 times in excess of prices agricultural products could be sold at.

- There should be a general, integrated watershed management plan for the entire Bani River, which would include all concerned parties and populations using the river.

- A reexamination of the Talo project needs to take place, taking into account all valleys and areas in the Bani River system, and a credible socioeconomic study needs to be carried out.

D. Project Concerns: Clark Research Team

In addition to all concerns raised above, the Clark Research Team has identified further reason for concern in each area.

1. Target Area

a. Viability of Proposed Agricultural Production

The AfDB and GoM claim that the project will result in 20,300 ha of new agricultural production, including 16,030 ha of rice, 4290 ha of pastureland, and 490 ha of fisheries. The Clark Team finds these claims problematic in the following areas:

- Type of Irrigation Scheme – Controlled Submersion – By use of the controlled submersion irrigation method, the AfDB and GoM documents claim they are imitating or recreating a natural process with which area's farmers are already familiar, that of the annual floods following the rainy season. Objectors to the project living downstream, and articles appearing in Malian newspapers have called into doubt the viability of controlled submersion, even calling it a "disqualified" method, citing past failed experiments in Segou and Mopti as proof of its inability to provide predictable and effective yields. (These controlled submersion experiments, though producing high yields in some areas, resulted in negligeable crop yields overall, forcing Segou farmers to expand the amount of surface areas cultivated to make up for losses, of which they eventually abandoned more than 750 hectares). The 1997 Agrer EIA, in particular, highlights the problems encountered with these previous controlled submersion schemes, which are attributed to poor management, non-maintenance of infrastructures, and the inability of local populations to cover recurring production costs. The 1997 AfDB document, although also acknowledging these past failures (5.7.1), still proposes controlled submersion for the Talo project.

- Conflict With Existing Land Use Institutions and User Groups – The AfDB states concerns that the Talo Project's new land management schemes will conflict with existing land use institutions and practices, and that problems may arise between different categories of users, for example between farmers and herders over water access. The 1995 EIA confirms that over 11,000 hectares of grazing land will be lost to rice production in the target areas as a result of land allocated to the new irrigation scheme (III.2.2.1). It also states that local animals could be poisoned by pollutants from fertilizers and pesticides in stagnant surface waters, and in particular potential problems could result from the annual passage of grazing animals, which could inflict significant damage on earthen dikes and canals while attempting to pass through the target area. Despite these concerns, no new institutional arrangements or structures are proposed to resolve potential land use conflicts and problems.

- Potential for Salinization in Fields – Although the 1995 EIA makes clear that the majority of soils in the areas to be irrigated have low NaCl concentrations, it nonetheless acknowledges the fact that the potential still exists (III 1.2.1). As a preventative measure, it recommends not only an adequate drainage system, but a systematic flushing out of all irrigated fields to eliminate salt accumulation on the soil surface at the end of the dry season, but before the next rainy season begins (IV.1.4.1.3). Such a measure is problematic, however, as the amount of water needed to flush out fields in any irrigation system is usually

substantial, and the same report states that in years of low precipitation, no water will remain in the reservoir at the end of the dry season to the high evaporation at that time of year (Conclusions G.2).

- Variability in Climate – The AfDB document notes that climatic variability in the Middle Bani may result in losses of up to 30% of dressed rice crops every five years, significantly reducing the overall potential for rice output (4.5.1). Given this admission, and the overall, general trend in the Sahel during the last 30 years of patterns of reduced annual precipitation and dry climate, the projected annual yields of 2.7 tons of rice per hectare in irrigated areas appear optimistic. Because of this, and the aforementioned doubts concerning the controlled submersion irrigation technique, the long-term economic viability of the project must be called into question.

b. Effectiveness and Maintenance of Proposed Infrastructures

In order to realize its objectives of increased agricultural production and enhancement of livelihoods in the San and Bla areas, the Talo Project requires, in addition to construction of the Talo Dam, the proper installation, as well as management, and maintenance of an irrigation infrastructure. The Clark team has the following concerns about the structures and management of the irrigation system.

- Management Capacities of the GoM (Offices du Riz) to Manage Irrigation Systems – The Malian government has a poor track record in managing irrigation schemes, as already mentioned in regards to the dismal performance of the controlled submersion systems at Segou and Mopti. The AfDB and Agrer documents all attribute past failure of these schemes to the inadequate capacities of the GoM to effectively operate, monitor and maintain irrigation infrastructures (5.7.2and 8.1 respectively). The Hedeselskabet 1995 EIA found significant evidence of lack of maintenance in the target area near San, where sedimentation and erosion of canals occurred because they were not serviced for over 14 years (III 1.4.1.3, III 3.4). Both Hedeselskabet and Agrer reports stress the necessity of highly effective organization and management if the irrigation infrastructures are to properly function, and overall project goals be realized. The Agrer report considers the Talo project to be the most extensive hydraulic system yet undertaken in Mali (8.2). Although the AfDB and Agrer reports emphasize the role and organization of the local population in village associations to participate in the management and maintenance of the project, as the Hedeselskabet report accurately points out, these organizations do not cover the entire area of the project, and their disaggregated nature does not translate to the type of “perfect coordination” at a higher level considered necessary for the functioning of the entire system. There is still little information indicating an improvement in GoM management capabilities or approach, or specific institutional frameworks proposed for collaboration between GoM management and the local population.

