THE SENEGAL RIVER:
RELEASE OF AN ARTIFICIAL FLOOD TO MAINTAIN TRADITIONAL FLOODPLAIN PRODUCTION SYSTEMS

1. BACKGROUND

Study area: location and geography

The Senegal River is the second longest river (1800 km) in West Africa. The river basin covers 300,000 km^2 and is shared by Guinea (11%), Mali (63%), Mauritania (26%) and Senegal (19%). The river originates in the highlands of Guinea and flows through Mali, before forming the boundary between Mauritania and Senegal to its estuary on the Atlantic Ocean.

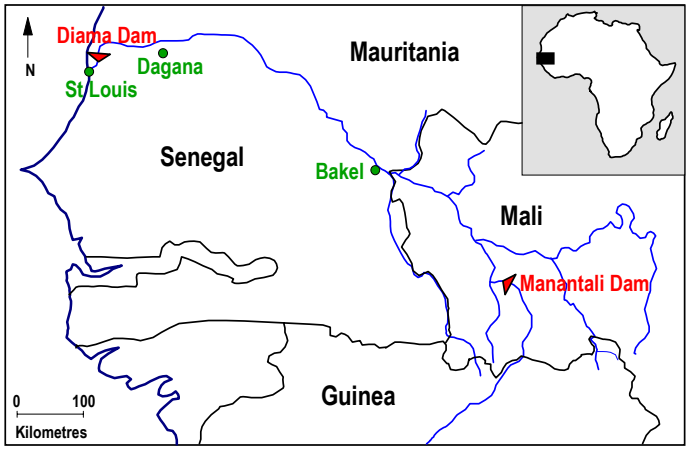

Figure 1. The Senegal River Basin in West Africa

The Senegal River Basin has three distinct regions: a mountainous Upper Valley from the source to Bakel; a Middle Valley from Bakel to Dagana; and a Lower Valley comprising the delta. Rainfall occurs from April to October, with the river flooding between July and October. Most floodwaters originate in the Upper Valley. During the annual flood large areas of floodplain are inundated, but the area covered varies greatly from year to year.

Two million people live in the Senegal River Basin, of whom 85% live near the river and rely on it for their livelihoods. Riparian communities in the Middle Valley (approximately 700,000 people) are particularly dependent on the riverine environment. Their livelihoods are largely based on traditional production systems (flood-recession agriculture, animal husbandry and fishing: Box 1) and so linked to the annual flooding cycle. People in the Upper Valley depend largely on rain-fed agriculture, while those in the Lower Valley practice irrigation agriculture, particularly of rice. The riparian communities of the Upper and Lower Valley regions are thus less dependent on the annual floods than those of the Middle Valley.

Box 1. Traditional use of the floodplains in the Middle Valley

Traditional use of the floodplains for farming, herding and fishing has enabled subsistence users to exploit different areas of them in different ways throughout the year.

Agricultural production: Riparian communities use both rain (July to October) and the nutrient-rich, moist floodplains after floods (October to March) to grow crops. Flood-recession agriculture is dependent on the annual flooding of the floodplain and is carried out on the riverbanks and alluvial plains once the floodwaters have receded. Rain-fed agriculture is practiced on higher land adjacent to the floodplain and is dependent on local rainfall. Historically, it is the least predictably successful of agricultural practices because of the highly variable rainfall.

Pastoral production: The floodplains provide seasonal grazing for large herds of ruminant livestock, which move in from higher land during the dry season (March to June). They browse shrubs, grasses and grain stubble, particularly nutrient-rich sorghum stubble, after crops have been harvested and, in turn, add manure to the fields. Small remnant ponds and marshes in the floodplains provide them with drinking water.

Fisheries: Fisherman fish in the river in the dry season and on the floodplains once floodwaters cover them. With the rising floodwaters, fish migrate out of the river and onto the floodplains in search of nutrient-rich feeding grounds for spawning and reproduction. The volume of fish available in any one year depends on how much of the floodplain was inundated and for how long.

The water-resource development

A long-term drought extending through the 1970s and 1980s led to a chronic water deficit in the region, the impact of which was felt by riparian communities in the Senegal River Basin. In response to this and to the high natural inter-annual variability in rainfall and river flow, Senegal, Mali and Mauritania signed a treaty to form the Senegal River Basin Authority (Organisation de Mise en Valeur de la Vallée du Fleuve Sénégal – OMVS). The OMVS, in an attempt to bolster food production and alleviate chronic food shortages, undertook two water-resource developments: Diama and Manantali Dams (Box 2).

Box 2. Water-resource developments in the Senegal River Basin

Diama Dam was constructed in 1986, 23 km from the river's mouth and in the Lower Valley, to act as a barrier to salt intrusion.

