

COSTA RICA: HOW AN IWRM APPROACH WOULD ACHIEVE BETTER WATER ALLOCATION – THE LAKE ARENAL WATERSHED

CASE # 10

This case describes the complex interplay between people, ecosystems and water users in the Arenal Lake, a reservoir used to generate hydroelectricity and irrigate agricultural land, and analyses the difficulties involved in achieving integrated management of their water resources.

ABSTRACT

Description

This case study presents the lessons that can be learned from a national attempt to make the most effective dual use (energy and agriculture) of the water resources of Lake Arenal in Northern Costa Rica, the country's largest water reservoir, and an increasingly important tourist destination.

In the late 1980s, concerns about the Lake, such as the stability of its watershed, problems of deforestation, and possible premature sedimentation, led the Government to create a Lake Watershed Plan in 1996, and a Commission to implement the plan in 1997. The intent was to involve all the interested parties and institutions to make the best use of all resources. However, after four years, the Commission has virtually disappeared, lacking funding and political support.

Lessons Learned

The project has yielded successful national and local benefits in terms of energy produced and area irrigated. But these outcomes have not been integrated, either with each other, or with conservation of ecosystems and other environmental sectors.

The Government's intention was to involve all parties, and they were consulted in the development of the Lake Arenal Watershed Management and Development Plan. However, during implementation, one party – the Instituto Costarricense de Electricidad (ICE) – had so much influence and power, that other parties (e.g. farmers groups and conservationists) felt their participation was useless.

Funding issues were ignored. Legislation creating the Commission omitted all mention of a financial plan for its functioning. Nor was it suggested that the main water users should pay for millions of cubic meters of water used for power generation.

Importance to IWRM

The Arenal project was created with an IWRM vision, with multiple productive uses of water, and related important environmental and natural resource conservation. However, unforeseen legal, institutional and economic outcomes mean that the project's potential as an IWRM star has yet to be realized. This may yet happen; the Government is promoting sustainable development, and its growing tourism industry, as well as encouraging protected areas. In this environment, the few large stakeholders simply have too much to lose if they do not engage the smaller interested parties.

Main Tools Used

- B1.4 River Basin Organisations
- B2.1 Participatory capacity and empowerment in civil society
- C2.1 Basin management plans
- C5.3 Consensus Building

MAIN TEXT

1 Background and Problems

The Arenal reservoir was created to provide energy and irrigation. The 8,300 ha artificial lake, with a storage capacity of over 2,400 M cubic meters, can supply 25% of the nation's electricity demand, and irrigate some 30,000 ha, about 77% of the total area of Costa Rica under irrigation.

The construction of the dam and irrigation structures was financed by an Inter-American Development Bank (IDB) loan of \$ 575 million. Environmental studies carried out since inception suggested the importance of protecting the watershed and its forests. As a result, the Ministry of the Environment (MINAE) became involved in the project. It expanded the Arenal National Park and others parks in the catchment and irrigation areas; these areas were merged into a single "Conservation Area"¹ in the 1990s.

The project has had a large social payoff, but some groups have benefited more than others. The whole country benefits from emissions-free and economical hydroelectricity. However, the environmental outcomes have been mixed. On the one hand there were the negative disruptions, caused by construction of the dam and irrigation project. On the other, the project attracted the attention of government authorities, and particularly MINAE, who has done a good job at protecting the forests and introducing a vision of sustainable development.

Institutions

At the national level both the Instituto de Acueductos y Alcantarillados (IAYA), responsible for urban water supply, and the Instituto Costarricense de Electricidad (ICE), which produces hydro-electricity, have the most influence and rights over water resources. SENARA is the organisation that manages irrigation projects. MINAE have a wide, environmental role, overseeing the development of the country's forest and biodiversity resources, including national parks and other protected areas. ARESEP is a regulating body in charge of setting prices and tariffs for gasoline, electricity and water; since its creation, MINAE and its Water Department have had additional powers over the nation's water resources.

Of the institutions operating in Arenal, ICE has had by far the largest impact in the way water is managed. SENARA, as manager of the irrigation project has been a strong actor, along with MINAE.

