Community Resource Management in a Tropical Watershed—A Case Study*

by Doracie B. Zoleta

Using a community watershed as the basis for managing and developing natural resources skirts some of the pitfalls of piecemeal development.

Upland and watershed areas have long been seen as reserves for growing populations and as development frontiers. As a result, in many tropical countries, the exploitation is destabilizing watershed-production systems. In the Philippines, one million hectares of watershed is now degraded. Inland fisheries are subjected to overfishing, agricultural run-off, mine tailings, and industrial and municipal waste pollution. In turn, these resource-use pressures have led to excessive soil loss, flooding, the drying up of tributaries, eutrophication, fish kills, sedimentation, species extinction, and the subsequent loss of income.

Most responses to such problems have been technical, piecemeal, and fragmented. Usually, a fragmented approach reflects a lack of understanding of how system components or adjoining ecosystems function and interrelate. Fortunately, the watershed is a sound unit for dealing with resource management problems, as the case of the Buhi watershed in Buhi, Camarines Sur, Philippines illustrates.

THE BUHI WATERSHED—A SKETCH

The 10,935-hectare Buhi watershed, which drains into the 1,800-hectare Lake Buhi, is the source of irrigation for more than 8,000 hectares of agricultural lands.

This essay is the winning entrant in WRI's 2nd annual student essay competition.

Lake Buhi and Its Watershed

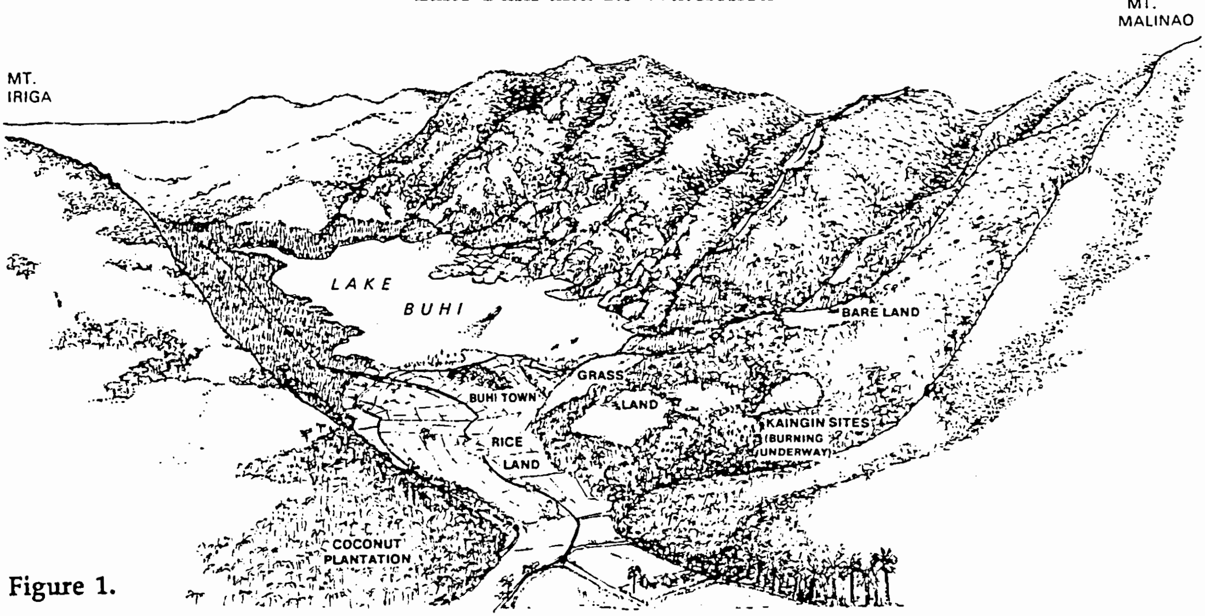


Figure 1.

The watershed also meets the domestic and agricultural water needs of more than 10,000 families outside of Buhi. (See Figure 1.) Buhi's 53,462 residents depend on the watershed for survival.