Manantali Dam was constructed in 1988, 1180km upstream of Diami Dam in the Upper Valley. Its three main purposes were to: generate hydroelectric power for urban and rural areas; help regional food sufficiency in cereal production, and particularly rice, to be attained through irrigated agriculture; support establishment of an internal port of trade at Kayes in Mali, with associated inland development of regional and local centres of trade and commerce that used the river as a navigable waterway.

A post-construction, transitional period was implemented from 1988 to 1992, in which an annual controlled release from Manantali Dam simulated natural flooding to the Middle Valley to allow recession agriculture to continue. The size and duration of this released flood was designed to optimise flooding for cultivation of 50 000 ha of floodplain. It was envisaged that the artificial flood released during the transitional period would give riparian communities time to move from recession agriculture to full-scale irrigation agriculture.

The need for an Environmental Flow Assessment (EFA)

Regulation of the flow regime downstream of Manantali Dam, and the intended cessation of annual flooding, posed a direct threat to the livelihoods of riparian communities, particularly in the Middle Valley. At the request of the Senegalese government and under the sponsorship of USAID/Dakar, the Institute for Development Anthropology (IDA) initiated the Senegal River Basin Monitoring Activity (SRBMA) in 1988. The aim was to explore the socio-economic and environmental impacts of river impoundment at Manantali on riparian communities in the Middle Valley.

2. ENVIRONMENTAL FLOW APPROACH USED

Research was conducted during the post-construction, transitional period and was implemented in two phases. Phase 1 (1988 – 1990) was an intensive field study of the demographics and production and economic strategies of three principal village sites. Drawing on findings from Phase 1, Phase 2 (1990 - 1992) expanded the investigation to 32 villages. The field studies documented the responses of riparian communities to the dam-induced changes in river flow and flooding (Box 3).

Box 3. Broad objectives of the SRBMA project

1. Examine costs and benefits at regional and national levels of terminating the annual flood in Senegal.
2. Establish the relationship of diversified agricultural and non-agricultural economies (i.e. the traditional mix of rain-fed and irrigated farming, flood recession cultivation, animal husbandry, fishing, commerce and migration) to household food security and income generation.
3. Promote a policy of economic development that protects the natural resource base.

Methods used included formal interviews and questionnaires about a range of activities related to production, income generation, household consumption, labour allocation and land tenure. Results were related to river flows and flooding, specifically the impact of flood cessation on subsistence use of resources and subsequent socio-economic impacts.

Outputs of the Environmental Flow Assessment

The study concluded that the release of an annual controlled flood was crucial for the maintenance of the floodplain environment and its inhabitants. Further, the timing and duration of the flood should resemble the natural flood as closely as possible. Changes already noticed four years after completion of Manantali Dam highlighted environmental (Box 4) and socio-economic (Box 5) impacts of terminating the annual flood.

Box 4. Environmental consequences

- Decline of the flood-dependent woodland species, *Acacia nilotica* (a major source of fuel and construction wood).
- Reduction in fish yields due to the loss of floodplain habitat for fish feeding and reproduction.
- Reduction in aquifer recharge and a loss in potable water supply for rural inhabitants.
- Proliferation of aquatic weeds in Diama Dam.*
- Sedimentation at Diama Dam.*
- Favourable environmental conditions for the growth, spread and increase of snails, an intermediate host of several diseases.*
- Potential loss of habitat for migratory birds in the delta.*

*effects noted after the SRBMA study.

Box 5. Socio-economic consequences

- Loss of land available for recession agriculture and an increase in conflict through greater competition for a reduced and homogenized resource base.
- Loss of floodplain habitat for livestock grazing.
- Change in population structure through emigration of adult males seeking alternative means of financing the capital costs of rice production.
- Increased number of woman and children doing formerly male tasks.
- Increase in waterborne diseases, specifically malaria, bilharzia and diarrhoea, as a result of more constant flows in the river.

The relative advantages and disadvantages of recession agriculture and irrigated agriculture were also compared (Box 6), since the intention was to encourage cessation of recession agriculture and ultimately terminate the annual flood.

Box 6. Recession agriculture versus irrigated agriculture

Recession agriculture

- Low labour costs
- Low capital costs
- Low yield per area farmed
- Seasonal, allowing rural inhabitants to diversify income by generating income in urban areas in the dry-season
- Traditional division of labour
- Diverse resources maintained
- Risk in food and income production spread over several options
- A varied floodplain landscape maintained
- Flooding and grazing livestock fertilise floodplains

Irrigated agriculture

- High labour costs
- High capital costs
- High yield per area farmed
- Non-seasonal, requiring labour year round
- Migration of males to urban areas to finance capital costs of irrigation schemes
- Increased workload in rural areas for woman, children and elderly persons
- Resources homogenized to maximise production
- Floodplain changed to a uniform landscape
- Artificial fertilizers needed

3. MANAGEMENT ACTIONS: DECISIONS TAKEN AND IMPLICATIONS

Whilst the original intention of OMVS was for the artificial flood release to cease after the transitional period, the importance of the annual flood to riparian communities and the environment was later recognised. Thus, since Manantali Dam became operational, an annual artificial flood has been released each year. Because of the severe droughts in the years preceding the construction of Manantali Dam, the artificial floods have actually led to an increase in flooding downstream of the dam with a concomitant increase in recession agriculture.

