

Managing a Watershed - A Resource Guide for Community Planners



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Introduction

A watershed is all the land area that drains down to a stream or other body of water. Your watershed is like your two hands cupped together, holding not just the water and land, but the forests, fish, plants, people and many of the resources on which your life depends. The inter-relationship of so many resources in a watershed often makes watersheds an effective and convenient method of managing resources.

The purpose of this guide is to help your community to identify your watershed and make a plan to manage its resources to help protect and improve your community. To do this will require time and cooperation. It will take time to identify the resources in your watershed, where they are, their importance, quantity, quality and how best to use and protect them. It will take cooperation between the various groups who depend on them, because not everyone will have the same level of interest in using or protecting them, or stake in the outcome of any particular element of the plan.

This Guide is basically divided into three areas. First the Guide describes how to create a Watershed Management Plan (hereinafter, “WMP”). Second, there are examples of communities who have created WMP’s and lessons from their successes and failures, or information on how to learn more about a particular WMP. The case studies reflect Green Empowerment’s emphasis on micro hydroelectric projects and their relationship to watershed management in the social, economic and/or environmental context. Managing a watershed can improve water quality, reduce sedimentation and ensure the long-term success of micro hydroelectric projects. Third, there is information on persons or organizations to contact to assist in creating or implementing your WMP or action plan involving micro hydroelectric power.

PART ONE - How to Create a Watershed Management Plan

Step 1. The Watershed Council

A. Create a Watershed Council. This is the group which will lead the community to create and implement the WMP. Speak with your community leaders. Get their ideas and suggestions. The Council should be large enough to lead the creation and implementation of the WMP, but be small enough to make decisions in a timely manner. The Council must gain the cooperation of the community. This will require the Council to work with the community leaders to educate the community on the purpose of the WMP and possible ways it can help improve or protect their lives. The Council will also need to establish a process to make decisions both within the Council and, eventually, within the community. Landcare Australia is a non-profit group which has helped Australian communities form local watershed management plans and its method has been used as a model for many other communities outside Australia. They have some nice tips on establishing and governing a Watershed Council and can be found at: www.landcareaustralia.com.au/projectlist.asp . Another review of a community's experience and suggestions is found at: Organizing for local level watershed management: Lessons from Rio Cabuyal Watershed, Columbia. AGREN Paper 65. London: Agricultural Research and Extension Network.

B. Identify the Interest or Stake-Holders. The Council should make a list of the various groups, public and private, who have an interest in the watershed's resources. This list should also include downstream or upstream communities and government agencies who regulate particular resources in the watershed. The case studies reveal that identifying and including ALL the interest or stakeholders is necessary for a successful WMP. Keep in mind how to make sure each stakeholder has a clear incentive to help the WMP succeed and consider how each stakeholder will have some share of the costs of making the WMP succeed. A useful text is: Manual for identifying stakeholders when doing watershed management. CIAT Publication No. 316. Cali, Colombia: International Center for Tropical Agriculture.

C. Identify Who Can Help. The Council should then determine who in their community is willing to work with the Council to first create, and later implement, the WMP. The more people-hours which can be contributed, the more detailed the WMP can be and the more effort can be invested in implementing the WMP.

D. Delegate the Work. The Council should divide the work to create the WMP. If sufficient interest is generated within the community during the creation phase, additional help may be available as the WMP is implemented and monitored.

Step 2. Resource Inventory Maps

The Council will want to have an accurate knowledge of what resources they have in their watershed, their quantity, quality, uses and any special issues related to them. Maps are a convenient way of collecting, visualizing and communicating this information. The maps should be sufficiently detailed to convey an assessment of the quantity and quality of the various resources. The Council can then use the mapping and inventory data to make better informed management decisions. If a computer is available, Geographic Information Systems (GIS) is a computerized method which allows decision makers to use the data to forecast benefits or drawbacks from various proposed management decisions. (GIS modeling and tutorial information can be found on the internet: www.gis.com)

A. Create a Border Map of your watershed. As the name suggests, the Border Map outlines the watershed. Putting the Map on a computer allows the greatest flexibility. If a computer is not available, the Border Map (and the following Maps discussed below) can be put on clear plastic acetate and overlaid with the other resource maps as desired.

