

Nandamojo River Action Plan (NAP)

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Mission Statement

NAP's mission is to restore the Nandamojo watershed to a drinkable standard and improve water flow by 2026 according to the World Health Organization's standards for potable water.



http://ourwatershed.org/#nandamojo_map

Background/History

The Nandamojo watershed is located on the west coast of Costa Rica at the top of the Nicoya peninsula in the province of Guanacaste. It encompasses 29,400 acres of land. The watershed is an important source of potable water for its 3,000 residents and those of nearby communities. It also provides habitat for hundreds of species of migratory birds, howler monkeys, and endangered sea turtles

Sadly the majority of the watershed has been deforested due to more cattle farming for export or for lumber. The demand from the US for cheap beef in the 1950s and 1960s caused much of the land in Guanacaste to be cleared by slash-and-burn agriculture. This is a method of farming that is a farming method that requires cutting and burning land to create grazing land for millions of beef cattle. The land is often burned illegally and the ash becomes an impermeable layer that causes runoff and erosion. Deforestation has led to major issues with erosion, water retention, and the loss of topsoil.

Climate: Defines the challenges and opportunities in this part of Costa Rica. Temperatures can climb over 100 degrees and there are two distinct seasons: wet and dry. The dry season occurs during the winter and is caused by trade winds that blow in from the Caribbean. As this air moves west across the country it loses moisture, reaching Guanacaste as a gusty dry wind that desecrates the landscape. In the spring, the trade winds shift and allow offshore weather from the Pacific to bring afternoon showers and humidity. For the next six months, rivers and lowlands areas are filled with water and the landscape is filled with plants. This is known as a “tropical dry forest” and it supports a unique ecosystem of flora and fauna (Restoring our Watershed).

Policies and Programs

Currently, the Nandamojo River has been under review by PAHO, the Pan American Health Organization, which monitors countries in Latin America such as Costa Rica where Nandamojo is located. Since 2000, this organization has been enforcing the Millenium Development goals. These goals were created in effort to promote basic human rights such as the rights of each person on the planet to health, education, shelter, and security. Goal number seven specifically is the most benefit to the river. This goal says we must Ensure Environmental Sustainability, which for this case means everyone should have the right to access safe drinking water and basic sanitation because this is so important for sustaining health. Since the Millenium Development goals were created, PAHO has been enforcing this by creating objectives to look into. The main objectives were to explore community perceptions regarding the impact of

improved water and sanitation sources on human health and the environment, to determine if improved drinking water and sanitation are safe for consumption and use in the Nandamojo watershed; and to explore community perceptions on recreational water use and contamination of recreational water sources.

Next, an US based non-profit called Restoring Our Watershed, or ROW has been working in the Nandamojo River Valley of Guanacaste, Costa Rica, for more than 10 years. ROW's strategy involves advocating for sustainable land use, bees for microfinancing, creating strong counterparts and watershed education. Row brought together community members and businesses to create the Nandamojo Valley Chamber of Commerce which aimed to protect the health of the watershed. The chamber has three main goals which include Attracting more visitors by promoting the area as a peaceful, family-oriented and authentic destination, uniting the community around a sustainable vision for the future and coordinating efforts to make that vision a reality and supporting initiatives that strengthen the community and protect the environment. An example of these goals in action was in 2017 when a Riparian Corridor Project was launched thanks to the Guanacaste Community Fund. This project was created to renew critical riparian forests along 13 kilometers of the Nandamojo's main channel stretching from the estuary to the community of Rio Seco. With help from a few local stakeholders such as *The Freshwater Trust* and *Drones Guanacaste*, the corridor's current vegetation was mapped, as was thermal uplift, land tenure and priority reforestation areas. *El Centro Verde* created a list of species in the area and designed model plantings. This gave a huge baseline for the area to determine the state of the environment, and how to move forward with policies and regulations. Another effort done by ROW was creating the "bees for trees" program. This program encourages farmers to partake in sustainable business opportunities that can provide an income to their family. ROW provides micro loans to these farmers to buy beekeeping equipment. In return, the farmers reforest their land, which is crucial for the health of the watershed.