- **Instituto Costarricense de Electricidad - ICE.** It dominates national energy production, with strong rights over the development of hydroelectric projects and associated water resources. It has the largest influence and impact in the region. ICE selected the area as one of three potential large sites (for multi-year regulation) in the country and undertook extensive hydrological research as early as 1950. As a result, there is extensive and detailed hydrological information for the watershed.
- **SENARA** is the government agency that runs the Arenal Irrigation District. The agency has less national prominence than ICE, a limited budget and is relatively new. The district is its largest project. It manages water allocation within the district and the development of infrastructure.
- The **Ministry of Environment and Energy (MINAE)** has the lead role in the prevention of deforestation, and leads management of the Arenal watershed forests. The Ministry's mandate has grown steadily to cover conservation and sustainable development in general, and they now work in both protection and extension. Concerning both the energy and the environmental sectors, MINAE quickly recognised the importance of Arenal and started to direct resources to the area; they attracted funds from the Canadian government and WWF-Canada to help prepare the Arenal Watershed Management and Development Plan.

MINAE's role has been strengthened by two large Costa Rican NGOs that protect more than 15,000 ha of forests in the south eastern part of the watershed. La Liga Conservacionista de Monteverde (Liga) and the Tropical Science Center have been able to direct national and foreign resources to the protection of these natural forests, easing pressure on their resources.

As noted, the main institutions have tended to work independently of each other. Lately, efforts have been made to co-ordinate actions and reduce tension between institutional stakeholders. While it functioned, the Commission enabled contact among representatives of all interested parties, providing a forum for dialogue, and creating an awareness of the need for an integrated approach.

Increasing water use conflicts

Both the Arenal energy and irrigation projects need water from the Lake. Conflict over use is not about quantity -- flow from the dam is about 100 m³/sec – but about when the water is needed. Both projects need more water in the dry season, although daily and seasonal requirements are not exactly the same for both. Also in the dry season, important wetlands could benefit from additional water to maintain a reasonable water cover, to service among other things, migratory birds as they travel across the country. Additional distributional conflicts have recently arisen. For example, rice farmers need the water during a critical period on the wet season, at the same time as managers seek to fill the Lake to save water for the next dry season. Some irrigators have specific demands at certain times of the day. But most distribution valves are operated manually and that restricts the ability to distribute water to different parts of the system.

Lack of payment for water services

Both ICE and SENARA have the right to use the water without payment. However, since ICE uses the water first, and has the first and legal right to it, SENARA has little influence over when and how much water is released. Water is released to satisfy the peak demand for electricity, affecting the way in which water can be used for irrigation. For instance, the capacity to open and close the floodgates to distribute the water (all locks and floodgates must be operated manually in the site) is currently a limiting factor. A significant portion of the water is actually unavailable to farmers. Lack of co-ordination has resulted in less-than-efficient uses of water and reduced the opportunity to find win-win alternatives.

Furthermore, cultural, economic and political factors do not allow the full recovery of costs associated with irrigation. Farmers regard water as free, especially since it has already once been used for electricity. They ignore the fact that land with irrigation sells for as much as \$4,000 per hectare, compared with about \$400 without it (Echeverria et al 1995). They also overlook the need to finance the many operational costs involved in keeping SENARA working and improving and maintaining the infrastructure.

The economic value of water has only very recently been recognized at the national level. According to Castro and Barrantes (1998) each cubic meter of water used to generate hydroelectricity saves the country between \$0.01 and \$0.04 in terms of the thermal production costs avoided. They cite Reynolds (1997) who estimated that 6,863 cubic hectometres were used in 1996 to generate 3,240 Giga Watt hour. (GW-h) or 0.47 kW-h per cubic meter

Pollution from agricultural run-off

Lately, non-governmental organizations (NGOs) have drawn attention to the new, and hitherto unrecognized problem of water pollution from agricultural runoff. As the intensity of agricultural activities has increased, so have the discharges of pesticides and fertilizers into water bodies that supply the Palo Verde National Park. Groups such as the Organization for Tropical Studies are working to protect lowland ecosystems, including wetlands that are considered vulnerable to increases in agricultural land.

Several organizations (including SENARA and the University of Costa Rica) are devising ways to reduce pollution and find environmentally friendly technologies. As long as the economy is expanding and a sectoral approach to management is used, the conflict between conservation and production will continue.

These emerging water conflicts should give stakeholders enough reason to move towards a more integrated approach to water resources management.

2. Actions Taken

Legislation

Law 449 (1949) is only one of a large body of legislation that affects water and watersheds in Costa Rica. This is the law that created ICE, making it the country's leading energy sector institution, and exempting it from the need for concessions to use water for hydroelectric purposes. The same principle holds true for the IAYA regarding water for urban consumption. SENARA, on the other hand, needs a water concession from MINAE's Water Department to operate its irrigation districts. And, according to the "Tariff for Irrigation bylaw" the tariff charged to water users should cover investment and operation costs, maintenance, administration, conservation and the financial costs of running an irrigation system (Aguilar et al 1998).