- Water Losses in the Irrigation System – Although the GoM and EIA documents contain estimates of water evaporation in the reservoir, there is no mention of the possibility and extent to which water will be lost in the irrigation system due to evaporation. The fact that the vast majority of the irrigation infrastructures will be earthen also indicates high potential for water loss through infiltration into the soil and due to biological growth in the canals if they are not regularly serviced and maintained.

c. Effects on Environment and Health

The AfDB and GoM documents claim that the Talo Project will bring about benefits in the areas of the environment and health, by the increasing the ground water level, reforesting areas, and the building of additional health centers and dispensaries. The Clark team doubts these claims for the following reasons:

- *Water pollution locally as well as downstream* – The AfDB Report noted that pollution was likely to result from the use of pesticides and fertilizers, as well as other human uses. Due to poor soil quality in the project area, according to the 1995 EIA, substantial levels of fertilizers must be used for agricultural production, in addition to pesticides, though much of the population has little or no previous experience using either (III.2.1). The report estimates that 15% of fertilizers used will find their way into downstream waters, which may also contain the chemicals Aldrine and Dieldrine (from pesticide use) at 20-160% times levels considered safe. In the target area, contamination of water due to fertilizer and pesticide use is anticipated to cause particular problems in areas where pools of surface waters that have passed through fields are likely to persist for several months following the rainy season into the dry season. The existence of these waters in proximity to local villages could lead to the poisoning of domestic animals as well as humans, as the 1995 EIA mentions some villages such as Tiekelenso use water from these pools for drinking purposes at the end of dry season when wells run dry (III.1.1.1.2).

- *Legislation and Surveillance of Pesticide and Fertilizer Usage* - It recommended legislation and surveillance concerning both pesticide and fertilizer usage. Has such legislation been enacted, and if so, who will be responsible for making sure it is carried out? Also, there is only passing mention in the Report of Integrated Pest Management (IPM), but nothing indicating how an IPM system would be designed and implemented, by whom, nor funds allocated for that purpose.

- *Increase in the incidence of water-borne diseases in the target area* – Cases of Malaria and Bilharzia are likely to dramatically increase, as has been the case with other areas brought under irrigation in Mali. The fact that epidemiological surveillance, health education, and an increase in health centers and dispensaries are planned for in the project indicates an anticipation of a higher frequency of disease.

d. Level of Participation by the Target Population

There is little or no evidence in the AfDB and GoM documents about local participation of the target communities in the conception, design, and planned implementation of the Talo project, except that the documents say that the public wants the project. This absence of inclusion in the decision-making process decreases the likelihood that the project infrastructures, especially the irrigation system, will be maintained, that institutional problems can be solved, and that the target communities will benefit from the project.

Unresolved issues and ambiguities:

In addition to the main concerns listed above, there are several unresolved and ambiguous issues regarding the Talo project of which the team is concerned, but need more information about.

- *Allocation of Landholdings* – The areas to be brought under cultivation (Tounga, Woloni, and San Centre in the first phase), or 4,750 hectares, are to be divided into plots of 2.8 hectares which will be allocated to 1,6000 individuals (4.4.5). By what process these

individuals will be chosen, again, is not clear, and leaves open the possibility that the least needy will benefit from the project by obtaining landholdings, and possibly controlling the holdings of other individuals. This has been a common precedent with new agricultural schemes resulting from dams in many areas of the world.

- *Economic viability of new agricultural activities for locals* – Locals will be responsible for the purchase of seed, pesticides, and fertilizers. (The latter will be needed after construction of the dam whereas before sediments from the annual floods formerly boosted soil fertility). How much these costs, in addition to tariffs on water usage (amounts not yet determined), will affect the profits locals can make from new agricultural production is not certain. Echoing the concerns of the AfDB Report, there is no evidence of feasibility studies examining how and where locals will market their products, or of the local economy. How much rehabilitation of the Cinzana-Katiena-Talo trail will improve access to markets is not clear.

- *Recompensating Pastoralists for Lost Grazing Areas* – The 1995 EIA, after mentioning that 11,300 hectares of grazing areas will be lost in the area of the project, suggests that the parts of the rice plants not harvested be treated and given to pastoralists as fodder for the animals to compensate their loss. There is no mention or provision for this practice in the 1997 AfDB document, which will require training on how to properly treat the plants in order that they be edible for livestock.

- *Costs of rehabilitating or creating new fields* – While funds are allocated to construction of irrigation infrastructure in the areas to be cultivated, there is little reference to what state these areas are presently in. Although documentation refers to the fact that the project is bringing water to farmers and areas where agricultural production once took place, it is clear that due to poor soil quality, there will need to be extensive use of fertilizers, in addition to pesticides, both of which many farmers have little former experience or training. It is apparent that some areas have not been cultivated for over 20 years, and land use may have already shifted to growing calebasse trees (according to the downstream population at Djenne). Existing agricultural practices, in addition to the 11,300 hectares of grazing areas, that will be displaced by the proposed agricultural schemes need to be accounted for, and subtracted as costs from the projects projected benefits.

- *Ambiguity concerning forage production and new rangeland management schemes* – Most of the AfDB document addresses agricultural production in terms of rice cultivation, and leaves out how and by whom the forage will be grown. Will the hectares of bourgoutieres be cultivated and harvested collectively, or sold by private landholders? From the EIAs, it appears that the latter is the case. It also appears that livestock will not be allowed to graze directly on fields after cultivation, as the animals could potentially damage the earthen irrigation infrastructures. It is not clear what is the new rangeland management scheme hinted at in areas of the 1997 AfDB report. If such a scheme exists, how does it relate to existing and traditional rangeland practices and institutions? A new scheme is likely to have losers as well as winners in terms of access to resources.

- *Ambiguity concerning proposed fisheries* – The AfDB 1997 Report also contains little about the proposed fisheries in the target zone, as they will be implemented in the second phase of the project, with the budget indicating one will be built at Tounga, and two in the Djenne area. Like the hectares going to forage production, it is not clear who will

participate in the fisheries, whether they will be run entirely by the Malian government, and how locals will directly benefit.

- *Level of local organization* – Though the AfDB Report speaks of the Malian government administrations managing the project in cooperation with local associations, there is no indication as to the level such associations exist already, and if they are primarily village-based, or made up of larger groups, and if most locals are, or would be, in fact, represented by these organizations.

- *Ability of locals to participate in infrastructure management and maintenance* – Uncertainty as to how much influence locals will have on the long-term management of the dam at higher levels (through the committee) as well as through village associations. There is no information as to what extent villages already have organized associations, and if they accurately represent all of the involved villages.