The better your map, the more you can rely on the information it gives you. Recent large scale (1:5,000 up to 1:20,000) aerial photographs of your watershed would be ideal, assuming your watershed is less than 10,000 acres. True color aerial photos at the appropriate scale make a reliable and easy-to-use map of waterways, vegetation types, landforms, roads, human population centers. In the 1980's and 1990's, the government of India mapped many of its country's watersheds at 1:8000 scale to facilitate community management of its watersheds. There are many examples of WMP's created in India using these large scale aerial photos, and how various communities have solved problems related to WMP's creation and implementation. For example, the mapping of 12 sq. km Kundapallam watershed of Nilgiris district of India is at:

www.gisdevelopment.net/application/nrm/water/watershed/watws0007.htm or a review of India's extensive efforts in watershed development was researched by John Kerr, Michigan State University, email: jkerr@msu.edu. Another suggested text is: Photoanalysis of Land Uses. Photographic analysis of land use tendencies in hillsides. Guide 3 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management." CIAT, Cali, Colombia

Aerial photos (in a useable scale) of your watershed may already exist. Some government's have begun taking large scale aerial photos for many uses, including land management, defense, and resource management. You should speak with government agencies to see if they have the photos you need. You might also ask non-governmental organization's (NGO's) or some other private group or person who has had a recent interest in your area. If you still cannot get photos after trying these sources, you should consider whether you have or can obtain the necessary funds to have them made.

If you cannot obtain aerial photos, you can create a map by surveying your watershed. The more accurate your survey, the more reliable your map. Consider the amount of time and tools you can devote to making it accurate. Global Positioning Systems (GPS) can provide an effective and relative inexpensive method of rapidly surveying your watershed. GPS is a handheld device which picks up satellite waves to identify your position on the Earth within a few meters. GPS devices can be purchased for as little as \$100. An internet cite provides further GPS information and even a tutorial on how to use it (www.trimble.com/gps/).

B. Create Resource Inventory Maps. Each resource within the watershed can be mapped on a separate sheet of clear acetate, mapped at the same scale as the original Border Map. The following maps should be considered:

1. Landforms Map
This is a map of the significant natural landforms, such as rivers, lakes, mountains, steep or flat areas and areas prone to landslides.
2. Waterways Map
This map identifies the aboveground (or significant underground) waterways. It will show where the water travels within the watershed. It should also classify the waterway channels by steepness and width (known as “channel habitat types”). This will help because various land uses impact flatter and wider waterways differently than steeper and narrower waterways. Classifying your waterways by channel habitat types can help determine where best to locate resource development, restoration and protection efforts. An example of how to create a waterways map, including the importance of channel habitat types, can be found at: www.oweb.state.or.us/publications/wa_manual99.shtml

The Waterways Map should identify the location of sources of drinking water, manmade structures such as wastewater sites, dams or wells (classified by depth), aquifers if known, pollution points, floodplains, flooding sites, micro hydroelectric plants and any other features within the channels which the community believes may be important.

The Waterways can provide an excellent indication of the quality of the entire watershed. Therefore, many communities perform a Water Quality Assessment (WQA). The WQA can be performed at various locations within the watershed and can help determine pollution or sediment sources. A baseline inventory can then be used to assess the impact of restoration, protection or exploitation of the watershed’s resources over time.

Try to identify the parameters which will best indicate your waterway’s quality.

Speak with local government or NGOs to find a water quality expert if possible. They may be able to assist you in identifying which parameters to measure, how to measure them, how to interpret the data, and how to maximize efforts to improve, protect or restore water quality. The U.S. Environmental Protection Agency provides free information on these topics, including a layman's guide to monitoring stream quality and how to measure many of the common parameters. The EPA publication is EPA-841-B-97-003, EPA, 1997. Internet: www.epa.gov/owow/watershed/wacademy/acad2000

A common WQA includes the following parameters:

- Temperature
- Dissolved Oxygen
- Phosphorus
- Nutrients
- Bacteria
- Chemical Analysis for metals and/or organics
- Turbidity (measured in nephelometric turbidity units (NPU's)
- PH (Hydrogen ion concentration)

The EPA site referenced above provides a description of the importance of each of these parameters.

Various supply houses sell equipment for measuring the various parameters. A long list of supply houses in the USA is available at <http://www.epa.gov/owow/monitoring/volunteer/stream/appendb.html> . Part 3, below, gives names and contact information for two such supply centers.

3. Land Use Map - delineate watershed by type of land use (grazing, agriculture, fuelwood, etc.). Further classification by quality or condition of site should reveal degradation levels, where restorative efforts should be concentrated, where protective efforts are warranted and perhaps where land use changes should be considered. Rapid Rural Appraisal (RRA) techniques are frequently used to inventory land uses. A nice description of RRA is provided at: www.unu.edu/unupress/food2/UIN08E/uin08e0x.htm or you may contact: John Kerr, : John Kerr, Michigan State University. Email: jkerr@msu.edu. The land use map can be further broken down into the following maps.
4. Roads Map - classified by width and road surface, consider including important stream crossings or problem washout/flooding areas.
5. Human Population Map - identify the human population center(s) and classify by population.

