Watershed Data from the Grassroots...Is it enough to Capture the Trends *and* Turn the Tide?[1]

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ABSTRACT

The "Water Resource Management and Education" work plan of the SANREM/Southeast Asia program was designed to facilitate the development of community-based water monitoring teams who could collect credible data on a regular basis and thus understand watershed trends. The community now has multi-year trend data on such things as bacteriological concentrations in rivers and drinking water supplies, stream discharge and sediment yield estimates. Thousands of samples collected by volunteers have provided a large amount of water information that would not otherwise be available because of limited assessments made by governmental or private agencies. The monitors are aware of what their information implies and they are influencing policy and community action in the Manupali River watershed and beyond. This paper will focus on the cost-effectiveness, reliability and value of community-based monitoring programs when they are implemented in technically sound and participatory ways.

INTRODUCTION

The “Water Resource Management and Education” work plan was one of the first in the SANREM CRSP’s southeast Asia regional program and has served as a model for implementation in the Andean region and other parts of the world. During the initial assessment of the Philippine study site, called the Participatory Landscape/Lifescape Appraisal, changes in water quality and quantity were among the more prominent concerns of the local community and governmental units. Particular water-related problems included erosion and sedimentation, drinking water quality and waterborne disease, and an increase in flooding and drought. In response, a partnership of U.S. and local universities, international and local NGOs and the local community developed an approach of participatory research to address these concerns.

Natural resource management for sustainable development requires an understanding of a complex mix of biophysical processes, community values and political realities. In the case of this work plan, these three components may guide us to ask, 1) What are the conditions and trends of the water resources in Lantapan, Philippines?, 2) What is the best "quality of life" mix of economic activity and conservation of rivers and springs? and 3) What should researchers, NGOs and the government do to implement a practical watershed management plan?

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The essence of this work plan was to facilitate the development of community-based water monitoring teams who could collect credible data on a regular basis and thus understand and make wise decisions regarding watershed trends and management plans. Citizen input in watershed data collection served two important purposes. It provided a large amount of water information that would not otherwise be available because of limited assessments made by governmental or private agencies. Secondly, it built a cadre of concerned and equipped citizens who began to think on watershed and landscape scales about the quality of their environment and what that meant for their futures.

Because virtually all of the watershed data of this work plan was collected by citizen volunteers, it would be reasonable to question the scientific reliability of the information. Even if such data could be verified as credible, the process by which the information impacts community perceptions, natural resource management and environmental conditions also needs to be explored. This paper thus has two objectives: to make a case for the accuracy and usefulness of community-based water data in capturing trends, and to document how the data have "turned the tide" by affecting the community and natural resource management plan.

METHODOLOGIES

The "Water Resource Management and Education" work plan of the SANREM/Southeast Asia program is currently a partnership of Auburn University, Heifer Project International/Philippines, the Tigbantay Wahig, Inc. people's organization of Lantapan, Bukidnon and Central Mindanao University. The ecosystem under investigation is the 36,000 ha, Manupali River watershed in central Bukidnon Province of the southern island of Mindanao. The northern, larger portion of the watershed, where most program activity has taken place, is in the Municipality of Lantapan. Elevations range from 2,900 m at the top of Mt. Kitanglad in a national park, to about 300 m in the lowlands where the Manupali River flows into the larger Pulangi River. The population of Lantapan is about 40,000 and is made up a diverse mix of ethnic groups.

A series of workshops and field exercises have been conducted since 1994 to train interested community groups in the evaluation of water quality and quantity using portable test kits and other basic analytical tools. Many of the methods used were modeled after those developed in Alabama Water Watch, a citizen volunteer, water quality monitoring program involving about 70 community groups that is now underway in the U.S. (Deutsch et al., 1998). Most of the chemical and bacteriological analyses were made using colorimetric techniques so that no electronic equipment was necessary. Filipino partners of the project who were educators and community developers helped customize the workshops and sampling techniques to the local situation. A full description of methodologies for each parameter is presented in Deutsch et al. (2001a).

The project researchers and water monitors selected 16 sampling sites on four main tributaries of the Manupali River (Figure 1). Sites were chosen that were generally accessible and representative of the diverse portions of the overall landscape, including subwatersheds of varying degrees of forest cover, agricultural land and population. In recent years, sampling has been restricted to one site on each of the four tributaries, just upstream of the main road bridge crossing.