Some of the resource-use practices employed by the growing population have destabilized the watershed. Illegal logging, permanent *kaingin* practices (sedentary slash-and-burn agriculture), tree cutting for fuelwood, and lack of reforestation have caused serious denudation of the upland Buhi watershed. Today, most of the watershed's sloping areas are now bare and unprotected, and annual soil losses amount to hundreds of metric tons per hectare in the steep cultivated lands. The Lake Buhi ecosystem is also deteriorating. Damming the lake outlet, introducing exotic fish species (such as *Tilapia nilotica* and *mossambica),* motorizing the traditional fishing technology, and building up the new fishing industry have affected lake conditions. And, while the lake's sediment content is as high as 500 parts per million (ppm), lake vegetation is being destroyed by the motorized pushnet technology. Overall, the lake's production is dwindling. Even the survival of the world's smallest commercial fish—*Mistichthys luzonensis* Smith—is at stake.

Buhi's population—most of which depends on the watershed for a living—is growing fast. From 1903 to 1985, it rose from 9,692 to 53,462. In 1985, the urban population was 11,904 (most of whom live in upland *barangays*, or villages) while the rural populace numbered 41,558. The annual population growth rate is 1.99; with 59 percent below 19 years of age. While Buhi is an out-migration area in general, migration to the upland areas from the lowland areas is increasing. By the year 2000, some 71,054 people are expected to populate the watershed, so demands upon the natural systems will continue to increase rapidly.

Poverty in Buhi is growing acute. In only twelve upland *barangays* in the area, some 1,200 cases of second - and third - degree and 1,000 of first-degree malnutrition were reported among 3,200 children. Perhaps because of this resource-related poverty, sympathy for the revolutionary New People's Army is increasing.

HOW UPLAND USE AFFECTS UPLAND RESOURCES

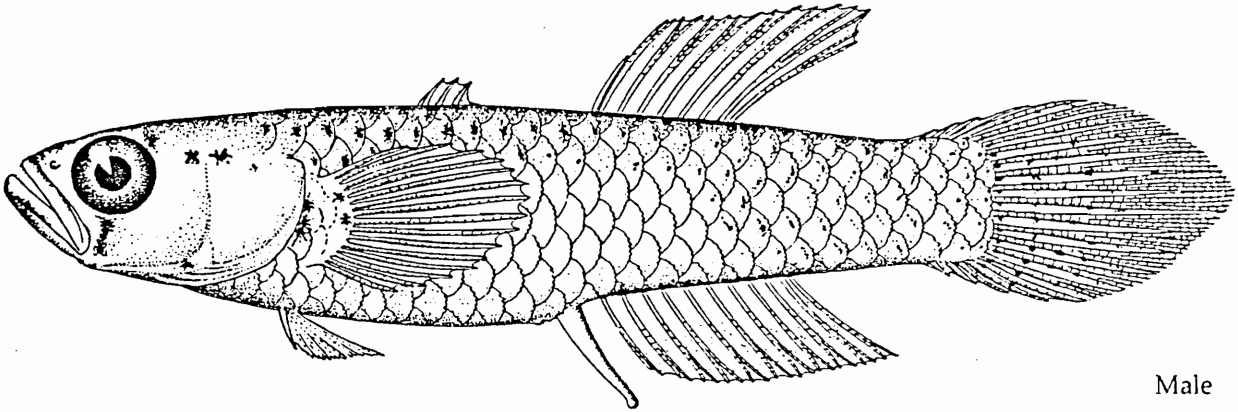
Over the years, slash-and-burn agriculture on slopes of 45 degrees and more have, along with heavy downward log-hauling traffic, disturbed the Buhi watershed. The soil's erodibility, the land's slope characteristics, frequent heavy rains, usurious interest rates, increasing dependence on cash crops, poor ground cover, increased demand for fuel, and population increases have only exacerbated these problems.

Gradual continued erosion is among the most serious effects of land abuse. Estimates of soil loss in the Buhi area range from 1.2 to 10.1 metric tons per hectare per year on the area's better covered lands to more than a hundred and possibly up to several hundred metric tons per hectare per year in the most denuded and disturbed areas.