6. Forest Map – classified by major over or under story species and/or habitats types and some description of quantity and/or quality of site.
7. Fisheries Map - identifying important spawning grounds, fishing sites, species locations, some description of quality and/or quantity.
8. Agriculture Map – classified by crop and/or quality of site, irrigated v. dry land farming sites.
9. Grazing Map – identify the location of grazing sites, classified by animal type, quality and seasonal use.
10. Soils/Minerals Map – identify the location of important mineral or mining sites, including clays or rock for building construction and soil identification to assist in determining land use suitability. CIAT provides a guide in their text: Local Soil Quality Indicators. Participatory Method for Identifying and Classifying Local Soil Quality Indicators at Watershed Level. Guide 1 (in Spanish) of the series “Methodological instruments for decision taking in natural resource management.” CIAT, Cali, Colombia.
11. Wildlife Map – identify major or significant wildlife population centers or corridors. Wildlife, especially bird life, is commonly used as indicator of watershed quality.
12. Property Rights Map - Further delineation by property rights (for example, governmental, communal or individual, etc.) can help identify trends in degradation related to property rights, and suggest social or political changes in property rights. For example, more clearly establishing land rights among user groups was effective in remedying limitations in the implementation of numerous WMP’s, such as encouraging Indian shepherds to collectively purchase grazing rights to resolve resource conflicts (Research by : John Kerr, Michigan State University. Email: jkerr@msu.edu). The Collective Action and Property Rights (CAPRI) is an active non-governmental organization which has generated much research on property rights and their importance in establishing a management plan. CAPRI Contact: Nancy Johnson (n.johnson@cgiar.org) or Olaf Westermann (o.westermann@cgiar.org). Also helpful may be the publication of “Effects of flow of water on property rights and collective action in catchment management.” Contact: Brent Swallow, ICRAF, Nairobi, Kenya. Email: b.swallow@cgiar.org

13. Other: Consider any other significant features or resources, such as tourism sites, vegetation for specialty uses/medicinals, etc.

Step 3. Historical Conditions Assessment

It is often helpful to assess the historical conditions of the watershed. This can help determine good or bad trends, identify natural conditions causing change (e.g. periodic flooding, landslides, disease) and manmade conditions causing change (e.g. land use changes, changing intensity or use of various resources such as logging, new technologies, population shifts, introduction of new species). By acknowledging the historical conditions of the watershed, the Council can better identify and prioritize current resource issues and make a plan to improve and protect its resources.

Step 4. Issues Map

The Council can now identify and prioritize the watershed's resource issues. Compare the maps and inventory assessments, the trends, the quality, quantity and demands on the resources and discuss the same with the interest-holders. Identify the conflicts between competing resource users, identify the specific areas where resources are endangered, and consider which areas are keys to protecting, restoring or enhancing the watershed.

Step 5. Action Plan

The Council, working closely with the people who have an interest in the watershed's resources, must develop an Action Plan. The Action Plan is the culmination of the Council's and the community's prior work efforts. The Action Plan sets forth the specific activities and locations, with target dates and people involved, to either restore, improve or protect watershed resources. The Action Plan is prioritized and tempered based on the time, money, available people-power and micro/macro politics.

As you will note, there is a natural overlap of benefits from many of the activities. This is a result of the natural inter-relationships of the natural resources within the watershed. For example, erosion control can improve water quality (decreased sediment), fish habitat (improved spawning sites), community health (reduced organic or inorganic materials in drinking water) agriculture (improved soil quality and water infiltration) and reduce the cost of a road (reducing or eliminating culverts). Your community can maximize the benefits from its activities by considering how one activity can improve several conditions within the watershed, and determining the most effective time and place to implement it.

Some examples of Action Plan activities include:

1. Erosion/sediment reduction – contour tilling, terracing, micro-catchments, contour strips, buffer strips, tree/grass cover plantings, reduced or selective

fuelwood or construction woodcutting, stream bank stabilization with planting of water-tolerant fast-growing species, culvert installation, rotational grazing, road drainage, water catchment systems (from roofs, for example).

