CASE STUDY **An assessment of the impact of water infrastructure in the Tana Basin on Ecosystem Services**

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This case study investigated the trade-offs associated with large dam construction. Many rural communities in the Tana Basin in Kenya rely on the floodplain ecosystem for crop production, livestock grazing and fisheries. The large dams built on the river have significantly increased overall financial returns by creating new revenue streams (i.e., hydropower and irrigation) and by reducing the adverse impacts of large floods. However, the dams have also reduced the benefits that accrue from moderate floods with the greatest losses in the agriculture sector. Although they benefit from increased flood protection, impoverished pastoralists and smallholder farmers lose the most revenue.

Important Details

time (or time period)	2015 - 2017
country & region	Tana River Basin, Kenya
context & agro-eco landscape type	river basin with large dams that support the water and energy demands of both rural and urban populations
key actors, stakeholders & beneficiaries	rural population who are highly dependent on ecosystem services; rapidly growing urban population, situated outside the basin
model and/or tools used	cost-benefit analysis

Overview

Large dams have long been a cornerstone of national economic growth and development vital for both the generation of hydroelectricity and, in many places, irrigation. In the face of climate change there is a broad consensus that in many places more large dams are needed to manage water scarcity and greater variability. However, large dams remain highly contentious, in part because of the huge capital costs incurred and in part because of the difficulty of mitigating negative environmental and social impacts.

In common with many countries in Africa and despite significant economic progress in recent years, inadequate built infrastructure is widely perceived as a drag on economic and social development in Kenya. As a result, large dams for hydropower and irrigation, as well as diversions for urban water supply, feature prominently in key policies and strategies intended to drive Kenya's future development. "Modernizing infrastructure" is a priority of both the previous (2012-2017) and the current (2018-2022) Medium Term Plans, both of which seek to transform the national economy to one that is high growth, broad based, inclusive and sustainable (GOK, 2013a; GOK, 2017).

The Tana River Basin, located in southeastern Kenya covers an area of 95,000 km2 (17% of the country) and supports the livelihoods of some 6.5 million people, the majority of whom (5.3 million) live in the upper 17,000 km2 of the basin (TNC, 2015). The upper basin includes two of Kenya's 'water towers': the Aberdare Mountains and Mount Kenya. The river is the principal water source for Kenya's capital city

Nairobi and, with an installed capacity of 547 MW in five hydropower schemes (built between 1968 and 1988), produces around 70% of the country's hydroelectricity, which in turn constitutes approximately 40% of Kenya's total generation (Baker et al., 2015). The total cultivated area in the basin is estimated to be approximately one million ha, of which only 68,700 ha is currently irrigated but with significant potential for further expansion. An estimated 288,600 ha of large-scale irrigation are planned by the year 2030 (GOK, 2013b).

Many rural communities in the basin rely on river dependent ecosystems for crop production, livestock keeping and fisheries (Baker et al, 2015). To evaluate the costs and benefits associated with the current dams, empirical relationships were determined quantifying the links between river flow and ecosystem services. These relationships were used to quantify how the dam altered flow regime impacted ecosystem services.

Against this background, a study was conducted to investigate the gains and losses associated with large dam construction. A method was developed to link values derived from a number of ecosystem services to the probability of occurrence of river flows of different magnitude. The approach enables quantitative comparison of the benefits gained from the dams (e.g. hydropower and irrigation) with costs incurred (e.g. reduction in recession agriculture, grazing and fisheries) as a consequence of the dam modified flow regime. Allowance was made for the benefits derived, across all sectors, from the flood protection afforded by the dams during more extreme flood events.

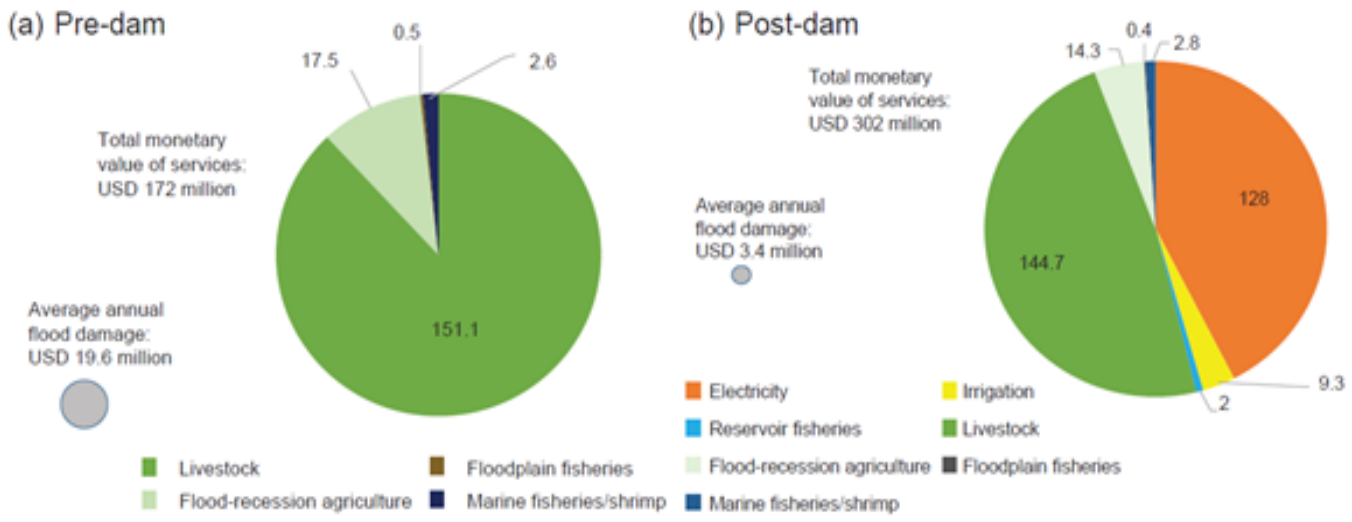

Figure 1. *Comparison of monetary benefits and costs a) before and b) after dam construction*

Lessons Learned & Recommendations

Depending on rainfall, river flow and other factors, the benefits vary from year to year, but a conservative estimate of the average cumulative value of six key water-dependent services (i.e., floodplain grazing, riverbank gardening and recession agriculture, freshwater fisheries, marine and estuarine fisheries, coastal shrimp fisheries and beach nourishment) in the lower basin is USD 152 million per year. The large dams built in the basin have significantly increased overall financial returns by creating new revenue streams (i.e., hydropower and irrigation) and by reducing the adverse impacts of extreme floods. Overall, average annual revenue has increased to USD 298 million. Nonetheless, the dams have also reduced the benefits that accrue from moderate floods with the greatest losses in the agriculture sector. Although they benefit from increased flood protection, impoverished pastoralists and smallholder farmers lose the most revenue; on average, USD 9.5 million per year.

To improve the effectiveness and durability of future development initiatives, policy-makers and decision-makers should:

- recognize that ecosystem services in the Tana River Basin represents a national asset, providing valuable services to people living both in, and outside, the basin;
- adopt an ecosystem services approach to make clear the synergies and trade-offs between different sectors in different development scenarios;
- ensure that environmental and other issues associated with human well-being, such as equity and social inclusion, are considered in decision-making; and
- plan and manage existing and planned dams with due consideration of the downstream ecosystem services and the benefits they provide.

Key references

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