- *Potential viability of local development initiatives* – Little is specified or elaborated upon concerning development activities to take place with villages in the target area, or how much a voice locals have in determining the types of activities. There is also lack of clarity as to the level of the CMDT (*Compagnie Malien de Developpement du Textiles*) in development activities, and their track record in the region.

- *Little mention or elaboration on the role of local government in the project* – The absence of specific government roles and responsibilities in the implementation and operation of the project is surprising, considering the decentralization program currently underway in Mali. Leaving local governments out could hamper local peoples' abilities to deal with larger, national administrations that will be responsible for much of the project.

2. Upstream

The 1997 Agrer EIA confirms that as a result of construction of the Talo Dam, upstream areas could face flooding levels as much as 1 meter higher than normal without the dam. The following are concerns about potential upstream impacts of hydrological changes that will be brought about:

- Persistent vulnerability of upstream communities to flooding, including the right bank - Through hydrological, topographical, and village surveys, the 1997 Agrer EIA minimized the potential for the flooding of nearly 20 upstream villages on the left bank, postulating that higher water levels could actually benefit these villages by restoring pre-drought, agricultural conditions. The fact that these villages were able to sufficiently cope with previous high floods in 1967, and even see them as beneficial, was cited as evidence for the dike from Talo to Douna recommended in the 1995 EIA not being necessary. What is not clear is the extent to which specific areas are still vulnerable to high levels of flooding, especially on the right bank of the river upstream from Woloni where villages and fields are located, but which was ignored in the 1997 EIA.

- Lack of a contingency plan, or resources for villages in case of high flooding – Even though villages on the left bank may have been able to cope with the effects of the 1967 floods, will they have the abilities and resources to do so in case of future, unexpectedly high levels of flooding? The fact that, not matter what the actual levels, the Talo Dam will be responsible for a 1 meter rise of the Bani's level means that implementers of the project, or GoM and AfDB, are partly responsible for whatever damages occur, including loss of human life.

Perhaps a dike extending to Douna is not necessary nor desired by the villagers, but a contingency plan and resources should exist to assist these communities in the case of high flooding.

- Ambiguity of what rights upstream communities will have to water use – Though part of the rationale for not building a dike all the way upstream to Douna on the left bank is that villages in the area can benefit from access to floodwaters for agricultural and other livelihood purposes, it is not clear to what extent or if they will actually have consistent access to the floods, or water in the reservoir. This could especially be a problem in years of low precipitation, when provision of water by upstream communities could come at the expense of the project's proposed irrigation schemes, or communities further downstream.

3. Downstream

There is substantial scholarly literature available on the unique ecosystem of the Niger Inland Delta and the problems similar dam projects have created in this region. The following is a review of that literature and a case study of an earlier project. This work suggests the detrimental effects the Talo Dam may have on the environment and the people dependent on the Bani's floods.

The Value of Natural Flood Plains

The Niger Inland Delta is a unique and valuable area that supports at least half a million people: farmers, fishers and pastoralists. The Bani River is an important part of this system. William Adams, an expert on the inland delta has stated, "Because of the floods it is able to support over 1 million head of cattle and 2 million sheep and goats, 20 percent of the total numbers in Mali" (1992:98). The floods also fill the aquifer below, ensuring water for the future. The importance of this cannot be understated given that Mali is in the midst of a long drought. Irrigation schemes in a floodplain area require special attention to certain environmental issues.

Dams on seasonal rivers are much more harmful than rivers with a steady flow. Both the quantity and quality of water is affected. Following is a review of the many negative outcomes of dams built on seasonal floodplain rivers.

Downstream Farmers will not Receive the Water They Need to Subsist- When dams are built on rivers with natural floodplains, downstream agriculture is always affected. As water is diverted for irrigation for upstream farmers, people downstream become more susceptible to the effects of drought. If there is sufficient water in the Bani, enough might be released to meet their needs. However, in years with lower water levels farmers in the target area will likely be given priority access to the water. Given that the average flow of the Bani has been decreasing for many years, a logical conclusion can be drawn that downstream farmers will not receive the water they need to subsist.

In addition to potential conflict between recipients of flood water up and downstream, the quality of the water for irrigation will also be affected. For example, the floodwater contains clay, which is good at holding water, and therefore an asset in irrigation (Adams, 1992:72-76). Long term deprivation of silt and sediment reduces agricultural productivity. Finally, the productivity of current agriculture needs to be fully understood. The land in the delta is already being irrigated in a natural and effective manner. "Indigenous Irrigation" is currently practiced in Mali, in fact 37% of farmland is traditionally irrigated. The most basic kind takes place on floodplains, deltas and swamps using both rising and falling flood levels.

Fish Populations will Decline, and Fishing Populations will Lose Their Livelihood- Fishing is a basic element in many African floodplain environments. There are an estimated 62,000 fishermen in the central delta (Lae, 1994:119). There are no statistics on the number of fishing people utilizing the Bani River downstream from Talo. Therefore, it is uncertain how many people will suffer as fish populations decline.

Life cycles of fish are dependent on flooding (nutrients carried in flood waters create plant and micro-organism life for fish.) "Significant impacts on fish populations are therefore to be expected as a result of changes in annual flow regimes brought about by dams" (Adams, 1992:145). For example, downstream of Kainji Dam on the Niger River showed that both the amount of fish caught and fish composition changed after the dam was built. The Niger Inland Delta is already experiencing drought and the level of water in the Bani is dropping every year (Lae, 1994). This drought is significantly affecting fish populations. The construction of dams exacerbates the drought effect, as proven by the Selingue dam (Lae, 1994:125). Dams restrict longitudinal migration. Even if a fish ladder is constructed, generally fish that spawn upstream will not travel through the ladder to reach downstream water-adding to the total reduction in fish. Additionally, many fish spawn during the natural cycle of low water, thus are negatively affected by water being released during the dry season (Lae, 1994: 125-26).