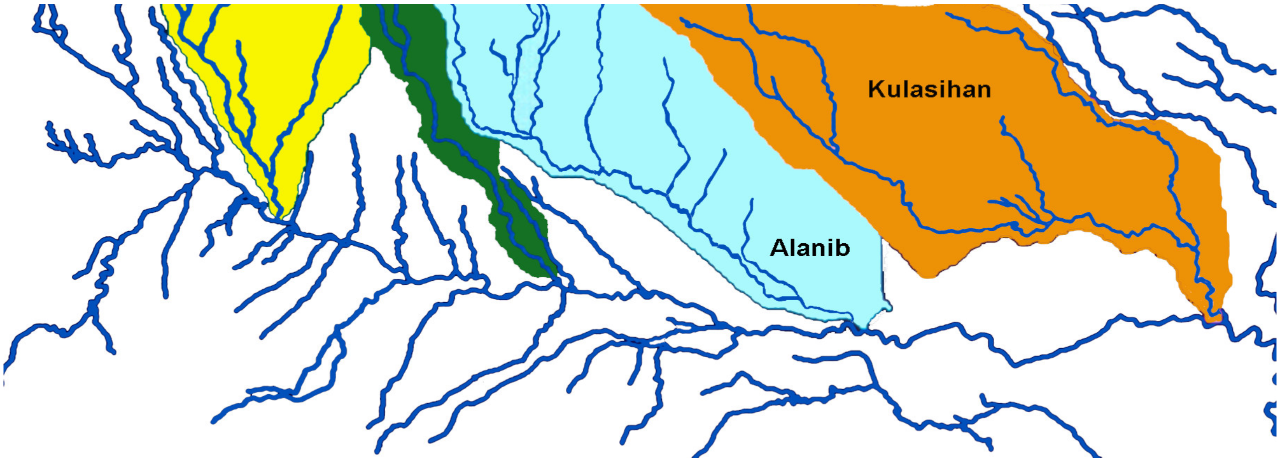


Figure 1. The four main subwatersheds of the Manupali River in Lantapan, Bukidnon, Philippines.

Community volunteers who attended workshops and began monitoring water primarily included farmers, teachers, members of certain women's organizations and some members of the local government unit. In 1995, some of the volunteer monitors created a people's organization called the Tigbantay Wahig, Inc., and they have remained the focal point for data collection and action in Lantapan (Deutsch and Orprecio, 2000; Deutsch et al., 2001b.)

Quality assurance (QA) protocols were established at several levels to ensure the reliability of community-based data. This was especially important because most monitors have relatively little formal education or technical background. The "micro" level QA protocols included 1) side-by-side comparisons of monitor techniques with Standard Methods developed for professional laboratories, 2) careful attention to training and practice by each monitor and 3) regular maintenance of the test kits and supplies. The "macro" level QA protocols included an evaluation of multi-year citizen data with research or agency data on a watershed scale. Laboratory and watershed-level evaluations were done for the Alabama Water Watch program in the U.S. before techniques were used in the Philippines. Monitor training and test kit maintenance protocols have been applied in the Philippines.

One of the goals of the training and monitoring efforts was to develop and test specific water quality indicators that were appropriate for natural resource management by community volunteers and the local government unit. The following criteria were established for each indicator:

1. scientifically valid methods, for credible qualitative and quantitative information,

2. relevant to the community, for their endorsement and participation in data collection, and

3. practical and relatively inexpensive, for sustainable use and applications using locally available materials.

Out of many possible indicators explored or considered, a selected list of variables emerged as the ones best meeting the criteria (Table 1). Some important and relevant variables such as pesticide concentrations have not been addressed to date because of logistical or cost considerations.

Table 1. Summary of Community-based, Water Quality Indicators.