In 1996 the Ministry of Energy and Environment (MINAE), through the Arenal Conservation Area, and with support from the Canadian Government, WWF-Canada and the Inter-American Development Bank (IDB) developed the Arenal Lake Watershed Management and Development Plan (Plan de Manejo y Desarrollo de la Cuenca Laguna Arenal). To implement this plan, the "Commission for the Implementation of the Development and Management Plan of the Arenal Reservoir Watershed" was created by Executive Decree in 1997. It was seen as a temporary entity, until a Watershed Agency, proposed in the Plan, could be instituted. The Commission consisted of representatives from MINAE, ICE, SENARA, IAYA, the Foundation for the Development of the Arenal Conservation Area, and a local catholic priest.

The spirit behind the Commission was clearly cross sectoral, seeking to bring together different key stakeholders. However, the legislation was flawed by the absence of producers' groups or local development associations and the omission of allocation of funding to keep the Commission functioning. Also missing were the identification of mechanisms for discussion such as public forums where all parties could come together.

Environmental surveys, issues and actions

As early as 1973, during the planning stages of the dam, an ecological survey was prepared by the Centro Científico Tropical, which was followed in 1980 by a comprehensive compendium of potential ecological impacts and mitigation measures for the hydroelectric project. Although this was a commendable consideration of the environment, the emphasis was largely on impacts in the upper watershed, without much consideration for downstream effect. The focus of the 1980 survey was on land use change and its relation to the sedimentation, and thus the lifespan of Lake Arenal.

In the mid 1990s the CCT and the Centro Internacional de Política Económica (CINPE) of Heredia, Costa Rica started a three-year investigation under the Collaborative Research Environmental Economics and Development (CREED) program, financed by the Dutch Government and executed jointly between the International Institute for Environment and Development (IIED) and the Free University of Amsterdam. The investigation looked at existing incentives to engage in different land use. It found that, contrary to popular belief and government policies, the optimal land use, considering income, production, erosion, sedimentation and changes in water flows, was a mixture of pasture for milk and forests that capture horizontal precipitation in the upper parts of the watershed.

Despite this report, both MINAE and ICE continued promoted reforestation with exotic species across the board, without consideration of the policy's economic implications, still fearing that excessive erosion would drastically reduce the storage capacity of the lake. However, according to Aylward et al (1998) who reviewed this issue in detail, most of these fears were unfounded: sedimentation appeared to have little effect on the live and dead storage capacity of the dam. Work by Echeverria et al (2000) questioned the wisdom of these reforestation projects.

This issue illustrates that interventions in the watershed by the major stakeholders were often based on erroneous assumptions.

Another key issue in Arenal concerns the effect of land use on water quantity, distribution and quality, but to date this potentially contentious issue has not been explored.

3. Outcomes

The following summarizes outcomes noted in previous sections:

- Separately, hydroelectricity and irrigation performance outcomes have been good. Not only is the Arenal Lake the only reservoir capable of multi-year regulation but it also supplies almost a third of the country's total electricity demand. "The reliability and robustness of the interconnected system depends on Arenal" says Carlos Obregon, ICE's Executive President. At the same time, using the water that has already generated electricity, SENARA has been able to double the productive capacity of more than 25,000 hectares by allowing production in the dry season. Even though irrigation efficiency is still very low, and there are no economic incentives to use less water, current production is generating additional income to hundreds of producers.
- From an integrated perspective, however, performance has been less than satisfactory. There has been little coordination between agencies and local stakeholders, environmental concerns have not received adequate considerations and the economic value of water is still not recognized. The establishment of the Commission was a good step towards integrating objectives and decision-making.
- MINAE directed much of its effort to the protection and conservation of forests in the 40,000+ ha Arenal catchment. However, its Plan was more of a zoning scheme than an integrated development proposal. It has been criticized as relying too much on technical information and being biased towards forest conservation, taking little regard for the objectives of other interest groups.
- The conservation of natural ecosystems ought to be an integral part of any integrated approach to water management. In Arenal there has been a complete separation between the use of the water for hydroelectricity and irrigation and the needs of important biological sanctuaries. In some environmental issues, MINAE has carried out many important activities, especially providing protection to the Palo Verde National Park and wetlands. However, in terms of coordinating and considering for example releasing small amounts of water off peak to supply these ecosystems during critical times, little has been done. People still consider that water given to maintain and manage natural ecosystems has no economic value, thus giving it the last and lowest priority in terms of water allocation.