Pastoralists will Lose Rangeland for Grazing- Pastoralists also use wetlands seasonally, concentrating onto seasonally flooded land as surrounding rangelands dry out. A relatively small area of wetland provides support for grazing at critical times of the year, and supports this activity through the rest of the year over a much larger area" (Adams, 1992: 69). Canals and controlled flooding cannot replace the amount of water provided by the floods, nor will its distribution remain equitable. Nomadic populations travel great distances to graze cattle in the delta. As the floodplain shrinks when the water is kept upstream, the rangelands will dry out.

Level of Groundwater will Diminish- Beyond immediate effects on those who are dependent on the resources the floodplain provides, there are longer-term negative environmental effects. One of these is the reduction in levels of groundwater. Given that Mali is in the midst of a prolonged drought, this situation is even more precarious.

Health of Local Populations will Deteriorate- According to the *Environmental Assessment Guidelines: Irrigation* (AfDB), wetland areas that are irrigated are susceptible to vector borne diseases like Malaria and schistosomiasis (3.2.13). Surface water in irrigation canals and stagnant water in the reservoir can increase existing diseases, and in addition to malaria and schistosomiasis can cause bilharzias (3.4.5).

The Manatali Dam "An Act of Economic and Environmental Nonsense"

The following case study looks at a similar dam project in a comparable natural context. Using this dam as a precedent provides a convincing argument that the Talo Dam Project will also be wrought with problems.

The Manatali dam was completed in 1988, inaugurated in 1992. It is located on the Bafing River, which is a tributary of the Senegal River. Its designed purpose was three fold: irrigation, hydroelectric power and river navigation. It still does not produce power. As for river navigation

there is none to speak of. Regarding irrigation, there is much to be learned as a precedent for the Talo Dam.

Government officials had promised during construction of the dam that water would be released to simulate flooding, so as to alleviate the hardship for downstream farmers and fishers. Some experts claim that simulated flooding is an effective way to diminish the hardship on downstream areas. However, upstream needs continue to take precedence over downstream needs, and this simulated flooding has never occurred.

The reservoir created by the Manatali dam has destroyed forest, depleted downstream aquifers and displaced 12,000 people. Only a little more than a quarter of the anticipated irrigation has occurred, and at a higher price than originally thought.

Local agriculture switched from sorghum to rice. However, rice production in this region cannot compete with world market prices. The farmers are going into debt, selling assets or even abandoning farming completely. Also due to changes in agriculture, diets have changed. Schistosomiasis and malaria have increased in villages near the reservoir.

The Manatali Dam has not met any of its original goals and objectives. Even the AFDB acknowledges its failure. Beyond not meeting its goals for irrigation, it has had a significant detrimental effect on downstream farmers.

Source: International Rivers Network (www.irn.org/programs/safrica/bosshard.study).

IV. Assessment of Costs and Benefits

This section analyzes and compares the claimed benefits of the Middle Bani Agricultural Improvement Project with its potential socioeconomic and environmental impacts. It will begin by an initial comparison of the main claimed benefits of the project with those of the chief objections. The validity of the claimed benefits, as well as feasibility of the Talo project will then be examined, followed by an assessment of the objections to the project in terms of its impacts.

A. Claimed Project Benefits vs. Objections

The claimed benefits and objections to the project will be examined in the following main areas in which they are concerned: agricultural (or rice production) cultivation, pasture areas and grazing, fishing, and environmental effects (water table, flora and fauna, etc.).

Claimed Benefits of the Talo Dam Project:

Rice Cultivation	4750 ha in 1rs Phase, 16,030 ha for both Phases *1,600 direct beneficiaries in 1st, 5,400 Total*
Pasturelands	2,470 ha in 1rst Phase, 4290 ha Total *Number of beneficiaries not specified.*
Fishing	490 ha of reservoirs for fisheries

	Number of beneficiaries not specified
Environment	150 ha reforested Higher Water Table Upstream – making groundwater more available and increasing vegetative cover.
Rural Development	Literacy and Projects Focusing on Women *Number of beneficiaries not specified.*
Health	Health Education Campaigns Increase in Number of Health Centers and Dispensaries *Number of beneficiaries not specified, nor exact areas known.*
Summary	20,320 new ha of agricultural production (rice, pastureland, fisheries) Potential improvements in groundwater and vegetation, access to health care, and projects for rural women. Over 40,000 people in San and Bla Circles claimed to benefit directly or indirectly.

Main Objection Claims to the Talo Project:

Rice Cultivation	30,400 to 50,000 ha lost downstream *Good portion of 116,000 Djenne Circle population, and others in Delta.*
Pasturelands and Grazing	250,000 ha of bourgou pasturelands lost in Lower Bani and Delta region *Affecting populations from Djenne, Bankass, Niafunke, Bandiagara, Macina, Goundam, Douentza, Koro, Tominian, and Bankass, especially Fulani.*
Fishing	250,000 ha fish habitat compromised. *Includes 62,000 fishermen and families in Delta region and Bani River, especially Boso.*
Environmental Effects	Water and Soil Pollution Due to Ferilizers and Pesticides in Project Erosion and Deforestation both in target areas and downstream. Lower Water Table – affecting access to potable water and dryland agricultural production
Health Effects	Increase of Malaria, River Blindness, Schistosomiasis Upstream and Downstream Effects of Water Pollution – affecting human health
Summary	More than 280,400 ha of agricultural areas (rice, pastureland, fishing) lost. Water Pollution, Erosion and Deforestation in Target Area and Downstream. Lower water table downstream affecting drinking water and agriculture. Malaria, River Blindness, and Schistomiasis upstream and downstream. Negative Effects of Water Pollution on Human Health. *More than 1,000,000 people negatively affected, including 116,000 in Djenne Circle, and farmers, pastoralists, fishing populations in Mopti and Timbuktu regions.*

From the above tables, it is apparent that the claims of potential harm the Talo project would bring about are larger than the claims of its potential benefits. If these claims are true, a much greater number of people and amounts of land currently in production would be negatively affected by the project in comparison to the number of beneficiaries and land it would put into production. This would seem to run counter to the project's objectives of increasing food security in Mali and contributing to permanent rural employment. The negative health and environmental effects would also appear to outweigh claims of benefits in these areas resulting from the Talo project.