Issue/Problem	Indicator	Unit of Measure
General Environmental Degradation	Community Perceptions, Memories, Experiences	Anecdotal, or Questionnaires/Surveys
Soil Erosion	Suspended Soils in Water	mg/L TSS
	Instantaneous Sediment Yield	kg/s/ha
Disrupted Stream Flow	Specific Discharge	L/s/ha (monthly measurement)
	Flow Variability	coefficient of variation (comparisons: time, space)
Bacterial Contamination	Coliform Concentration	no. colonies/mL of water **(*E. coli* and other coliforms)**

RESULTS AND DISCUSSION

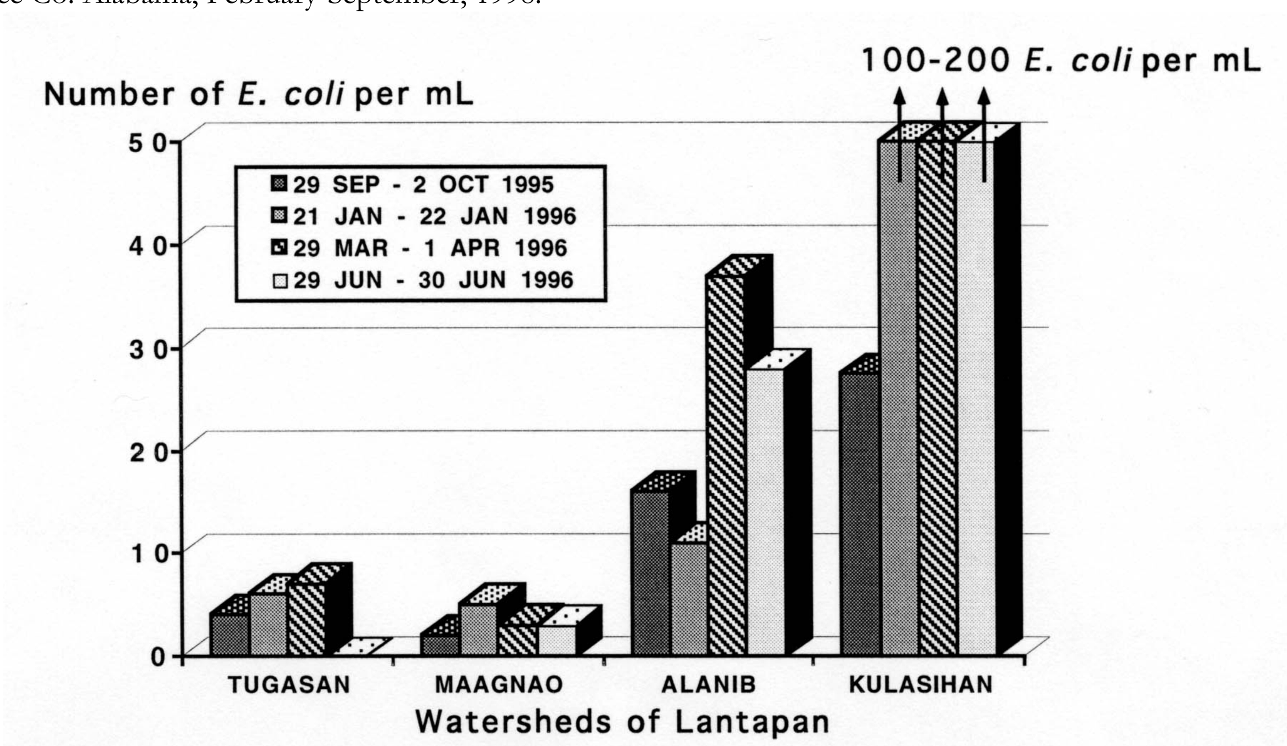
After almost eight years of continuous water monitoring by the Tigbantay Wahig citizen group, an extensive database has been developed. This has allowed an assessment of how well the data seem to capture important watershed trends and how the trend information is used by the community and local government.

Can Community-based Data Capture Watershed Trends?

Data Reliability: Example of Bacteriological Surveys

Bacteriological surveys of streams and drinking water supplies of Lantapan were made using a relatively new technique (Deutsch and Busby, 1999) that quantifies concentrations of *E. coli* and other coliform bacteria. Field and laboratory studies conducted at Auburn University which compared the monitors' method (Coliscan Easygel) with Standard Methods indicated close correlations of results (Figure 2). This information, along with a detailed documentation of other QA protocols, resulted in approval of the methods by the U.S. Environmental Protection Agency (Deutsch and Busby, 1999).