Costa Rica also has an Ecological Blue Flag Program which is a nation-wide effort to incentivize working to protect water resources. Costa Rica has Blue flag program's popping up throughout the country to protect watersheds, beaches, communities, schools etc. The program requires submitting plans/reports and having them evaluated by the National Blue flag organization. Flags are rewarded for successful work, and the government tests water quality. This is a great national effort to implement regulations for watershed health.

Finally Costa Rica passed a water act in 2014. Their previous water act was from 1942 that did not follow modern watershed management methods. The new law is based on current integrated water resource management principles. The 1942 Water Law was mainly focused on surface water, leaving groundwater out so this act includes groundwater and provides an updated framework for water sanitation.

Problem	Description	Cause
P1. Low water levels	Without the protective benefits of vegetation, soil becomes eroded and blocks surface pores contributing to surface crusts that restrict the water movement into the soil.	The water table is low due to erosion and poor agricultural practices causing low infiltration
P2. Erosion	A once fertile valley is now dry and lifeless due to soil build up in the river which can no longer support seasonal fluctuations in rain.	Extensive cattle grazing around the river has degraded much of the topsoil and vegetation leaving it unfertile and lacking plants for absorption.
P3. Fecal Coliforms in Water	Septic tanks, leaching into water supply	<ul style="list-style-type: none"> ● Poor Construction ● Poor management and lack of testing. ● Depleted water table

Problem 1: Low water levels

The majority of the watershed has been deforested due to more cattle farming for export or for lumber. This has led to major issues with erosion, water retention, and the loss of topsoil. This directly impacts the water levels of the Nandamojo river. This has a negative impact on the community’s access to freshwater for drinking and agriculture, economic benefits of the water (both tourism and fishing), and biodiversity. The Forest plays a crucial role in the hydrologic regime of watersheds. Deforestation decreases evapotranspiration which replenishes clouds and helps produce rainfall. The decline in rainfall is causing the seasons between rain to become longer and hotter and many rivers including the Nandamojo began to dry up for part of the year. Nearby communities are struggling through the dry season with little available water. deforestation also decreases the infiltration to groundwater. The water table falls due to the erosion taking away the ground’s ability to absorb water. Without the protective benefits of the vegetation, the soil becomes eroded and blocks surface pores contributing to surface crusts that restrict the water movement into the soil. This leads to a decrease in groundwater recharge, which is important especially during drought periods. Low stream and river flow also can significantly increase water pollution by concentrating pollutants like bacteria and excess nutrients in lower volumes of water. There are many causes of this low water flow. First erosion

and poor agricultural practices caused low infiltration of water in the water table. This leads to runoff and no replenishment of groundwater (Watershed Action Alliance).

Goals: NAP's goal is to have water flow year-round. In order to do this infiltration should be increased and trees should be replanted to produce more tree cover to reduce evaporation. Some great management strategies to improve soil inflation include: reduced tillage and using cover crops. Reducing tillage helps reduce the surface crusting and enhancing the amount of rainfall absorbed by the soil. It requires less intensity, shallower depth, and less disturbed land. To do this farmers should use less impactful farming equipment. Cover cropping is a technique that uses plants to cover the soil rather than for the purpose of being harvested. This method is successful in increasing infiltration by covering the ground with their biomass and improving soil structure with strong roots. Using rotation cropping with high-residue and perennial crops produce the best methods. Great high-residue crops include corn and small grain. Great perennial crops include grass and alfalfa. Alfalfa has deep roots which will leave channels for improved infiltration. Reforestation is a great way to produce more tree cover to reduce evaporation. Reforestation is the replanting of existing forests that have been depleted from deforestation and clearcutting. Restoring Our Watershed has set out to help watershed landowners plant trees by providing them with free saplings. In addition, rainwater retention and recycling could be beneficial (Watershed Action Alliance).