Aside from sheet erosion, logging operations have created logging path gullies of from one centimeter to five meters deep. (Half the foot trails once used to haul logs are now impassable.) Erosion also undercuts crop production.

HOW UPLAND USE AFFECTS LAKE RESOURCES

The amount of soil lost to erosion in the Buhi watershed is staggering. A sediment sample taken by the Philippine's Forest Research Institute at the lake's major tributaries after an 18-mm rain in 1980 revealed a sediment content of at


Male

Mistichthys luzonensis Smith
Artist: A.H. Baldwin of the U.S. Fish Commission
Source: Division of Fishes, National Museum of Natural History, Smithsonian Institution

least 500 parts per million (ppm). By conservative estimates, 13 metric tons of soil per hectare per year (or 162,155 tons in all) enter the lake—enough to raise the lake bottom by one millimeter per year. If the estimated average is 26 metric tons of soil/ha/yr, as fishermen in the area claim it is, the bottom will rise by two millimeters per year.

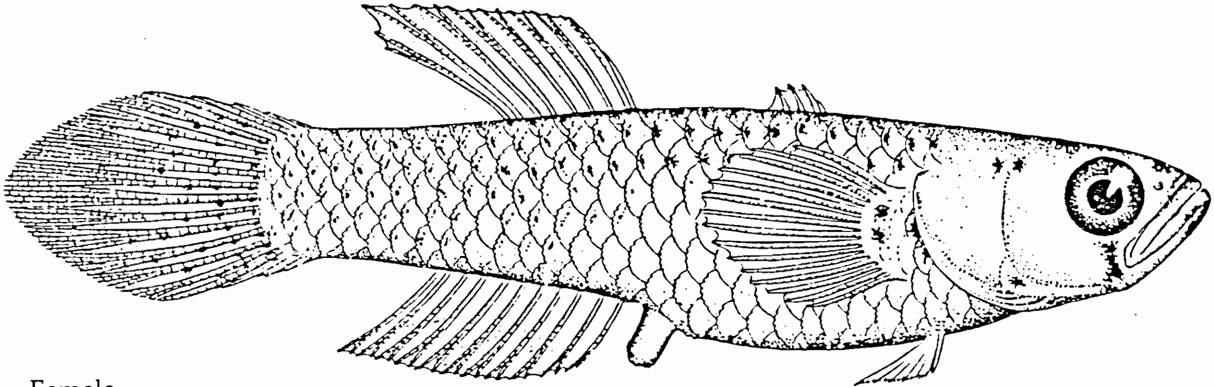
Among the other noticeable changes in the lake is increasing turbidity. According to Zafaralla *et al.* (1983),

> *By November 1982, light penetrated down to 100 cm and in May the next year, 40 cm. This declining trend is attributed to the enhanced growth of autotrophic algae. Growth enhancement is, in turn, attributed to increasing enrichment of the lake arising from the combined effects of the growth of* [the use of] *fish cages, the occurrence of an unusually prolonged summer, and the growth of agriculture in the outlying areas of the sample sites.*

HOW LAKE USE AFFECTS LAKE RESOURCES

The overuse and misuse of resources have changed Lake Buhi. Damming the lake in 1956 kept at least five species of migratory fish out forever. Constructing a bigger control structure in 1983 now appears to have precipitated sulfur upwellings that have killed fish, especially those trapped in fish corrals and cages. The maximum drawdown of water by the control structure to irrigate the Rinconada Area during the dry months reduced the lake's littoral region, crimping fish-cage production and depleting the lake environment's oxygen.