2. Integrated Pest Management – malaria reduction programs via improved site drainage, improved forest health to decrease diseased wood product, managing for increased bird habitat (for example as predator of spruce budworm in Northeast USA).
3. Sustainable Energy Development – creating renewable energy plants, such as micro-hydro electric plants (see numerous case studies in Part 2, below) or solar power. These can bring socio-economic benefits and stimulate the protection of the watershed. Contact: Green Empowerment, Internet: www.greenempowerment.org
4. Water Quality Improvement – identification and reduction of chemical/bacterial pollution, well development including secure closed-well drinking water source, irrigation coordination with aquifer levels or temporal stream flows, nutrient load monitoring and fertilization management, community education to reduce wastewater/chemical contaminants, reducing waste discharge into waterways (creating wastewater treatment site, reducing wastewater through use of composting toilets, designing community water system to segregate supply of drinking water from water for all other uses to allow reuse of water without health or treatment costs) identifying/implementing alternative livestock watering sources, coordinating use of drinking water, greywater and solid waste water(blackwater) discharge, linking waterways to electricity development, channeling drinking or greywater closer to village, creating vegetative buffer zones along waterways, contour vegetative plantings on hillsides to reduce runoff.
5. Forest Management – selective cutting plan to sustainable levels, maintenance of vegetative cover, species mix, mixed species selection on replanting based on site attributes, coordinated plan to mix grazing and allow time for seedling establishment, shade coffee plantations maintaining over story.
6. Grazing Management – secure grazing rights, rotate grazing to mimic natural cycles, for example heavy but short-duration grazing by cattle in western USA to mimic buffalo’s use in increasing the carrying capacity of rangeland and reducing encroachment of less-desirable grasses, matching species to site or natural herding guards to reduce conflicts with wildlife (for example, using llamas as sheep guards in USA reduced coyote predation and efforts and expense associated with farmers trapping or killing coyotes).

7. Road-building Management - planning overall land use of watershed to minimize road-building. When roads are constructed, techniques to reduce impact can be used such as installing appropriate sized culverts to decrease washouts, installing water velocity dampening devices such as vegetative cover along roadside water channels, increasing vegetative cover on landslide prone areas.
8. Agriculture Management - coordinate land use to maximize crop production in relation to soil and water conditions, encourage harvesting methods to allow stubble, reduce pesticide use by minimizing monocultures or coordinating efforts of agriculture of contiguous watersheds to reduce pesticide use and thereby avoid opportunistic pest migration to single watershed or part of watershed, avoid overuse of fertilizers and chemical runoff, seed storage to protect source, coordinate experimental plots among farmers to share risk of potential failure.
9. Fisheries Management - improving fish habitat by locating and addressing pollution sources, installing fish ladders, reducing sedimentation, coordinating fishing pressures to promote repopulation of desired species or quality of species.
10. Education - educate community through posters, literature, meetings on efforts to improve watershed and social/economic condition of community. The Association of Rural Development Workers (ATDER-BL) and the community of El Bote, in Nicaragua have designed a watershed education program with workshops on watershed protection, forest management, environmental health and other related topics. Contact Green Empowerment at info@greenempowerment.org
11. Funding - Use the Watershed Management Plan's Inventory, Action and Monitoring Plan can be an effective means to obtain funding for the watershed's communities. Studies suggest that there is still relatively little available data assessing the impact of watershed projects. (Contact: John Kerr, Michigan State University. Email: jkerr@msu.edu). If your community has followed these WMP Guidelines, it can provide such data and be an important factor in gaining additional funding for its watershed development efforts. The international community is placing increasing importance on watershed development as a means of improving social, economic and biological conditions. The funding could obviously be used for multiple purposes, one of which could be the scaling up of the Plan to adjacent watersheds and thereby integrate upstream or downstream effects or limitations of the present WMP.

Step 6. Monitoring Plan

The Council should establish a Monitoring Plan. The goal of the Monitoring Plan is to measure the degree of success or failure of the Action Plan. It will also help modify the Action Plan to best protect and enhance the watershed's resources and resolve user conflicts. The Monitoring Plan should include the people who will monitor the actions, the method of monitoring and the frequency of monitoring. The Council can create a process to review the information gained from the monitoring and a process to update and modify protection and enhancement efforts.

Conclusion

Creating and implementing a Watershed Management Plan is a method for the people to protect and improve their lives. It is a community effort which acknowledges the possibilities and limitations of their watershed's social and natural resources. Ultimately, it is a dynamic process which mobilizes the human activities to address the changing resource conditions for the maximum social, environmental and economic benefit of the people and life in the watershed.

PART TWO - Case Studies

Africa

Niger, Mali, Burkino Fasso –

Increasing water infiltration and soil development by having commercial woodcutters spread their woody debris. This generated termite activity to eliminate hardpan and allow heavy rainfall to penetrate and seeds to establish. Contact: : David Lefkowitz; email: topanien@jeffnet.org.

