CASE STUDIES IN WETLAND VALUATION #6: May 2003

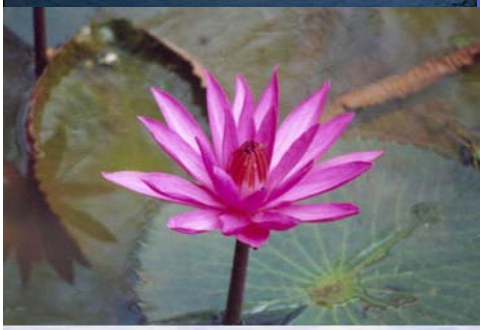
TANA RIVER, KENYA: integrating downstream values into hydropower planning

Hydropower development on the Tana River

The Tana River has a length of some 1,000 km, rising in the Aberdare and Mount Kenya ranges of central Kenya and running through the arid and semi-arid lands in the eastern part of the country to enter the Indian Ocean through a fan-shaped Delta which covers approximately 1,300 km^2. The Tana's catchment covers an area in excess of 100,000 km^2, and contains more than 4 million people. The Tana River is the only permanent river in this extremely dry region, and constitutes a vital water resource for all sectors of the human population.

The Tana River is also heavily utilised for hydropower. To date, five major reservoirs have been built on the upper reaches of the Tana: Kindaruma (1968), Kamburu (1975), Gitaru (1978), Masinga (1981) and Kiambere (1988). Together, these schemes provide nearly three quarters of Kenya's electricity requirements. Dam construction has however had a major influence on the river's downstream flow and physical characteristics, most notably through regulating waterflow and decreasing the frequency and magnitude of flooding. A new hydropower scheme, the Mutonga-Grand Falls dam, has recently been proposed for construction on the Tana River below these existing dams.

This case study describes a valuation exercise that was carried out as part of a pre-project environmental assessment of the likely impacts of dam construction on downstream ecosystems.