Introducing species, particularly *tilapia* in 1956, has also caused problems. The



Female

Mistichthys luzonensis Smith

hardest-hit species has been *sinarapan* or *tabios (M. luzonensis*). According to local fishermen, when the *tilapia* population was booming, the *sinarapan* population declined. *Tilapia* competes with *sinarapan* for phytoplanktons and also eats *sinarapan*. Even so, the *sinarapan* population would still be great but for motorized pushnets *(sakag)*. Using fine mesh nets and dragging the bamboo support structure back and forth uproot the aquatic vegetation (*Vallisnera sp.)* in which *sinarapan* and other fish lay eggs and hide from predators. In turn, dislodged vegetation and upwelled mud increase water turbidity and reduce light penetration, so production falls significantly. Motorized pushnets, which catch about 100 kilograms of *sinarapan* in one operation, are also the vehicles of overharvesting: the *sinarapan* population has sunk to a level from which recovery may be impossible.

Sinarapan is important to most of the fishing community. Once it was also the cheapest and most readily available protein for the majority of fishermen, who cannot afford to install *tilapia* fish farms. Considering that fish-farm construction requires at least P1,050.00 (U.S. $114.00) as initial capital, depletion of the *sinarapan* fishery comes as a hard blow to subsistence fishermen, who earn an average of P19.00 per day (U.S. $1.36).

As *sinarapan* populations decline, populations of *irin-irin (Vaimosa dispar)** and freshwater shrimp *(Macrobrachium sp)* grow. At present, *irin-irin*—a small goby that ranges in length from 20 to 30 mm—and this shrimp are the most common fish (aside from *tilapia*) available in the town market. The explanation lies in the food chain. *Sinarapan* and *irin-irin* have the same food base—phytoplankton. But,

**Generic placement of this species is under review.*

unlike *sinarapan*, *irin-irin* can protect itself from possible predators: the male has a big mouth in which the eggs are protected for the three-day incubation.

Another observed change in the lake is the thickening water-hyacinth population. These plants can be marketed, but if they are allowed to rot in the lake, their decomposition consumes great amounts of oxygen that other aquatic and fishery resources need.

HOW LAKE USE AFFECTS UPLAND RESOURCES

To supplement their very meager earnings, most fishermen have other sources of income. Some gather fuelwood. Others ferry logs from the *barangays* across to the town proper. Still others cut trees. Some plant rice in low-lying lands near the lake. Many who do not own lands establish *kaingin* sites in the uplands to plant camote (a root crop), corn, and other crops. All these activities exert pressure on upland resources. Today, slopes of 30 percent and more are cleared and planted with corn, camote, and cassava.

Fishing itself contributes indirectly to deforestation. The 1,050 fish cages, fish pens, and more than 150 fish corrals in Lake Buhi are supported by bamboo and wooden poles that must be changed annually. An average corral requires 40 to 200 bamboo or wooden poles, a fish cage uses four to eight poles, and a fish-pen normally requires thousands. In all, some 14,520 to 20,000 poles are needed annually—enough to deplete the watershed's wood resources unless trees are planted continuously.

ACTIONS TO DATE

To halt forest destruction, the Buhi watershed has been closed to logging concessions and operations. This ban, however, has not been well implemented. Indeed, log hauling is still a common sight.

A somewhat more successful effort to protect the forests has been a joint project undertaken by the Philippine's Bureau of Forest Development and U.S. AID to develop the upland area. This project, the Buhi-Lalo Upland Development Pilot Project, involves many farmers in reforestation schemes and in training programs conducted by the University of the Philippines at Los Banos' Program on Environmental Science and Management. Unfortunately, however, initial successes were short-lived. Among other problems, some subsistence upland cultivators and laborers who helped construct graded trails were not paid the promised compensation. Twice, disgruntled farmers set fire to one of the major training centers. The third time, the facility burned.

Attempts to replenish stocks of *sinarapan* also failed. In 1976, people started worrying about the disappearance of the *tabios* population. Local authorities petitioned the Bureau of Fisheries and Aquatic Resources (BFAR), the Ministry of Natural Resources (MNR), and even the Office of the President of the Philippines to ban *sinarapan* collection and motorized pushnets in the area. Unfortunately, it took two years for the BFAR and the MNR to approve the bans. By then, the *sinarapan* had all but disappeared.