Introduction of diesel-powered water pump into formerly animal-drawn water for vegetable irrigation resulted in overuse of small aquifer after nearly a century of sustainable irrigated vegetable farming in Saharan Desert of Niger. Contact: : David Lefkowitz; email: topanien@jeffnet.org.

Community-Scale Watershed Improvement in Rural Economies. ICRISAT project controlled water runoff in watersheds with frequent torrential downpours in India, Thailand, Ethiopia, Vietnam, Mali and Niger. Water harvesting methods included contour micro terracing to optimize infiltration and channeling for later use. Contact: S.P. Wani, ICRISAT. Email: s.wani@cgiar.org

Promoting and restoring soil quality using vegetative strips reduced soil erosion by 60%-90%. Vegetative strips also filtered out excessive phosphorous and nitrogen runoff into streams. Contact: Brent Swallow, ICRAF, Nairobi, Kenya. Email: b.swallow@cgiar.org

Asia

Borneo

Partners of Community Organizations (PACOS) and Green Empowerment developed a micro hydroelectric plant (10kW) pilot project in Long Lawen with development training and watershed improvement. The community made agreements with logging companies to prohibit logging of watershed in contact with MHP system. The Borneo Project and The Indigenous Peoples Network of Malaysia also conducted a workshop to teach mapping skills to community to allow them to strengthen their land rights and improve rainforest conservation and its relationship to the MHP system. GPS training, surveying, committee governance and communication procedures with community/watershed resource interest holders was included. The community mapping effort was influential to convince the local government and logging companies about the authenticity of community land use rights/claims and protection of drinking water catchments and MHP system maintenance. Contact: Green Empowerment, email info@greenempowerment.org

Bhutan

1996 micro-hydro project for 200 kilowatt plant for off-grid rural electrification. Project per principles agreed under United Nations Framework Convention on Climate Change (UNFCCC). Successfully commissioned in 2001, the project provided drinking water to 8 households, irrigated 25 acres, generated 200 kilowatts, a road, electrification of 130 households. Second phase now planned to extend the electricity 20 kilometers upstream. Added benefits included reduced kerosene and fire wood use, education of village community to greenhouse gasses, increased study time for students resulting from increased evening light, less travel to procure kerosene and wood fuel, improved health with less respiratory consumption of exhaust gasses when cooking. “Micro Hydro Project for Off-grid Rural Electrification” Author: Tharat Tamang, Thimphu and Dutch Ministry of VROM.

India

Trivandrum, Kerala, India. United Nations Industrial Development Organization (UNIDO) established regional center for small hydro power. Established in 2003, this Center’s goal is to bring electricity to remote rural communities through the use of the renewable energy source of micro-hydro turbines. Benefits to include improved communication, reduced urban migration, village-level industry development, training. Contact: Mr. K.M.D. Unnithan, Technical Director, UNIDO Regional Centre for SHP, Energy Management Centre, Poojappura-Karamana Road, Trivandrum 695 002. Telephone: 00-91-471-234-5597; email emck@vsnl.com or www.keralaenergy.org.

Pusil Village Micro-Hydro Project. The 1998 commissioning of a 13 kilowatt micro hydro plant substituted kerosene fuel lighting for entire village. Village also used electricity for cooking, rice huller, oil expeller and flour mill, community computer. Problems to address include end-users bypassing restrictive use to overload limited

capacity. Contact: V. Ram Subramanian, email: sahyadri@xmbox.com or Global Village Energy Partnership Online at <http://www.gvep.org/content/general/detail/6662>

Review of successes of India's efforts in 1980's in watershed development demonstrated importance of identifying and incorporating every interest group. Inclusion of landless herder groups and creating immediate incentive for them was essential. Some level of cost sharing among stakeholders was also necessary. Collective purchase of grazing rights by shepherds during high meat prices allowed investment into growing high quality fodder with technical assistance. Contact: John Kerr, Michigan State University. Email: jkerr@msu.edu

Nepal

Geographic Informational Systems (GIS) tools were applied in watershed management, including the prediction and identification of the sources of sedimentation and erosion and the effect of growing nitrogen-fixing trees to address sedimentation/erosion problem. GIS also used to determine frequency and duration of travel of village women for fuelwood and fodder. Thereafter, action plan was developed with strategies developed by the women. Contact: Hans Schreier at University of British Columbia. Email: star@interchange.ubc.ca