The SRBMA study emphasised the value of indigenous knowledge and production systems. Further, the value of maintaining a varied landscape that supports a range of floodplain activities and is less likely to lead to environmental degradation was recognized as superior to a landscape made uniform by rice cultivation.

Since the SRBMA (1998-1992) study there have been several further developments (Box 7). The most recent is the GEF-funded (Global Environment Facility) programme on Water and Environmental Management, initiated by OMVS. It aims to develop a trans-boundary land-water management plan and a strategic environmental framework for sustainable development of the Senegal River Basin.

Box 7. Recent activities related to the Senegal River Basin

1997	Designation of management, operation and maintenance of Diama and Manantali Dams to two separate holding companies located in Mauritania and Mali respectively.
1997	Initial collaboration of OMVS with the World Bank to develop a GEF-funded project for the Senegal River Basin.
1998	Creation of the Environment Impact Mitigation and Monitoring Program (PASIE) by OMVS. PASIE is an environmental programme designed to address, monitor and mitigate the environmental issues related to power generation from the Manantali hydroelectric power station.
2000	Completion of the hydroelectric power station.
2000	Establishment of the Environmental Observatory by OMVS to monitor environmental change in the Basin as part of PASIE.
2002	Senegal River Water Charter signed. A legal and regulatory framework stating that river water must be allocated to riparian states not in terms of volumes of water to be withdrawn, but rather in terms of uses as a function of possibilities. The various uses can be for agriculture, inland fishing, livestock raising, fish farming, tree farming, fauna and flora, hydroelectric energy production, urban and rural drinking water supply, health, industry, navigation and the environment.
2002	Workshop on “Scientific data for decision making toward sustainable development in the Senegal River Basin”.
2002	GEF-funded Programme on Water and Environmental Management

4. LESSONS LEARNT

Accurately recording the costs and benefits of traditional-production system is essential. The ecological and social costs of losing systems such as floodplains used by several interacting food-production groups should be built into cost-benefit analyses at an early stage of water-resource planning.

The importance of working with riparian communities during all stages of the water-resource development, particularly in relation to dam operations, was highlighted. Failure to do so can lead to confusion, frustration and economic losses for rural inhabitants.

With an appropriate EFA-defined released flood, it was possible for a dam built primarily for hydroelectric power generation and irrigation to be used to improve downstream smallholder production systems.

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Websites

www.omvs-hc.org/ - website of the Senegal River Basin Authority (Organisation de Mise en Valeur de la Vallée du Fleuve Sénégal)

www.nap.edu/html/srb11/ch2.html - Summary of a workshop on scientific data for decision making toward sustainable development.

SUMMARY

The Senegal River is the longest in West Africa, with four countries (Guinea, Mali, Mauritania and Senegal) sharing its Basin. Two million people live in the Basin, of whom 85% rely on the river for their livelihoods. Riparian communities living on the floodplains in the Middle Valley Region in Senegal are particularly dependent on the river, with fishers, pastoralists and flood-recession agriculturalists sharing the production potential of these vast wetlands. Manantali Dam, built in 1988 to generate hydropower, and to provide water for irrigation and increased navigation, was also designed to ultimately stop flooding of the Middle Valley floodplains. It was envisaged that the riparian people in that area would transform to rice growers on irrigated land. Studies by the Institute for Development Anthropology showed substantial realised and potential ecological and social losses from such a policy, and considerable costs as well as benefits involved in the move to irrigated agriculture. Thus, since Manantali Dam became operational, an annual artificial flood has been released each year and, because of the severe droughts in the years preceding the dam, has actually led to an increase in downstream flooding and flood-recession agriculture. Lessons learnt were that: the ecological and social costs of losing systems such as floodplains used by several interacting –food-production groups should be built into cost-benefit analyses at an early stage of water-resource planning; failure to work with riparian communities during all stages of the water-resource development, particularly in relation to dam operations, can lead to confusion, frustration and economic losses for rural inhabitants; and a dam built primarily for hydroelectric power generation and irrigation can be used to improve downstream smallholder production systems.

KEY WORDS

Senegal River. Manantali Dam. Flood-recession agriculture. Traditional floodplain production systems.