THE WATERSHED—ELEMENTS OF COMMUNITY RESOURCE MANAGEMENT AND DEVELOPMENT

1. An appraisal of the resource endowments and limitations of the watershed.
2. An analysis of human population dynamics.
3. An appraisal and analysis of local people's uses of and demands on the watershed.
4. An appraisal and analysis of outside groups' demands on the lake and the watershed.
5. An analysis of the conflicting demands and uses of the watershed dwellers and outside groups and the identification of ways to deal with them or to reach compromises.
6. An appraisal, analysis, and ranking of the problems besetting the area.
7. An analysis of the possible impacts of these problems on the watershed and the lake over time.
8. An appraisal and ranking of possible solutions that could solve the area's problems.
9. A thorough understanding of the legal, institutional, social, economic, political, and cultural scenarios in the watershed.
10. An assessment of the potentials or prospects for developing the lake and watershed.
11. An appraisal of feasible practical programs and activities that could complement each other.
12. An appraisal of local people's and other resource users' willingness to cooperate and affect changes in the watershed.
13. An appraisal of local government's efforts and willingness to initiate, cooperate, and bring about constructive changes.
14. An appraisal of the influences of regional and national policy-makers and the identification of ways to maximize these efforts through cooperation.
15. An appraisal of the benefits and possible problems that would result if the watershed and lake resources were developed.

TOWARD MORE EFFECTIVE ACTION

Numerous laws, rules, guidelines, and regulations have been set and promulgated both locally and nationally in the Philippines to deal with resource problems. But conflicting political and economic interests have made it difficult to execute them, and even their potential effectiveness is open to question given current economic conditions. An approach that may work better is to increase community awareness of present conditions and, more important, of current activities' probable impacts on the next generation. With a better understanding of their resource problems, people can collectively solve them and pressure offending individuals and groups to abandon environmentally unsound activities in favor of alternative income-generating projects that help rehabilitate the physical resource base. At the same time, local residents can be organized to pressure the government to regularly and systematically monitor environmental and socio-economic conditions.

Perhaps the best use of funds in the Buhi area is for implementing projects to augment local people's income and enhance the food supply. Worthwhile projects include agroforestry, home gardens, fruit and forest tree plantations, long-term leases of forest land to the local people, and cooperative fish farming. It might also make sense to create a group that would market the produce of subsistence farmers and fishermen.

Buhi's problems can be dealt with more effectively if the whole watershed is managed as one development unit and analyzed as a single functioning system. Experience has shown that the extraction, transformation, and utilization of natural resources are intimately linked with the human population's social, economic, cultural, and institutional characteristics. A comprehensive approach dealing with the systemic characteristics of Buhi watershed and the lake could be the only practical way of resolving resource-management issues there. (See box.)

The community watershed is the appropriate focus for managing and developing a watershed's limited land and water resources. This approach utilizes the combined efforts, resources, and time of the area's people, government, and concerned public and private sectors. It aims to restore degraded watershed sites and maintain the system's productivity and sustainability, develop and harness watershed resource potentials, or some combination of these. The ultimate goal is to keep the system's capacity for resource production adequate and to improve the lives of those who depend directly on the system for survival.

In Buhi, development programs have so far been designed to solve only a single problem in the uplands or a single problem in the aquatic areas. Yet, the watershed and the lake resources have great potential for development if they are viewed as interconnected and interacting components of a whole productive system. If the two adjoining ecosystems were seen as one large system, resource management and development would be more workable and effective.

Other ways to better manage development include the more efficient handling of development funds, efforts to demonstrate possible development benefits to local people so as to garner their confidence and participation, and project arrangements whereby local authorities are empowered to act on local problems involving local resources, especially in resource-protection schemes. More generally, a comprehensive, focussed, and pragmatic approach to intricate resource problems is a necessity.

As Buhi's case makes clear, the resource conditions in a production system can best be improved through three mechanisms. First is an inventory of the resource system's capabilities. Second is an understanding of the area's limitations and development prospects and of the interrelations among the resource users' growth, needs, and techniques and the socio-economic and institutional settings over time. Third, the combined efforts of people, government, and other concerned groups are essential. Without all three, a pragmatic resource development program won't become a reality.

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