Annapurna Conservation Area (ACA) micro hydro electric project to offset pressure on forests from traditional source of energy for biomass fuels, reducing deforestation. ACA has built 11 micro hydro plants totaling 453 kW since 1990. Major problems encountered include lack of micro enterprises to support long term maintenance costs and water policy issues putting hydroelectricity at bottom of priority list below drinking water, irrigation and agriculture. Inadequate training and source for low wattage cookers are major technical problems. Recommendations include additional training and micro enterprise development including budgeting for capital replacement/maintenance and repair. Contact: Bikash Pandey at Winrock International. Email: bpandey@winrock.org.np

Pakistan

2003 micro-hydro project in remote Pakistan. The project installing 50 micro-hydro turbines, each supplying 10-50 kilowatts. Each mhp plant of 10-50kw and each to serve 50-200 rural households. Project incorporates assistance in establishment of small industry, education, health and gender equality. Contact: Isthiaq A. Qazi, Pakistan Council for Renewable Energy Technologies, Islamabad, Pakistan. Email: ishtiaq_qazi@yahoo.com

Philippines

Manupali watershed users conflicts with government land use restrictions created by Mt. Ktanglad Range Nature Part (biodiversity reserve) being solved through grass-roots movement of farmer-led land care groups and a Negotiation Support System. Contact: Dennis Garrity or Brent Swallow, ICRAF, Nairobi, Kenya. Email: b.swallow@cgiar.org

Watershed coalition formed for Philippine Watershed Management. Internet: www.jeef.or.ip/EAST_ASIA/phillipine/PWMC1.htm

YAMOG completed the Mindanao micro hydro project to bring electricity to 750 people in the rural village of Saloy. Watershed management plan for 25 hectares is being established and implemented to curb erosion, keep river clean and keep the MHP system from clogging with sediment. Contact: Green Empowerment, email: info@greenempowerment.org

Sri Lanka

Use of micro hydro electric power to offset grid-supplied electricity in tea production. The area's peak water flows coincides with the grid power system's peak demand and prices. Micro hydro power reduces production costs of tea and is sustainable. In addition, restocking of abandoned tea plantations with fast growing biomass is being used for fuel for drying tea and electric generation. Contact: Kiran Dhanapala, West Virginia University, PO Box 6108, Morgantown, WV 26505, USA or Priyantha Wijayatunga, Department of Electrical Engineering, University of Moratuwa, Moratuwa, Sri Lanka.

Syria

Integrated Land Management Research in dryland Khanasser Valley, Syria. Watershed resource inventory focusing on water, soil, vegetation and human resources, with action plan implementing soil stabilizing planting of olive trees and fruit trees, installation of simple erosion and groundwater monitoring equipment. Contact: Dr. Christoph Studer, ICARDA or Michael Zoebisch, ICARDA. Email: m.zoebisch@cgiar.org

Thailand/Vietnam

Community-Scale Watershed Improvement in Rural Economies. ICRISAT project controlling water runoff in watersheds with frequent torrential downpours in India, Thailand, Ethiopia, Vietnam, Mali and Niger. Water harvesting methods included contour micro terracing to optimize infiltration and channeling for later use. Contact: S.P. Wani, ICRISAT. Email: s.wani@cgiar.org

Mekong Delta watershed management to address over fishing and overuse of agrochemicals. Clearer establishment of land rights was critical to addressing problem. Contact: Mahfuzuddin Ahmed, ICLARM. Email: m.ahmed@cgiar.org

Central/South America

Andes

Andean and Central American Hillside communities, CIAT is developing partnerships to disperse tools, methods and knowledge to rural communities developing sustainable watershed management plans. Specific solutions for pest control (white grubs and leaf cutting ants, erosion control and water management. Water modeling available to forecast water production, quality and quantity. Contact: Jose Ignacio Sanz or Olaf Westermann of CIAT. Email: o.westermann@cigiar.org

Bolivia and Peru

Joint plan to manage Lake Titicaca-Desaguadero River System. Cooperation of United Nations Environmental Programme. See, www.oas.org/EN/PINFO/arsge43e.htm

Brazil

Program for Development of Priority Areas in Amazon Valleys (PROVAM) developed common market among Brazilian/Venezuelan border communities, environmental impact study, language registry, training of prospector, and hydro-geological surveying of farms, See, www.oas.org/EN/PINFO/arsge43e.htm

Columbia

Failure to have all stakeholders in watershed represented in management plan process limited ability to create alternatives to field burning. Contact: Olaf Westermann, Email: o.westermann@cigiar.org

Columbia and Ecuador

San Miguel and Putumayo River Basin Management Plan. See, www.oas.org/EN/PINFO/arsge43e.htm