Problem 2: Erosion

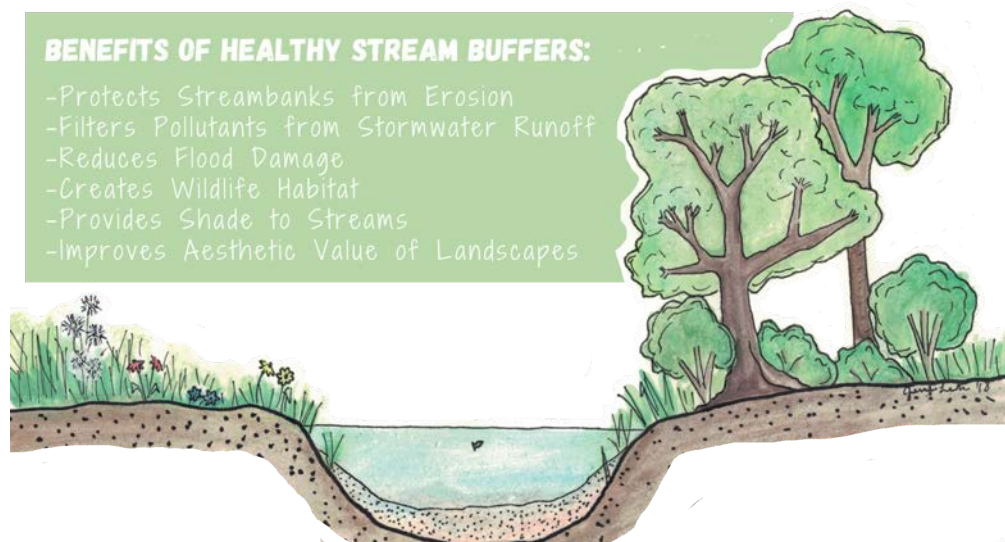
Due to deforestation in the Guanacaste region, erosion has increased significantly. On top of that, using this land for cattle grazing had detrimental effects on the local ecosystem. In the past, this region was a self-sufficient agricultural community. Now that the forests have been cleared, the area is much hotter and drier. With the addition of large open pastures, heavy clay soil from the nearby hills washes down and obstructs the valley. This causes there to be an impermeable layer of topsoil which traps the native, nutrient-rich soil underneath (Esquivel, 2019). This phenomenon also prevents the recharge of aquifers and rivers. In addition, exotic grasses were planted on the pastures to provide food for the cows, however they contributed nothing to replenishing mineral content of the lands and soils. Recently, the land has become so nutrient-depleted that cattle production is very low. Erosion and dry soil make it impossible to support plants which makes it extremely difficult for carbon sequestration by plants to take place.

The eroded soil particles can be carried by stormwater to surface water. This will increase the turbidity of the water body (Murphy). Turbidity is not a health concern in itself, but the measured particles provide attachment places for microorganisms and metals. According to the USEPA, turbidity can also promote the re-growth of pathogens in the distribution system. In addition, erosion carries nutrients, especially from poor agricultural and livestock practices, that can poorly impact the river and stream habitats. Nitrogen pollution can lead to eutrophication and

dead zones. Nitrates can also have multiple negative impacts on health such as making it difficult for aquatic insects and fish to survive.

Goals: To combat erosion, NAP encourages local farmers to participate in sustainable agriculture through methods such as intercropping. Intercropping with native plants would be very beneficial to the land. It is evident that fertilizers and pesticides should not be used in the area because this will only exacerbate the problem. Intercropping would create an area of land that more closely resembles a natural environment. This will preserve soil quality and replenish some nutrients. Plants would be strategically selected so they could provide benefits to the plants growing near them. Also, NAP encourages the use of permaculture in the area surrounding the Nandamojo river. Permaculture in this area would allow local farmers to make a profit while keeping their farming practices more sustainable. Instead of cattle grazing, farmers could incorporate chickens into their permaculture farms. Chickens have less of an impact on the environment, and take up much less land. Animals and native plants that do less damage must be incorporated into the landscape.