With a view to achieving "sustainable development", MINAE, ICE and SENARA, all working independently of each other, generated bits and pieces of what could be considered a process towards integrated basin management in Arenal. But each organization and institution sought to further its own agenda, with no group looking at the whole, big picture. Recently, water has become scarcer because more land is under irrigation and there have been dryer-than-normal years. This has heightened awareness of the need for an integrated

approach to water management, which in turn has led to different institutions initiative dialogue towards coordinated work efforts.

Environmentally the project has produced both benefits and costs. The renewable source of energy avoids emission of greenhouse gases. However nutrient and pesticide pollution from the irrigation project is affecting sensitive freshwater ecosystems in the Palo Verde National Park. Erratic water flows resulting from the periodic peak time demand for electricity affect nature in uncertain ways. Worries about increased sedimentation of the watershed that were raised in the 1990s have, after careful examination, been dismissed, and it is expected that the lake will be effective for a few hundred years at least.

Some more specific outcomes are outlined in the following sections.

Legal and institutional outcomes

- The law establishing the Commission provided a framework for IWRM, but neither named nor provided a source of funds for its operations. Nor did the legislation provide for allocation of investment funds or coordination of activities.
- Within their own mandates and scope, the Arenal institutions have performed well. ICE has done very well to develop the backbone of the nation's electric grid, and is operating it very efficiently. SENARA with a limited budget has constructed the largest irrigation project in the country and continues to improve efficiency and provide many services to its customers. However they have operated in isolation from the rest of the system.

Stakeholder Participation

- Because of the dominance (underlined by legislation) of ICE, and, to a lesser extent, SENERA, other, smaller groups have had little motivation to participate. Nor did the legislation provide any incentives for consultation with other stakeholders, although post-implementation there have been improvements in this regard.
- One partially successful example of participation processes can be cited. MINAE and the Canadian Cooperation Agency produced the Land Use Plan that led to formation of the Commission. Unfortunately, this process is stalled right now for lack of funding, or interest from stakeholders. An executive decree without any financial appropriations was destined to be short-lived. Furthermore, the limited power and resources of the Commission made it a weak actor between strong users who lobby in the basin.
- The first stages of the development of the lake Arenal basin have not motivated the participation of local communities in the decision making process. Cattle ranchers, for instance, were somewhat hostile to MINAE and its Plan. Other local groups felt that decisions were imposed from the Capital in a strictly top down approach; in the last few years, however, local participation seems to be increasing.

Economic, pricing and financing outcomes

- Recognition of the economic value of water resources is one of four principles of IWRM. In Arenal, and indeed throughout Costa Rica, however, this value has not so far been recognized. Water is basically free for both ICE and SENARA and the only costs usually considered are distribution and operation costs. Thus, there is no incentive to make an efficient, coordinated use of water resources. Watershed protection activities are under-funded because pricing schemes do not consider its benefits.
- For a variety of technological and cultural reasons volumetric pricing was not established at the beginning of the irrigation project. Therefore, users make no effort to increase the efficiency at which water is used. Farming practices, especially in rice, require enormous quantities of water and the distribution system desperately needs new investments in new technology. As a result, water users currently pay according to the amount of land that

they irrigate, not the amount of water they use. This is in effect rewarding the most inefficient producers, hampering new investments in the system and reducing the capacity to recover costs. According to personnel from SENARA, moving to a volumetric pricing system is now a mid-term goal.

- The inability to collect the true costs of supplying water from farmers reduces the capacity to run the system in an integrated way. For example, there is equipment such as automatic valves and floodgates that could quickly make the system much more efficient. However, SENARA can barely keep on running with existing equipment, let alone make investments in durable items.
- Then there is the issue of crop choice. When the irrigation project was originally evaluated it assumed a combination of high-yield, high-price non-traditional produce such as flowers, tropical hardwoods and fruits. However, market distortions and protectionist policies have resulted in sugar cane and rice being the main crops planted there. These are commodities with very low margins, further reducing the capacity, and willingness, of farmers to pay the true price of water. This has rendered the original feasibility study and its conclusions useless, and shows that the projected benefits were over estimated. However, persuading farmers to change cropping patterns will be complex, involving a mix of cultural, economic and social issues
- One outcome was unplanned. Planners did not anticipate the land speculation that resulted from introduction of the project. Squatters tried to acquire land rights, cutting the forest and planting pastures in an attempt to maximize their land holdings. They anticipated that they would be bought out by MINAE, as part of their plans to create national parks in the watershed.
- The Commission was established in part to bring different stakeholders together, however the transaction costs of organization and participation were underestimated. Failure to secure funds for the Commission can be interpreted as lack of interest from the main players involved. Nevertheless, there have been well-funded initiatives. The Costa Rica government has financed the establishment of the ACA (Area de Conservación Arenal) including payments of more than US\$11 million in land purchases for conservation. Furthermore, several local NGOs have also invested in conservation measures, including forest protection and environmental education with grant funds obtained from foreign aid agencies and NGOs. Planning and land use zoning, including the Basin Plan cost an estimated US\$1 million.
- According to Aylward et al 1998, IWRM activities carried out by ICE, SENARA and ACA are quite efficient, partly as a result of building on a range of initiatives underway in the area, lowering transaction costs. However, according to the same source, the prohibition against change in land use is economically inefficient and not well founded on economic grounds.