We acknowledge that this cost-benefit analysis is incomplete without an adequate assessment of downstream environmental and socioeconomic effects. But nonetheless, it is apparent that the potential costs of the project could be substantial, and need to be addressed.

V. Non-Adherence to AfDB Policies and WCD Guidelines

In addition to the above ambiguities and concerns about the viability of the proposed project, we believe the process by which the project was conceived and designed did not follow the AfDB's own stated policies. Further, the project plan and design falls short of the international guidelines recently developed by the World Commission on Dams. The AFDB has recently expressed a willingness to operate in accordance with WCD Guidelines. In a recent correspondence entitled "Response to the Final Report," the AfDB stated "The criteria, guidelines and standards, provided in the report, would be particularly useful during the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams financed by the Bank."

The following sub-sections are examples of direct violation of AfDB Policy as documented in the Environmental Assessment Guidelines: Irrigation

a. Effects on downstream population: Section 3.4.2 states that irrigation projects upstream can deprive downstream populations especially during droughts. In order to avoid conflict, the bank's stated policy is to ensure a reasonable distribution of water throughout the area and including nomads. *There have been no provisions made for downstream populations, nor for the Nomadic herders also dependent on the floodplain for grazing.*

b. When there is a disruption of local economic and social structure, the bank's stated policy is to minimize loss in sensitive or critical areas through careful planning and design of project infrastructure. Specifically, there is to be a special provision for nomads' land use (3.3.1.2). *The disruption of downstream local economic and social structure, as well as environmental concerns have not been taken into consideration.*

c. Irrigation of wetlands poses many problems, among these increased salinity and alkalinity in semi-arid areas and deficiencies in nitrogen, P, K, Zn and S (3.2.13). The bank's policy is to fully research possible detrimental effects to the soil. *There is no evidence of consideration and preparations being made in regards to the damaging effect this dam could have on soil quality.*

d. In order to prevent conflict arising from affected groups, the bank's stated policy is to promote community involvement and participation early on in project design and continued follow-up by project managers. *There are no indications of local participation in project design.*

e. Section 4.2.3 discusses the impact of irrigation projects on two groups of stakeholders: directly and indirectly affected groups. Both groups need to be consulted and allowed to participate throughout the life of the project. Indirect stakeholders include downstream farmers. Potential future problems should be identified early on to avoid later conflict. *There is no indication of identifying and involving indirect stakeholders- for example,. pastoralists who do not live in the region but are dependent on the floodplains for grazing.*

f. Finally, the bank has established guidelines for the project cycle. The following questions all receive a negative response, yet the project continues on:

1. Is the proposed project in conformance with explicit Bank Environmental Policies?
2. Is the proposed project located in or near, or can it have an impact on, an environmentally sensitive area?
3. Have alternatives been adequately conceived and considered?
4. Has the scope of the initial assessment been adequately conceived?

Failure to Meet WCD Guidelines

The World Commission on Dams (WCD) has recently documented that large irrigation dams typically fall short of their irrigation goals and they are usually less profitable than originally thought. Large dams also tend to have negative impacts on rivers and there has been a "*pervasive and systematic failure to assess the range of potential negative impacts*" and a "*failure to account for the consequences of large dams for downstream livelihoods*" (WCD, XXXI). There are two issues we are concerned with: the social impact of the Talo dam on downstream communities, and the environmental impact on the river, its fish, and the fragile floodplain ecosystem.

"Downstream communities throughout the tropics and subtropics face some of the most drastic impacts of large dams, particularly where the changed hydrological regime of rivers has adversely affected floodplains that supported local livelihoods through flood-recession agriculture, fishing, herding and gathering floodplain forest products" (WCD, 112.) The commission also refers to the serious consequences to fish and fishing communities downstream. The impact on fishing should be adequately assessed. Citing a case study in northern Nigeria, they compare the economic benefits upstream with the corresponding losses downstream in the floodplains. In this case, net losses could rise to $24 million. There is a direct trade-off between irrigating upstream and losses downstream. The Talo project does not demonstrate that this trade-off has been fully considered.

Because of the disruption of the natural flood flow patterns, riparian plants, fish diversity and productivity are dramatically affected. Soil becomes less fertile as it is deprived of its annual silt. Bird species are affected and groundwater dries up (WCD, 83.) The commission specifically refers to the Niger Inland Delta as an area that has been adversely affected by dams in agriculture, fishing, grazing and forests. Managed floods *may* help alleviate some of the adverse affects (WCD, 84.)

There is substantial data documenting the negative affects on fishing production when dams are built in Africa. An example is on the Senegal River, where 11,250 tons of fish are lost each year due to dam construction (WCD, 84.)

Section 3.4 Human and Cultural Impacts highlights the importance of taking health concerns of the local population into consideration in project planning. The level of local management effects sustainability of project and community involvement must be clarified during the planning stage.

During the planning stages of irrigation projects government health, water and environmental sanitation agencies should be contacted. Potable drinking water should be supplied, and included in project budget.

The commission developed several strategic priorities and policy principles to help ensure that the decision-making process surrounding large dams is fair, participatory and transparent. They following are guidelines that were not met in the project planning for the Talo dam:

- Public Acceptance of key decisions- *Local groups have raised objections and there is no evidence of participation of downstream communities in the planning and design of the project.*

- Exploring alternatives to the dam-*Were smaller dams considered? Was the effectiveness of indigenous irrigation considered? Other types of irrigation projects?*

- Sustaining Rivers and Livelihoods- *Adherence to this is demonstrated through good site selection and understanding river systems.*

- Recognizing Entitlements and Sharing Benefits- *The downstream communities stand to bear the burden while not receiving the benefits.*

- Ensuring Compliance- *AFDB did not comply with its own guideline in project design and planning.*

V. Summary and Conclusions

Upon completion of our independent review, we arrive at two distinct conclusions. The first reviews the ambiguity and inconsistencies with the project itself. As is clear in section three of this report, there are numerous concerns about this project from a variety of stakeholders- all of which must be addressed. At the end of this section we offer suggestions and recommendations to the AfDB that must be taken into consideration before construction of the dam could begin. Our final conclusion discusses an irremediable decision that the bank made in the design of this project- the decision to not include all stakeholders and local populations. This participation should have been an integral part of project planning, and cannot be fully remedied with quick additions or band-aids put in place at this point in the project cycle. Because of this, it is difficult for us to offer any conclusive or overarching recommendations. The only final conclusion we are able to arrive at is that the Talo Dam project is inherently flawed in regards to the inclusion of local communities.