Figure 2. A comparison of Coliscan Easygel methods with Standard Methods for the analysis of water for *E.coli* and other coliform bacteria. Based on concurrent samples collected in Saugahatchee Creek, Lee Co. Alabama, February-September, 1998.



The bacteriological survey techniques for citizen monitors were first implemented in the Philippines and later used among community groups that were part of Alabama Water Watch. The results of four surveys of the four subwatersheds of the Manupali River in Lantapan (Figure 3) revealed two things that supported data reliability. The first was an east-to-west pattern of water quality degradation among the subwatersheds that correlated with prior perceptions of the community and researchers. Much greater human and livestock densities in the eastern subwatersheds with resulting fecal contamination of surface water was generally expected. However, quantification of these levels of contamination, which enabled comparisons of conditions with World Health Organization standards, was a critically important advance in understanding watershed trends.

Figure 3. Concentrations of *E. coli* bacteria (number of colonies per 100 mL) in subwatersheds of Lantapan, Bukidnon, 1995-96 (average of 2-3 replicates per site per survey).

A second factor which supported data reliability was the general consistency of results at each site across seasons and years. Although there was not opportunity to compare the community data with those obtained from Standard Methods (as was done in the U.S.), four surveys over a nine month period indicated the same, basic condition of each stream. In sum, using tested and approved methods and finding consistent patterns that generally concurred with other sources of information all support the claim of data reliability.

Data Location and Frequency: Example of Stream Discharge and Sediment Yield

Even if the community-based data are accurate, there is a question as to whether or not the information is collected at representative sites and in great enough frequency to determine watershed trends. The data obtained from monitoring total suspended solids (TSS), stream current velocity and cross-sectional area suggested that there were strengths and weaknesses in sampling location and frequency used by the community monitors.

Multi-year measurements of TSS and other stream variables were normalized by subwatershed area to estimate sediment yield and specific discharge (Figure 4). These data seem to have been collected frequently enough and at representative sites to elucidate watershed trends in four significant ways:

1. A pattern of increasing TSS from west to east across the Manupali River watershed was very similar to that obtained by bacteriological monitoring. This substantiated a general pattern of degradation that was positively correlated with population densities and land use.

2. The more forested watersheds had more consistent stream flows as indicated by coefficients of variation in discharge measurements (Table2). The resiliency of forested watersheds to drought was dramatically demonstrated during the El Niño phenomenon of 1997-98, when the Kulasihan River had no surface flow for six months while the Maagnao River had a constant flow.

3. The specific discharge (normalized by subwatershed area) of the forested subwatersheds was greater than the less forested subwatersheds (Table 2). This observation calls for further observations and raises researchable questions. More detailed information on water withdraws and subsurface flows would be needed to confirm that the forested watersheds of Lantapan actually do yield more water than watersheds that have been largely cleared. The opposite observation was made in southern Africa, for example, where extensive plantings of exotic trees in a semi-arid region reduced stream flow.