Columbia

Local Agricultural Research Committees (CIAL's in Spanish acronym) are groups of two to four community members who undertake experimental research on behalf of their community. There are more than 250 CIAL's in Latin America. In Columbia, representatives of 50 CIAL's meet annually to exchange experiences. This effective low-cost approach has led the Colombian National Extension System to adopt an approach based on the CIAL model. Contact: Nancy Johnson, CIAT, Apartado Aereo 6713, Cali, Columbia. Tele: (572) 445-0000; email: n.johnson@cigiar.org

Costa Rica/Nicaragua

San Juan River Management Plan. Strategic Action Plan for Integrated Water Resources Management <http://www.oas.org/sanjuan/English/Puinvol.HTM>

Dominican Republic

National Water Resource Plan to inventory hydraulic projects. Developed Yaqui del Sur River Basin Management and Conservation Plan See, www.oas.org/EN/PINFO/arsge43e.htm

El Salvador, Guatemala and Honduras

Joint watershed plan for Trifinio Border Area. In cooperation with Government of Finland See, www.oas.org/EN/PINFO/arsge43e.htm

Guatemala, Haiti, Bolivia and Paraguay

In 2003 Latin American Energy Organization (OLADE) began program to install 12 pilot projects to bring micro-hydro power (each plant less than 10 kilowatts), solar, wind or small scale gas to 30+ families per project in Guatemala, Haiti, Bolivia and Paraguay. Project in cooperation with University of Calgary, Canada and Canadian International Development Agency (CIDA). Contact Byron Chiliquina, OLADE, (Latin America Energy Organization) at internet: <http://www.olade.org.ec/>

Honduras, Nicaragua and Colombia.

Establishment of a “Telecenter” where community and local organizations can share technology and watershed management solutions. Technicians are trained in the use of decision support tools in watershed management issues. Contact: Bronson Knapp. CIAT, internet: : <http://www.ciat.cgiar.org/impact/index.htm>

Mexico

Winrock International assisting in development of 4 micro-hydro projects in Mexico. Contact: www.winrock.org

Nicaragua

El Bote – watershed protection and micro hydroelectricity. Green Empowerment worked with the community and ATDER-BL (The Association of Rural Development Workers - Benjamin Linder) to establish a Forest Reserve that will include about 1600 acres of the El Bote Watershed. Almost 600 acres are currently included in this community owned forest reserve. The Forest Reserve serves as an important buffer to the largest intact rainforest in Central America (BOSAWAS Biosphere Reserve). In addition, a 250 kilowatt hydro turbine was installed below a dam with a capacity of 5,500 cubic meters in lieu of diesel generator. The watershed is 22.6 square kilometers. The WMP targeted the following activities: model farms, manual replanting of trees, restoration of eroded soils and stabilization/regeneration on landslide areas, conservation training, assistance for farmers to secure ownership of lands, establish a forest reserve in coordination with government program. Contact: Green Empowerment, 2950 SE Stark ST, Suite 100, Portland, OR 97214. Tele: 503-284-5774; email www.greenempowerment.org

San Jose de Bocay - Green Empowerment worked with the community and ATDER-BL (The Association of Rural Development Workers - Benjamin Linder) to establish a MHP in operation since 1994 and is currently working to expand the MHP system to bring electricity to additional villages. The MHP served as a catalyst to begin reforestation efforts within the watershed where the MHP system exists and to bring potable water systems to the community, a training center for forest resource/sustainable agriculture education, biomass rice dryer technology and community established organizations to implement and maintain the electric and water systems. Contact: Green Empowerment, 2950 SE Stark ST, Suite 100, Portland, OR 97214. Tele: 503-284-5774; email www.greenempowerment.org

La Pita - Green Empowerment worked with the community and ATDER-BL (The Association of Rural Development Workers - Benjamin Linder) to establish a 300 kW MHP bringing electricity to serve 400 community members for home, school, carpentry shop and local farms. The community is located 70 Km from the national electric grid and the community established an Association to run and maintain the community-owned electric system. Contact: Green Empowerment, 2950 SE Stark ST, Suite 100, Portland, OR 97214. Tele: 503-284-5774; email www.greenempowerment.org

Managua Watershed Management Plan. Control of industrial effluents, pluvial drainage, reduction of malaria. Internet: www.abtassoc.com/pag.cfm?PageID=1454&familyID=1400

Nicaragua International Food Policy Research Institute – Collective Action and Property Rights (CAPRI). San Dionisio Watershed, Nicaragua. Watershed Plan to identify and prioritize social problems and natural resource management activities/training. Tools to facilitate decision-making by watershed stakeholders and assistance in selecting best crop varieties. Contact: Nancy Johnson (n.johnson@cgiar.org) or Olaf Westermann (o.westermann@cigiar.org).