Water Allocation

Water is allocated mainly according to the needs of the hydroelectric plants. The Arenal system is used to regulate the interconnected system and accumulates water in the wet season to release it in the dry season. It also complements the run-of-the-stream plants during peak hours of the day. Once the water is released it is SENARA's responsibility to distribute it among the farmers.

Due to low efficiency of distribution and application systems, and the unanticipated crop selection, water use was much higher than design volume. Theory was much different than reality. In fact 100 m³/sec would suffice to irrigate up to 60,000 ha under design assumptions. Given the much higher water consumption this figure is likely to be much lower. During dry seasons, or even during the wet season when the Arenal Lake is being filled up and the run-of-the-stream plants are supplying the demand, there are water deficits

for farmers. This situation is only expected to get worse, as more area is included in the irrigation district.

Some of the people interviewed suggested the need for a hydrologic budget and an integrated decision support system to guide the allocation of water. Then, all requirements could be analyzed and water allocated according to its different uses. A non-linear approach, which recognizes the diminishing returns of scale in all the different water uses, could be very useful in this regard.

IWRM Impacts

The need for IWRM in Arenal is becoming clearer by the day. Success has been achieved in specific sectors, but efforts to integrate other issues into the decision making process, like conservation of ecosystems and other environmental concerns, have so far failed. But there is hope. The formalization of the Commission to include several different interest groups under one instance is encouraging. And, as water becomes a scarcer good, the importance of an integrated approach will be clearer to all involved. Only then will willingness to support the Commission and to adopt an integrated approach to water management increase.

4. Lessons learned and replicability

- Properly managed, water resources in Costa Rica have a large potential to generate social benefits. The Arenal Lake has allowed the country to harness water, generate power and irrigate agricultural land with a large social payoff. However, IWRM could increase these benefits, by guaranteeing the supply of water in quantity and quality. A quantitative decision support tool should prove useful in this case to optimize water allocation and explore different policy options. In Arenal, it is becoming clear that there are enormous gains to be realised through integration and co-ordination between stakeholders.
- To function properly, a basin organization (the Commission in this case) needs broad representation and a sound financial base. The organization needs to include farmer's groups, conservationists, and major water users. These main users of the water should provide, proportionally, the needed funds for such a body to operate. A per unit tax or contribution should not represent a significant amount, when divided by the millions of cubic meters of water and kilowatt-hours of electricity that are produced.
- Water resources should be priced to reflect their real value. Volumetric pricing should be encouraged to increase efficiency. Prices should allow the recovery of costs, which is indispensable for sustainable water management. When the price of water does not cover even its distribution costs, pressure starts to build up from different sides.
- Participation is difficult when one of the stakeholders is very powerful and has the legal right over water. In the Arenal case, ICE had so much influence and power, that many felt participation was useless. This has been a disincentive for others to participate.
- Conservation of important ecosystems deserves more attention and consideration in the decision making process. It would be possible to imagine a situation in which it is more important to deliver water to a preserve a natural ecosystem, than to generate electricity or deliver water to produce rice.
- A watershed management and development plan needs to be much more than a zoning map. It needs to go beyond land use and land use change and include other issues. It needs to provide real options to the people who are using the territory for their livelihood.

Replicability

This case study has lessons that might be relevant for relatively small catchments in Central America and perhaps Africa. It would also be applicable for situations when there are trade-

offs between different factors such as between land use and electricity generation or between irrigation and nature conservation.

It is also makes the case for the importance of providing for appropriate funding mechanisms whenever creating a basin commission or authority. Legislation that creates these bodies should also consider the source and the amounts necessary to run them.

5. Contacts and references

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