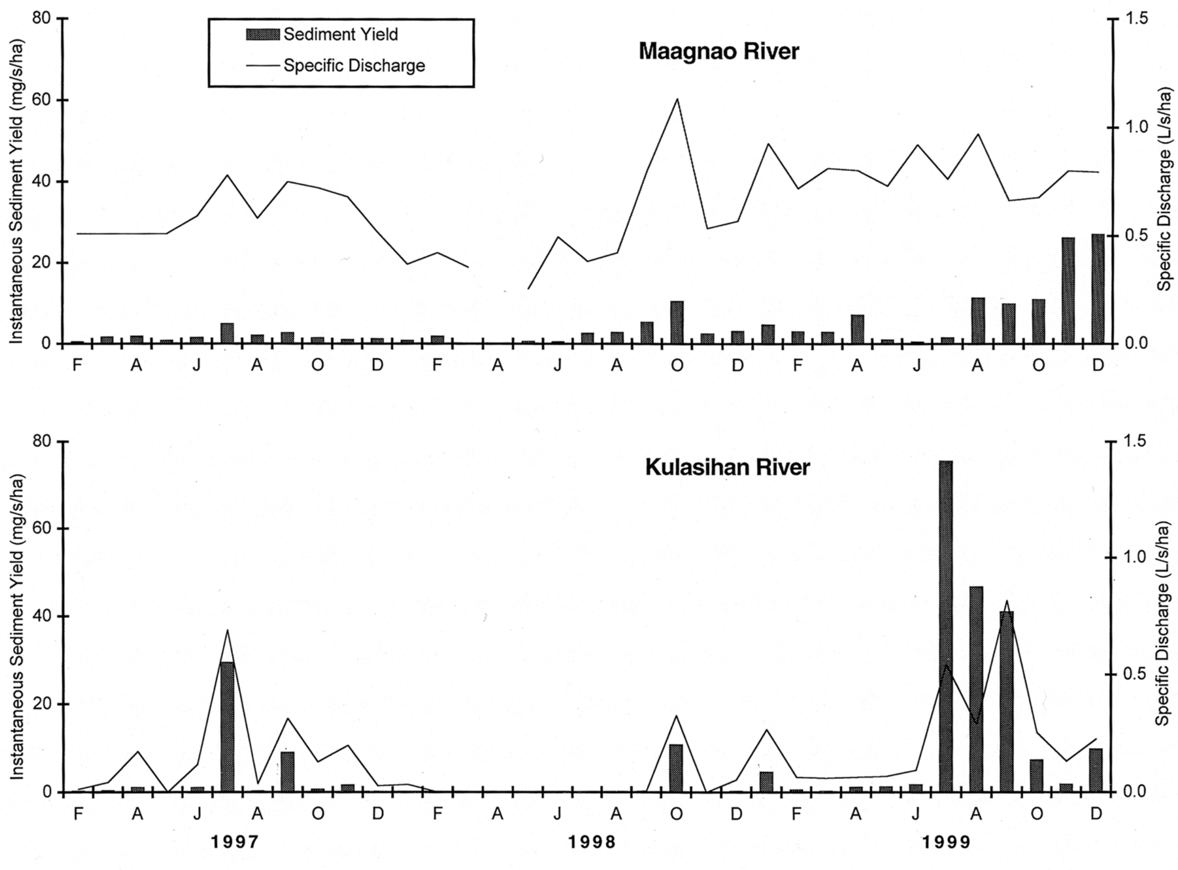
4. The TSS and sediment yield data suggest that degradation is occurring in all four subwatersheds. For example, maximum sediment yield in the Maagnao subwatershed in 1999 was similar to that found in the Kulasihan subwatershed in 1997 (Figure 4).

Table 2. Watershed area, average specific discharge (measured monthly on the same day), February 1997- December 1999), range and coefficient of variation (CV as %) of four tributaries of the Manupali River.

Stream	Watershed Area (ha)	Average Discharge and Range (L/s/ha)	CV
Tugasan	5,024	0.30 (0.04-0.64)	51
Maagnao	2,397	0.65 (0.26-1.14)	31
Alanib	7,513	0.13 (0.01-0.31)	60
Kulasihan	10,042	0.14 (0.00-0.82)	138

Although the stream flow and TSS data have probably captured important watershed trends, there were also limitations of both the location and frequency of sampling. Sampling at only one site on each stream made it impossible to determine more specific subwatershed characteristics, such as "hot spots" of erosion. Low sampling frequency (monthly, base flow) certainly missed significant rainfall events that resulted in peak TSS and stream flow. The estimated sediment yield in even the degraded, Kulasihan subwatershed (Figure 4) was considerably lower than estimates derived from more frequent sampling of upland watershed in Indonesia (Dr L.A. Bruijnzeel, Free University of the Netherlands, personal communication, September 2001).

Figure 4. Specific discharge and sediment yield estimates of the Maagnao and Kulasihan River subwatersheds, 1997-99.



What Information is Needed for Managing Natural Resources?

The above analysis of the reliability and usefulness of community-based data was primarily from the scientific or technical perspective. To the degree that land use decisions are made with scientific information, the monitoring program of the Tigbantay Wahig seems to have provided a significant amount of useful data. Scientific information must be processed through cultural values and local politics, however, before any resource management decision by a farmer or governmental unit "touches the ground."