Integrating Wetland Economic Values into River Basin Management

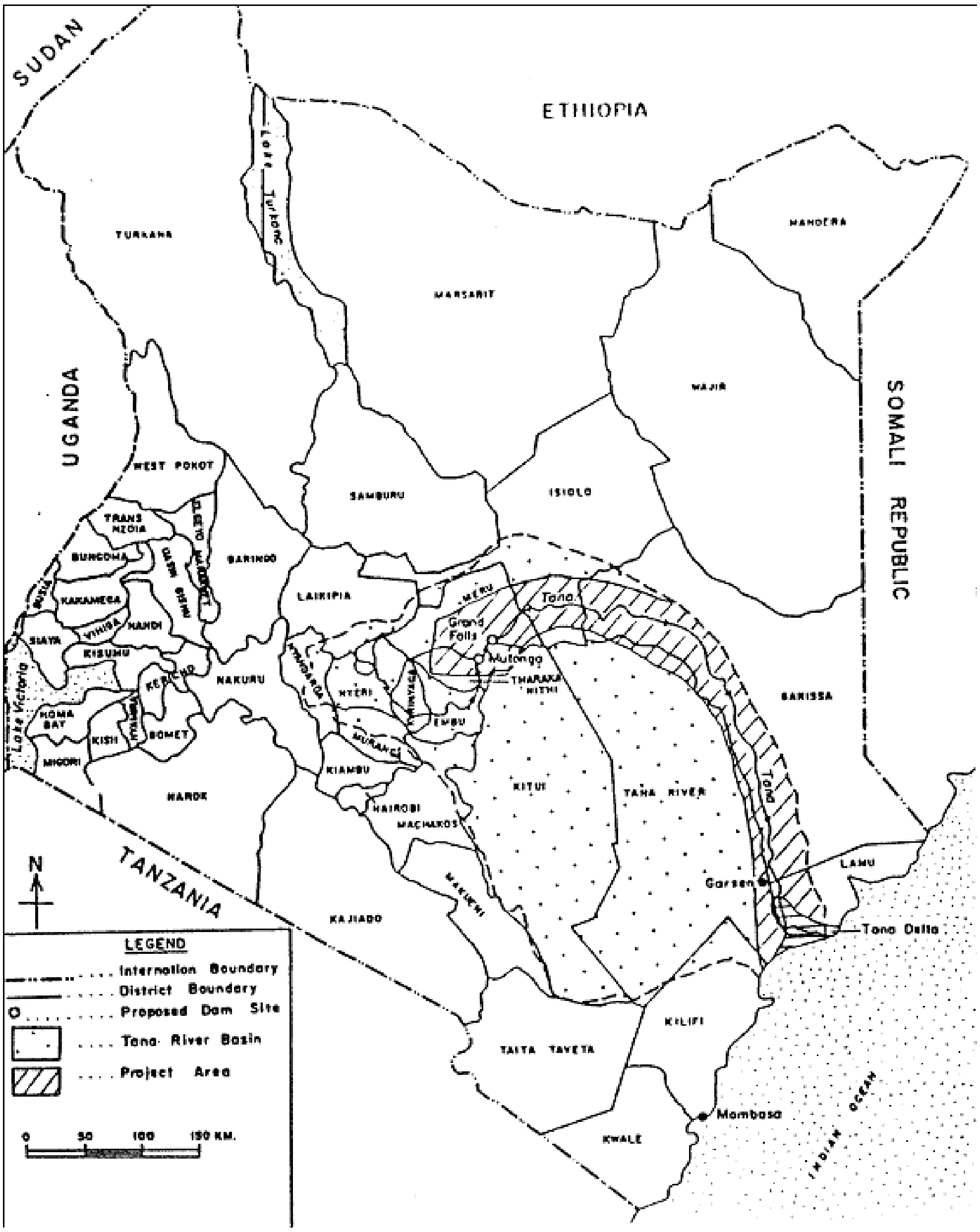
IUCN
The World Conservation Union

With a variety of design options being considered for the proposed Mutonga-Grand Falls dam, the study aimed to quantify the environmental economic costs and benefits of further changes to the Tana's hydrology. It yielded figures which could be integrated into more conventional economic cost benefit analyses of the proposed investment. To date economic appraisal had considered only the physical costs of dam construction and the financial and economic benefits arising from power generation, and had made little allowance for design options that would mitigate or avert the environmental impacts of flood loss. Providing comparable data on environmental costs and benefits allowed for a much more thorough economic analysis of the predicted returns to different investment options, and a better indication of the likely profitability of building flood release measures into dam design.

Impacts of the proposed Mutonga-Grand Falls Hydroelectric Scheme

A variety of options are being considered for the proposed Mutonga-Grand Falls dam, with a reservoir surface area of between 100 and 250

Figure 1: Location of the Tana River



km^2, impounding time of between 9 months and 2.5 years and a rated power output of between 60 and 180 MW. All of these options will have some influence on downstream riverflow, compounding the effects of the 5 dams that have already been constructed on the Tana River. Prior to the construction of the existing dams, the Tana River used to flood its banks, usually twice a year. These biannual floods would inundate the floodplain and delta area up to a depth of 3 metres, supporting grasslands, lakes, seasonal streams, riverine forest and mangrove ecosystems. Since 1989, when the last dam was commissioned, flooding has decreased dramatically in volume and frequency.

The proposed Mutonga-Grand Falls dam would be the last stage in complete control of the Tana's waters, as after construction there would be no appreciable addition to its flow except in extreme events occurring every 5 and 10 years. This would effectively end the regular bi-annual floods, cut off most of the floodplain from water, and significantly lower the local water table. Reservoir construction would reduce the sediment loads transported down-river, and stabilisation and regulation of waterflow would lead to deepening of the river channel and limit meander and oxbow formation. Changes in downstream ecosystems and biodiversity, which have already been heavily impacted as a result of existing dam construction, would be hastened and exacerbated. These include reduction in the area and composition of floodplain grasslands, lowering of surface and groundwater sources, loss of fertile riverbank sediment depositions, reduction in swamps, ox-bow lakes and seasonal water bodies, senescence of riverine forest areas and mangrove degradation due to inadequate freshwater flows.

Flood loss and the local economy

Almost 200,000 crop farmers, livestock keepers and fisherfolk live permanently in areas that are directly adjacent to the Tana River and the Tana Delta. In total, it is estimated that over a million people depend on the river's flooding regime for their livelihoods, including an additional 800,000 nomadic and semi-nomadic pastoralists as well as seasonal fisherfolk and fish traders. Almost 2.5 million livestock, including over a million cattle, rely on the Tana's floodplain grasslands and water bodies for dry season pasture and water (CADP 1991b). With no other permanent water sources in the region, the Tana provides the only source of emergency and drought pasture, and in years of extreme low rainfall cattle populations more than double (CADP 1991a). As the flooding regime has decreased, dry season pasture and watering points have become limited to the area that is directly adjacent to the river. Traditional patterns of transhumance have been disrupted, grazing pressure has increased, and there has been intensified conflict between pastoralists and floodplain agriculturalists over land and resource use on the Tana's banks (Goldson 1994).