Nicaragua Rio Calico Watershed. This is a sub-watershed of the San Dionisio watershed described above. It is being used to develop a model of an integrated environmental management plan by identifying the parameters which determine resource material use within the watershed e.g. coffee, pasture and forests. Contact: Nancy Johnson (n.johnson@cgiar.org)

PART THREE - Contact Information

Consultive Group on International Agricultural Research (CGIAR). Association of 16 Harvest centers in over 100 countries to coordinate efforts and share experiences to increase food security and decrease poverty. 10 centers engaged in 18 watershed management research projects in 21 countries (Thailand, Cambodia, Laos, India, Thailand, Vietnam, Sri Lanka, Philippines, Ethiopia, Mali, Niger, Ivory Coast, Ghana, Nigeria, Kenya, Egypt, Yemen, Syria, Honduras, Nicaragua, Colombia). Data compilation and dissemination of impact evaluation. Internet: www.cgiar.org Contact: Nancy Johnson, CIAT, Apartado Aereo 6713, Cali, Columbia. Tele: (572) 445-0000; email: n.johnson@cgiar.org

Europa. A search engine for case studies and technical assistance on micro hydro electricity provided by European Union. Layman's Guidebook on How to Develop a Small Hydroelectric Site. Contact: <http://europa.eu.int/comm/energy/library/hydro/layman2.pdf>

Global Village Energy Partnership Online (GVEP). A voluntary partnership of developing and industrialized country governments, public and private organizations, and end-users established in response to United Nations World Summit for Sustainable Development. Contains search engine for action plans, finance facilitation, case studies for watershed management and sustainable energy development in rural villages. Internet: <http://www.gvep.org/>

Green Empowerment. The author of this manual. Green Empowerment is a non-profit international development organization providing technical, organizational, media, public relations and financial support to non-governmental organizations developing sustainable energy and potable water systems and related watershed management plans in remote rural villages. Contact: Green Empowerment, 2950 SE Stark ST, Suite 100, Portland, OR 97214. Tele: 503-284-5774; email www.greenempowerment.org

International Centre for Small Hydro Power. Contact: Professor Tong Jiandong, Director,

International Center for Small Hydro Power (IC-SHP)
PO Box 202
136 Nanshan Road
Hangzhou 310002
People's Republic of China
Tele: (86-571)870-233-80
Email: hic@mail.hz.zj.cn
Website: <http://www.inshp.org>

International Center for Tropical Agriculture (CIAT). Non-governmental organization with extensive work on watershed management and impact assessment databases. Internet: <http://www.ciat.cgiar.org/impact/index.htm>

Landcare Australia. Cooperative group of business and individuals with goal of environmentally sustainable resource development and watershed restoration. Model method for several other countries. Database of case studies and watershed restoration techniques. Internet: www.landcareaustralia.com.au/projectlist.asp

Management of Soil Erosion Consortium (MSEC). Asian based consortium operating in India, Indonesia, Laos, Nepal, Philippines, Sri Lanka, Thailand and Vietnam. Focuses on soil improvement by developing village-level establishment of micro watershed management and land use management techniques. Internet: <http://203.209.62.252/msec/res/about/about.htm>. Contact: Amado Maglinao, Senior Research Coordinator, Thailand. Email: a.maglinao@cgiar.org

Toolbox. A search engine for integrated water resources management. Contains tools, case studies and references for all facets of watershed management. Internet: www.gwp.ihe.nl/wwwroot/GwpORG/home.cfm?event=home&targetFrame=top&

USAID – US Agency for International Development. Clearinghouse site for over 120,000 reports on international development projects, with search engine delineated by country and research sector (energy, natural resources management, etc.) Internet: www.dec.org/default.cfm?CFID=528953&CFTOKEN=58662793

US Environmental Protection Agency – provides training via internet on how to create and implement a WMP. Internet: www.epa.gov/owow/watershed/wacademy/acad2000

UNIDO (UN Industrial Development Organization) Regional Centre for Small Hydroelectric Power. Contains databases, search engine, case studies, technical support for all facets of micro hydroelectric power. Internet: www.unidorc.org

Water Quality Monitoring Equipment Supply Houses: A long list of supply houses in the USA is available at <http://www.epa.gov/owow/monitoring/volunteer/stream/appendb.html>

Two suggested supply houses are:

Aquatic Research Instruments, PO Box 2214, Seattle, Washington 98111 USA,
Tele: 206-789-0138

Millipore Corporation, 397 Williams ST, Marlborough, Mass. 01752 USA,
Tele: 800-645-5476

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