Natural resource managers and policy-makers must integrate scientific data into other important aspects of community life and usually favor clear evidence that is conducive to making practical decisions. In the experience of working with community-based water monitoring in Alabama and the Philippines, a key element in people acting on data is a personal perception that the environment is getting better or getting worse. The remaining part of the paper will provide brief examples of how community data was perceived to be valuable and how it is being used to "turn the tide" and impact policy. This may also be thought of as the process by which locally-derived, scientific information blended with local norms to affect environmental action strategies.

Can Community-based Data "Turn the Tide?"

Community mobilization

The training workshops in water monitoring emphasized "hands-on" field experience and allowed local people to view their environment in new ways. They became the "scientists" and gained personal confidence in their ability to collect important data. With technical support by the SANREM-funded universities and the organizational support of the NGO partner, the Tigbantay Wahig defined their mission and volunteered thousands of hours to systematically assess their watershed.

Initially, there was some skepticism that busy, rural people with virtually no technical background would have the interest to join a monitoring team. Now, eight years of consistent monitoring is a tribute to their commitment, community service and positive outlook that they can make a positive difference in their quality of life. Water monitoring played a major role in mobilizing the group and recruiting others to join the Tigbantay Wahig.

Community credibility and recognized stakeholders

After about two years of monitoring, enough data was gathered to begin to describe watershed trends and drinking water quality. Regular meetings at the Barangay and Municipal levels began to raise awareness of the work of the Tigbantay Wahig, and they gradually earned a place among stakeholders for environmental protection. A significant step was the appointment of the President of the Tigbantay Wahig to the Natural Resource Management Council of Lantapan, and subsequent invitations to describe the group's activities and data to scores of groups at provincial, regional, national and international levels.

Public awareness and environmental education

The water monitoring results made their way into the community and classrooms by way of public displays, teacher training workshops and classroom visits by Tigbantay Wahig members. An environmental education work plan of SANREM facilitated this in 1995-97 but has since been discontinued. The work plan had resulted in contacts with the district and national authorities in the Ministry of Education, with support from these offices to promote environmental education using local data.

Local ordinances and policy

The development of a Municipal-level, Natural Resource Management Plan for Lantapan began in earnest in 1997, and incorporated elements of community-based water monitoring. A stated goal of the local governmental unit was to establish water monitoring teams at each of the 16 barangays of the municipality.

More recently, the Tigbantay Wahig members and NGO partners met with governmental officials and representatives of other community sectors to present a data set that indicated probable degradation of water quality in all subwatersheds over the last few years (Figure 4, etc.). The quantitative data of the monitors was taken seriously by the group and was also substantiated by others' observations about deforestation and development along streams. One observer noted that the audience was "stunned" by the Tigbantay Wahig's evidence that surface water was being degraded in even the more pristine, western subwatersheds. Some weeks after that meeting, a SANREM colleague from the University of the Philippines, Los Baños said that the Municipal Mayor was a "changed man," with greater focus on protecting the natural resources of Lantapan.

A Memorandum Order was issued to all Barangay Captains to initiate a streambank restoration project under the Lantapan Watershed Management Council (see below). A prominent member of the Tigbantay Wahig and associate of HPI was designated to oversee the planting of 2,100 bamboo seedlings to protect the riparian zone and reduce erosion. The Council is currently considering the expansion of the riparian zone from 20 to 40 meters as a Municipal ordinance. Such a riparian zone would be larger than most that are created by ordinance in the U.S. and would probably provide significantly more protection for streams.

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October 17, 2001

MEMORANDUM ORDER NO. 2001-99

TO: All Barangay Captains

Pursuant to Executive Order No. 2001-05 creating the Lantapan Watershed Management Council and in order to effectively preserve and protect Alanib, Maagnao, Manupali and Kulasihan rivers and its tributaries, we are implementing a "Giant Bamboo Planting Project" for the purpose of planting the "giant bamboo trees" along the respective territories. This giant bamboo tree planting project shall be coordinated by the LGU through the Lantapan Watershed Management council and the Heifer Project International (HPI) - Tigbantay Wahig.

To initially start with the project, the Protected Area Management Board (PAMB) has donated 2,100 giant bamboo seedlings to be used for that purpose.