About 115,000 people practice flood recession and riverbank farming around the Tana, which provides the only source of land in the region that is suitable for arable agriculture. These farmers depend both on floodwater to irrigate their crops, and on the depositions of fertile sediments that the floods bring. With dam construction, the possibilities for floodplain agriculture have diminished considerably, and it is likely that after the construction of the Mutonga-Grand Falls scheme cropping will be limited to riverbanks only (Quan 1994). Many farmers also depend on fishing as a source of income and household protein, and there is a thriving trade in fresh and dried fish in the main towns and cities of the area. The Tana River, Delta and estuary area support both subsistence and commercial fisheries, providing the main livelihood for more than 50,000 people (Nippon Koei 1989, CADP 1991b) and yielding a freshwater catch of up to 500 tonnes a year (Welcomme 1985). Dam-related changes in river hydrology have already reduced the area and longevity of flood-supported wetlands and mangrove areas, as well as diminishing fish populations and diversity in the main river channel. It is thought that additional dam construction will rapidly exacerbate this decline in fishing area and catch (Mavuti 1994).

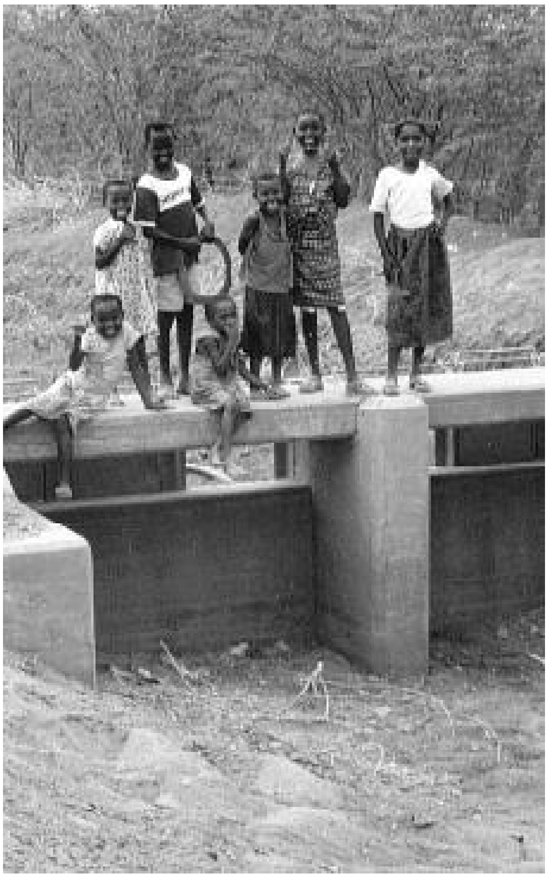
The Tana River region contains unique species and habitats which are not found elsewhere in East Africa. Six protected areas are located in the river and delta area, including some of the few remaining riverine forests which support at least four endemic plant species, three of the four primates that are endemic to Kenya and two endemic bird species, and savannahs and grasslands that contain populations of large mammals such as hippopotamus, zebra, oryx, hartebeest, topi, lion, hyena, cheetah and leopard (Gachugu 1992). As well as supporting tourism activities, forests and wildlife are also utilised by local communities. Approximately a third of local populations in the Tana River and Delta region regularly hunt, and rely on fuelwood, construction materials, medicines, boat building materials and wild foods sourced from natural forest (Emerton 1994). Forest and grassland areas, in particular, have been heavily impacted by dam construction, leading to changes in wildlife and plant species composition and numbers (Duthie 1994, Wakanene and Njue 1994).

Valuing downstream flood loss

The aim of this study was to quantify the economic costs arising from flood loss and resulting downstream ecosystem degradation. The results were targeted specifically at influencing on-going economic appraisal and dam design processes, and so attempted to present a set of data that could be easily incorporated into the traditional cost-benefit approaches that were being used as a measure of dam profitability. To date consideration of the economic desirability of the dam had focused almost exclusively on physical construction costs and power generation benefits, and the choice of options for dam design had been driven primarily by considerations of cost effectiveness and revenue maximisation. This valuation study introduced an additional element of costs and benefits into project analysis and decision-making: those related to the environmental economic impacts of flood loss.