Summary and Conclusion 1: Project Ambiguities and Flaws

We began this report with a summary of the information available to us regarding the Talo Dam Project. According to the AfDB and Government of Mali, 20,000 ha of agriculture production will result from this project. We believe that the proposed benefits of this project are inclusive and unsubstantiated. It is unclear who the 1600 beneficiaries will be, and how they will be selected. It is unclear what type of irrigation system will be utilized. And significantly, the World Commission on Dams has demonstrated that irrigation dams rarely meet production goals.

Following is a table illustrating key problems or concerns with the project as established by the AfDB, the 1995 and 1997 Environmental Impact Assessments, local communities and the Clark Research Team. To the left are the problems/concerns raised, and on the right our recommendations as to measures that should be taken to mitigate those problems. Until the AfDB can demonstrate quantifiably, (i.e. in a revised project plan with an appropriate budget), that the recommendations will be adhered to, we cannot accept this project as viable or beneficial to the people of Mali.

Problem/Concern	Recommendation
Water Quality: *-Pesticides* *-Fertilizers*	- Training among farmers on usage, and strict regulations concerning proper levels. - Proper drainage of surface waters. - Regular monitoring of water quality
Soil: *-Salinization* *-Degradation*	Flushing at the end of every dry season (in order for this to occur, sufficient water must be left in reservoir) This process needs to be well managed and well-coordinated Manure and fertilization must be carefully managed, with access by farmers.
Hydrology	- Need complete study of the effects of this project on downstream communities, especially during dry years. -Assurance to downstream communities that target area won't be given sole priority during dry years.
Irrigation Infrastructures - *Sedimentation* *-Fish Grills* *-Damage from the building of the dam, i.e. extraction of stones*	-Removal of sediments every five years. Provision of $1 million for equipment (per 1995 EIA) -Need to be serviced annually -Monitoring and coordination to minimize the damage

Agriculture/Grazing *-Rice stalks will need to be grazed* *-Earthen structures may be damaged by cattle* *-Seasonal Migration* *-Bourgu Cultivation*	 -Stalks will have to be treated so cattle can eat them -Management and monitoring of graze land -Education and Training for pastoralists -Precautions regarding canals as waterholes -Incentives for people to stay in the area -Manage access and usage -Ensure equality/participation of all groups
Fishing *-Stagnant water can poison fish* *-Migrating fish need a way to pass through the dam*	 -Regular monitoring of water quality and levels of pollution, contingency plan for dealing with dangerous situations -Fish ladder
Flora and Fauna *-Damage from construction of the dam* *-Erosion of canals* *-Increased pressure on target area* *-Loss of forest from new rice production, submersion*	 -Protect, regulate and monitor -Plant trees along banks -Regulate grazing and woodcutting -Create woodlots, program to improve cook stoves
Humans - *Level of local participation* - *Inequitable distribution of benefits*	 - Evidence of local participation in project design, implementation, and operation needs to be more apparent; as well as dissemination of information to local communities. - Provisions for up and downstream communities. - Policies in place that do not prioritize target communities in low-water years. - Fair, transparent and participatory process for choosing 1600 beneficiaries

- *Flooding of upstream villages*	- Assist communities in building dikes to protect their villages, including right and left bank - Provisions for those who must be relocated- further studies addressing concerns of 1995 EIA
- *Health: increased incidence of disease*	- Long term evaluation and monitoring - Health structures in place - Health education in all three areas
-*Culture* • *Protection of historical sites*	• Assurance that protection of the mosque, as a UNESCO World Heritage site, will be given high priority
• *Preserving cultural diversity*	• Special attention must be paid to indigenous populations, migrating groups, and other inhabitants of the downstream and greater Niger Inland Delta region.
Overall Environmental Impacts	
- *Downstream Bani River Areas*	- An Environmental Impact Assessment must be conducted taking into account hydrological changes and downstream topography, and the environmental and socioeconomic effects of these changes.
- *Niger Inland Delta*	- An Environmental Impact Assessment must also taken into account the dam's effects on the entire Niger Inland Delta and its ecosystems, including flora and fauna, and the diverse human populations that depend on its resources for their livelihoods.
- *Upstream*	A contingency plan must be formulated and put in place for upstream communities, which still face the possibility of flooding, and may lack the resources to protect villages, fields, and other areas. The AfDB has the responsibility to provide financial and technical assistance to these villages as is needed.

In addition to the above project concerns, specific groups or institutions responsible for carrying out the recommended measures need to be identified and assigned clear, defined roles. It is also necessary to assure that the necessary funds and resources to carry out these measures will be provided by either the AfDB and other donors, or the Government of Mali.

Summary and Conclusion 2: Exclusion of Local Stakeholders

The issue of participation pervades all levels of project planning and implementation in the rhetoric of major lending institutions working in the name of poverty alleviation. The World Bank, the largest international lender of this sort has time and again affirmed its commitment to local participation. They define participation as "a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them" and they encourage participation through Community Driven Development, which they define as "processes that give community groups control and authority over the decisions and resources which affect their lives" (www.worldbank.org/participation.)