In view thereof, we are delivering each of you 160 seedlings to be planted in the main river banks passing through your respective barangays. Mr. Jhonie Sumampong of Hefier Project Intrnational-Tigbantay Wahig will coordinate and make arrangements with regards to the planting of the giant bamboo seedlings in your barangay.

Kindly acknowledge the receipt of 160 seedlings to be used for the above stated purpose. It is requested that the said seedlings be planted immediately in order to avoid damage to the seedlings.

Signed: Atty. Narciso Rubio, Municipal Mayor

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Clearly, the data and work of the Tigbantay Wahig are being used to design and implement policy. The success of the monitoring group in positively influencing their community and environment has come after several years of data collecting and participating in local meetings. Recent growth, recognition and involvement in local politics suggests that the Tigbantay Wahig is becoming an autonomous group that will outlive the SANREM project.

Model and inspiration for spread

Through HPI networks and other NGO and governmental contacts, the Tigbantay Wahig have hosted many visits and study tours of other groups interested in community-based water monitoring. A brief description of key examples follows.

1. Sarangani Province, southern Mindanao. Through initial visits to Lantapan by representatives of the International Institute for Rural Reconstruction (IIRR) and the Provincial Government, training workshops have been conducted by Auburn University and HPI/Philippines in the Municipality of Maitum. The governmental units provided resources to purchase water test kits. A second round of training was conducted in October 2001, with the addition of the bacteriological parameter.

2. Bohol Province in the Visayas. Through HPI contacts with the Provincial Governor, requests were made for training in water monitoring. A team from Auburn University and HPI visited with local officials in May 2001, followed by a study tour of Lantapan by representatives from Bohol. Initial workshops were conducted in September and a follow-up workshop in TSS monitoring is scheduled for December 2001.

3. Asia/South Pacific Region of HPI. A study tour and water quality/quantity training workshop for HPI country directors from Thailand, Indonesia, Cambodia, Vietnam, China, Nepal, Mexico, Poland and Zambia was conducted by HPI/Philippines and Auburn University in October 1999. A water monitoring workshop was conducted by Auburn University and HPI/Philippines in Chengdu, China in May 2000, hosted by HPI/China. A second round of training for field personnel and water monitoring coordinators from the Asia/South Pacific Region of HPI was conducted in Lantapan in October 2001 and China and Cambodia have requested that they host similar training workshops in early 2002.

During all of the above training sessions and in several others, Tigbantay Wahig members were key in local arrangements, demonstrations and training. Their expertise as trainers is growing along with their database, and they are becoming important resource persons for extending the community-based approach to other regions of the Philippines and throughout Asia.

As a result of strong interest in community-based water monitoring and current projects in Alabama, the Philippines, Ecuador and Brasil, a network of groups is being loosely organized under a new, Global Water Watch program centered at Auburn University. The network is established to maintain standardized training, sampling and quality assurance protocols, and data sharing capabilities. A Global Water Watch website is planned for 2002, with remote data entry and data processing via the internet. The monitoring groups will be supported and mentored by Auburn University, local NGOs or other agencies as mutually agreed upon.

CONCLUSIONS

Determining exactly how much information of a particular quality is required to make a complex resource management decision is probably impossible, but there are general principles that can guide these decisions. One principle is to rely on sound science and to gather as many scientific facts as possible. In many parts of the world, including Lantapan, scientific information is limited and policy-makers must make land use decisions where landscapes are rapidly degrading. The challenge is to act as quickly as possible on limited knowledge to protect and restore the environment. There are too many examples of where this sense of urgency was ignored and resulted in a virtually irreversible decline in the resource.

Community-based water monitoring programs can be a cost-effective way to gather scientifically valid data that is useful for natural resource management. Because of the low-tech methods and relatively modest sampling frequency and number of sites, the data are strongest in detecting relative changes in watershed conditions over space and time.

To maximize value and sustainability of community-based programs, monitoring methods should be carefully chosen to be inexpensive, simple, relevant to the community and reliable. In addition, a quality assurance plan should be implemented to substantiate citizen data in several aspects. Adapting monitoring programs to non-technical volunteers is challenging and has several limitations, but the amount of good data obtained from such efforts can far outweigh constraints.

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