The valuation study was carried out as a component of an environmental impact assessment of the dam. It therefore had access to detailed data on flood-dependent ecosystems and human production systems, hydrological models of the river system, and likely impacts of flood reduction on biodiversity, ecology, hydrology and economic output. The study did not involve detailed primary data collection: rather, it was used to influence what kind of information was collected as part of other studies, and to collate and analyse these data in order to yield estimates of the economic values associated with flooding. For the most part, valuation focused on assessing and quantifying data that were collected on ecological and economic changes that had taken place to date as a result of existing dam construction, and assessing the economic implications of future changes that were predicted as part of a detailed river basin modelling exercise. The main method used for valuing flood-related economic impacts was to identify and analyse the changes in production and output that had already occurred, and would be exacerbated in the future, as a result of dam construction.

Analysis of data was carried out so as to yield a set of figures that could be related to each major ecosystem or sector that would be affected by dam construction, and which formed the subject of individual thematic studies carried out as part of the environmental impact assessment. It also generated a set of economic indicators of the overall ecological desirability of different dam design options, which could both be related to the conclusions of the environmental impact assessment and to the findings of prior cost-benefit analyses of the project.



Using ecosystem valuation to influence infrastructure planning

The findings of the study confirmed the extremely high, and quantifiable, costs of designing the Mutonga-Grand Falls dam in a way which would lead to continued reductions in downstream flooding. It showed that the construction of dams on the upper reaches of the Tana River had already imposed significant economic losses on downstream systems in terms of lost production, estimated to have incurred a net present cost of some $27 million, and that the incremental cost of building an additional dam would also be high, with a median present cost of almost $20 million (Table 1).

The study also highlighted the significance of dam-related flood loss for local populations. The livelihoods of more than 1 million people have already been affected by changes in the Tana's flooding regime, and one of the poorest sectors of this population – nomadic and semi-nomadic pastoralists – bear almost half of the downstream economic losses associated with dam construction. The study also quantified the heavy toll that dam construction has had on floodplain farming, freshwater and marine fisheries, forest and wildlife use, and domestic and urban water supplies. Although largely unquantifiable, these economic losses have also been linked to severe, and escalating, social and cultural costs related to the loss of traditional livelihoods, growing pauperisation, social change and increasing conflict over scarce natural resources.

The major implication of the valuation study, and the wider environmental impact assessment of which it formed a part, was the strong support it lent to investing in measures which would mitigate or minimise the effects of dam construction on downstream riverflow and flood regimes. By presenting estimates of the environmental cost of dam construction which could be integrated into more traditional economic appraisal frameworks and balanced against the gains and profits from electricity generation, it showed that some of the dam design options that had initially been indicated to be unprofitable – such as extending the commissioning period so as to permit adequate downstream flows and flooding, and construction of the reservoir and dam to allow for bi-annual flood simulation – would in fact yield the highest economic net present values and rate of return if environmental costs and benefits were taken into account. Incorporating such values into the economic appraisal process showed that such mitigative measures were not only economically desirable in the light of the new dam under consideration, but had an additional economic premium because they could also potentially reverse some of the changes – and economic costs – that had occurred as a result of dam construction to date on the Tana River.

Table 1: Net present costs of dam construction with flood loss

	Cost to date of existing dams (US$ mill)	Median incremental cost of Mutonga-Grand Falls (US$ mill)	Human population affected
Livestock pasture and water	11.14	9.02	850,000
Floodplain agriculture	1.16	0.43	115,000
Commercial freshwater fisheries	0.32	0.21	3,600
Subsistence freshwater fisheries	0.92	0.60	50,000
Commercial marine fisheries	0.08	0.05	1,000
Subsistence hunting	1.04	0.58	31,000
Forest and mangrove utilisation	0.30	0.23	1,000
Domestic water supplies	8.36	5.68	45,000
Urban water supplies	3.42	2.33	18,750
TOTAL	**26.74**	**19.13**	**1,115,350**

This case study is adapted from Emerton, 1994, An Economic Valuation of the Costs and Benefits in the Lower Tana Catchment Resulting from Dam Construction, Report prepared by Acropolis Kenya Ltd for Nippon Koei, Nairobi

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This project aims to develop, apply and demonstrate environmental economics techniques and measures for wetland, water resources and river basin management which will contribute to a more equitable, efficient and sustainable distribution of their economic benefits at the global level and in Africa, Asia and Latin America, especially for poorer and more vulnerable groups.

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