The World Commission on Dams (WCD) also reinforced the inherent value of including all stakeholders in the design of irrigation dams. Last year they issued a report that, among other things discussed the socio-economic impacts of large dams, especially in terms of downstream communities. They stress that it is important to look beyond monetary impacts of dams in an effort to understand how dams affect local communities. In accordance with the WCD, we at Clark believe that the best way to understand the potential impacts of dams and irrigation projects is to involve all affected people in the project's design and implementation. The WCD's findings demonstrated that "poor, vulnerable groups and future generations are likely to bear a disproportionate share of the social and environmental costs of large dam projects without gaining a commensurate share of economic benefits" (WCD, 2000: 98.) They also concluded that "the most unsatisfactory social outcomes of past dam projects are linked to cases where affected people played no role in the planning process" (WCD, 2000:176.) When local communities are not provided the opportunity to participate in an open and transparent process, there are more project delays, higher project costs and the benefits are not evenly distributed (WCD, 2000 177-78.)

The AfDB has affirmed its commitment to the participation of local communities in the design and implementation in the projects it funds. In order to prevent conflict arising from affected groups, the bank's stated policy is to promote community involvement and participation early on in project design and continued follow-up by project managers. Section 4.2.3 of Irrigation Guidelines discusses the impact of irrigation projects on two groups of stakeholders: directly and indirectly affected groups. Both groups need to be consulted and allowed to participate throughout the life of the project. Indirect stakeholders include downstream farmers, nomadic groups, and fishing populations. Future consequences of the project should be identified early on in an effort to avoid later conflict- these problems are best identified in consultation with the stakeholders themselves.

The Clark University Research Team concludes that the AfDB has failed in regards to its own policy on the inclusion of local communities in the Talo Dam Project. Further, the bank did not adhere to internationally accepted policies and guidelines on participation. Upon completion of our independent review we see no indications that the bank took the initiative to involve local communities outside of the target area in project conception and design. Specifically, it is the exclusion of downstream communities that raises the greatest alarm. Modifications at later stages in the project do not negate their initial exclusion. When up to 20% of a region's livelihood is going to allocated elsewhere, that community has a right to a voice in the conception, design and implementation of the project.

Unfortunately, the AfDB and the Government and Mali's neglect of its own and internationally accepted policies on local participation can never be fully remedied. Those whose rights and livelihoods will be most affected by the Talo Dam- the downstream community- were not consulted on this project in any evident way.

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World Commission on Dams

February 24, 2003

Clark University-IDCE
950 Main St.
Worcester, MA 01610

Dear Lisa Meierotto:

I have evaluated the data that you sent on the proposed Talo Weir in Mali, Africa. I was able to draw some conclusions from the compiled data.

The model of the hydrological impact of the weir submitted by the African Development Bank (Figure 29) modeled the flow (or volume of flow) overtopping the weir in comparison to the volume of flow entering the proposed reservoir. The volume of water released from the floodgates was not included in the model; therefore I only looked at the hydrologic impact in terms of the volume of water overtopping the weir. From my assessment of the data, the following issues should be raised:

1. The African Development Bank states that 6% of the total river will be diverted for new agricultural projects. I am assuming that what is presented in the model is for an average year. According to their model, it should be noted that at any given point, the percentage of diverted water varies. For example, in the 27th time period, 477 millions of cu. m flows over the top of the dam, when 515.7 millions of cu. m enters the reservoir. The reservoir is holding back 20% of the total river volume flowing into the reservoir at that time period. If they state that they are only diverting 6% of the river, it should be 6% of the river *at any given time.*
2. Assuming that the model represents an average hydrologic year, a dry hydrologic year (ie. a year with minimal precipitation) will increase the impact of the reservoir. Unless more water is released through the floodgates, the percentage of the volume of water overtopping the weir from the water entering the reservoir will decrease.
3. The peak flow is muted by the reservoir and could significantly affect the ecology of the riparian corridor downstream. A river is defined by a series of natural occurrences and, including its flood events. If the peak flow of a river system is dampened, the downstream hydraulics can be affected (ie. ability to transport sediment and meander). The floodplain vegetation (especially in a dry climate) is greatly dependent upon the ability of the river to overtop its banks.
4. It should be noted that any obstruction placed in a channel could hold back upstream sediment that naturally is transported downstream. Sediment tends to build up on the upstream side of weirs and dams, clogging them and decreasing their storage capacity. The lack of sediment supply downstream can be detrimental to a river as well, especially if boulders and gravel are screened out. The water's energy increases and tends to scour downstream.
5. Groundwater seepage was not included in the water balance presented by the developers. Dependent upon the type of soil in the area, seepage can greatly affect the volume of water stored in a reservoir. Less porous soil, such as clay has a greater ability to seal in water and inhibit seepage. Porous soil can be like a sieve.