Another strategy proposed by NAP is to create river buffers to prevent erosion. Buffers are areas of vegetated land right near bodies of water. The trees and plants placed here dig roots into the soil which keep it compact and in place. This prevents sedimentation from occurring in the river. NAP believes this would benefit the Nandamojo river because it will prevent pile up in the river, and will intercept non-point source pollutants from entering the waterways. This new forest along the river will also provide a new habitat for many of the species that were relocated due to the pasture clearing. ROW is an organization that includes many people in the community, but it's led by U.S. ecologists Tom Peiffer and Matt Rosensteele, Costa Rican Marcia Gómez and Italian Alberto Pistorello. Since 2015, they have been offering plants to reforest the 15 meters that should be respected along riverbanks. They also help them plant them and provide money (\$0,15 per square meter) so they can enclose the reforested zone and cattle don't destroy it. If we can expand this program that would be ideal (Esquivel).



Problem 3: Fecal Coliforms in Water

Even though there has been some improvements to water quality in Costa Rica (septic systems and piped water from wells), the country still faces challenges. For the most part, it is unknown whether the water quality of household drinking water meets Costa Rican or World Health Organization (WHO) water quality standards. It is also unclear whether septic systems within these communities are properly constructed to prevent overflow or leaching of human waste into the environment. One recent study by McKnight shows that septic systems in the Nadamojo watershed are not fully preventing bacteria from getting into the watershed. Results from the second study revealed 57% of household samples had total coliform bacteria above the Costa Rican standard for safe drinking water exceeding the single standard limit of zero, while 61% failed the World Health Organization standard for fecal coliforms exceeding the single standard limit of zero.

This is important for many reasons. First this bacterial pollution is a threat to human health in the area and has an estimated economic loss of around twelve billion dollars per year. In addition, this is a concern because it comes from nonpoint sources. Thus, it is harder to address. Health-based water monitoring is often used as a tool for assessing this risk. In Costa Rica, recreational water sampling is conducted at coastal beach areas only, neglecting other surface waters used by residents and tourists. Community perspectives regarding recreational water use and the associated risks are limited. Understanding these perspectives will enable public health professionals to better target community needs, such as education and to address the concerns of participating communities.

Goals: The goals of NAP should include providing better definitions for water quality, water quantity, proper construction and containment of storage tanks, and oversight and maintenance of these systems. Collaboration between scientists, researchers, policy makers, water committees, health providers, and community members is needed in order to design and implement strategies in water resource management and proper waste management. Communities and water committees would also be best served if they worked together with government agencies to conduct regular testing of both recreational water and drinking water, especially since both of them target many of the same parameters (McKnight). Once data is collected, problematic septic systems can be identified and fixed.

Summary and Conclusions

Goal	Recommended Strategy	Outcome
Improve water flow year round	Reforestation Sustainable agriculture	<ul style="list-style-type: none"> ● Improve soil structure and water infiltration ● River will flow year round
Reduce erosion and improve habitat/water quality	Sustainable agricultural practices (intercropping, crop residues) Riparian buffers	<ul style="list-style-type: none"> ● Erosion reduced, reduce turbidity and nitrogen pollution ● Healthier stream
Reduce pollution of fecal coliforms	Better definitions for water quality, more water testing, improvements to septic system	<ul style="list-style-type: none"> ● Improved water quality ● Safe drinking water ● Long term improvement to disposal of waste water in a developing nation

The Nandamojo River Basin is a vital part of Costa Rica. It provides water, food, and vast economic benefit. Clean water is a basic human right. The Nandamojo Action Plan's goals focus on addressing some of the main problems with a watershed approach that directly involves the community and world water standards.

If the Nandamojo can restore year round water flow and water quality, not only will quality of life improve, it will open up the region to opportunities of economic growth. Many parts of Costa Rica have benefited from ecotourism. A study published in the journal of the National Academy of Sciences reveals that ecotourism has improved the quality of life of Costa Ricans living in areas close to parks and protected areas by 16% (Staff 2014). There are many opportunities for growth and strong collaboration in the area will help lead the Nandamojo community there.

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