Sincerely,

J. Rose Patenaude
Hydrologist

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ROSE@PWA-LTD.COM

		JAN			FEB			MAR			APR			MAY			JUN
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Entry flow	(m^3/s)	21	13	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Volume @ entry	(millions of m^3)	18.2	11	4.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Level of reservoir	(m)	274.48	274.4	274.4	274.4	274.3	273.9	273.6	273.2	272.9	272.5	272.2	271.1	271.8	271.5	270.8	270.4
Evap	(mm/mo)	215	223	231	240	261	282	305	298	290	282	277	243	273	268	228	203
Precip	(mm)	0.33	0.33	0.33	0	0	0	1	1	1	4	4	4	14.33	14.33	14.33	32.33
Evap	(mm)	71.67	74.33	77.00	80.00	87.00	94.00	101.67	99.33	96.67	94.00	92.33	81.00	91.00	89.33	76.00	67.67
Surface area	(millions of m^2)	28.42	29.02	29.02	29.02	28.99	28.8	28.68	28.33	28.04	27.7	27.31	25.57	26.84	26.27	24.69	23.67
Vol of precip	(millions of m^3)	0.01	0.01	0.01	0.00	0.00	0.00	0.03	0.03	0.03	0.11	0.11	0.10	0.38	0.38	0.35	0.77
Volume of evap	(millions of m^3)	2	2.2	2.2	2.3	2.5	2.7	2.9	2.8	2.7	2.6	2.5	2.1	2.4	2.3	1.9	1.6
Flow entering main canal	(m^3/s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Volume entering main canal	(millions of m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reservoir volume	(millions of m^3)	175.6	175.6	175.5	175.6	173.3	162.1	150.8	139.2	127.8	116.4	105.2	94	82.9	71.9	61.2	50.7
Volume variation	(millions of m^3)	0	0	0	0	-2.3	-11.2	-11.3	-11.5	-11.5	-11.4	-11.2	-11	-11.2	-11.1	-10.8	-10.5
Volume passing over the top of dam	(millions of m^3)	16.2	8.8	2.6	0	0	0	0	0	0	0	0	0	0	0	0	0
Flow passing over the top of dam	(m^3/s)	19	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Flow released through floodgate	(m^3/s)	0	0	7	10	10	10	10	10	10	10	10	10	10	10	10	10
Volume released through floodgate	(millions of m^3)	0	0	6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Total flow passing dam	(m^3/s)	19	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Vol @ entry - vol passing over dam		2	2.2	2.3	0	0	0	0	0	0	0	0	0	0	0	0	0
Percentage of volume diverted to res.		0.11	0.20	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		JUL			AUG			SEP			OCT			NOV			DEC				
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	TOTAL	
0	9	25	36	60	134	216	340	460	573	596	564	463	317	228	158	115	80	55	34	4503	
0	7.7	21.3	30.9	51.7	115.9	187	293.8	397.4	495.4	515.1	487.3	400.2	274.2	197.1	136.5	99	68.8	47.6	29.8		
270.1	269.8	269.7	270.1	270.8	272.1	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4	274.4		
193	183	173	165	157	148	150	150	152	165	175	188	200	205	212	205	200	198	205	208		
32.33	32.33	61.67	61.67	61.67	83	83	83	40.33	40.33	40.33	9	9	9	1.67	1.67	1.67	0	0	0	743.00	
64.33	61.00	57.67	55.00	52.33	49.33	50.00	50.00	50.67	55.00	58.33	62.67	66.67	68.33	70.67	68.33	66.67	66.00	68.33	69.33	2583.67	
22.1	20.04	19.47	22.05	24.69	27.22	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02	29.02		
0.71	0.65	1.20	1.36	1.52	2.26	2.41	2.41	1.17	1.17	1.17	0.26	0.26	0.26	0.05	0.05	0.05	0.00	0.00	0.00	19.28	
1.4	1.2	1.1	1.2	1.3	1.3	1.5	1.5	1.5	1.6	1.7	1.8	1.9	2	2.1	2	1.9	1.9	2	2		
0	0	0	0	8.8	8.8	17.9	62.7	107.5	104.8	117	24	24	24	24	24	0	0	0	0		
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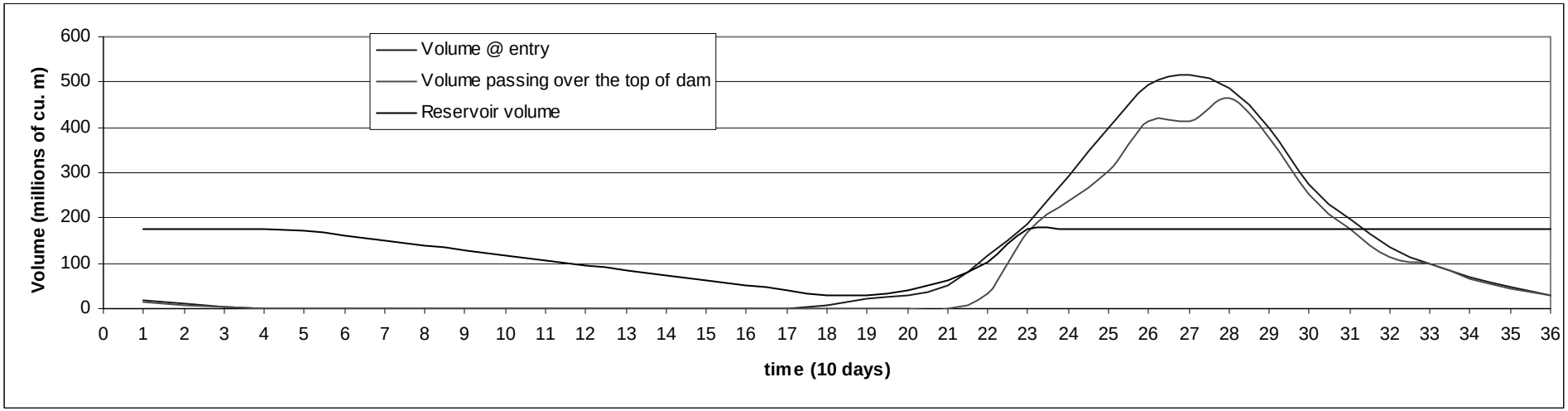
40.4	30.4	28.2	40.2	61.2	103	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6	175.6		
-10.2	-10.1	-2.2	12	21	41.8	72.6	0	0	0	0	0	0	0	0	0	0	0	0	0		
0	0	0	0	0	34.3	170.1	238.2	303.1	413.3	412.3	464.7	377.5	251.4	174.4	113.8	97	66.9	45.6	27.8	3218	
0	0	0	0	0	40	197	276	351	467	477	538	437	291	202	132	112	77	53	32		
10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
8.6	8.6	8.6	8.6	8.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	160.8	
10	10	10	10	10	40	197	276	351	467	477	538	437	291	202	132	112	77	53	32		
0	7.7	21.3	30.9	51.7	81.6	16.9	55.6	94.3	82.1	102.8	22.6	22.7	22.8	22.7	22.7	2	1.9	2	2		average
0.00	1.00	1.00	1.00	1.00	0.70	0.09	0.19	0.24	0.17	0.20	0.05	0.06	0.08	0.12	0.17	0.02	0.03	0.04	0.07		0.19


Volume @ entry
Volume passing over the top of dam
Reservoir volume
Volume (millions of cu. m)
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
time (10 days)