Sustainable Practices in Watershed Management: Global Experiences

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Watershed management is considered by scholars as well as practitioners across the world as the most appropriate approach to ensure the preservation, conservation and sustainability of all land based resources and for improving the living conditions of the people in uplands and low lands. More over watershed management technologies have proven to be effective for mitigating erosion on sloping land, stabilizing landscapes, providing clean water, stabilizing and improving agrarian production systems on small and medium scale. The degree of success of watershed management interventions primarily depends on the will of the people and the scale of activities involved in it.

A watershed can be defined as a catchment or drainage basin. It refers to an area which has a ridgeline on three sides and whose surplus run-off is drained from a drainage point. Watershed management is the art and technique of managing watershed resources in way that maximum benefits can be derived from them without affecting the ecological sustainability. Watershed management requires an integration of all scientific knowledge from many disciplines and a combination of technologies, strategies and techniques with the development and use of available tools. Watershed management is a holistic concept, which tries to integrate several components like soil and water conservation, forestry development, agriculture and livestock. It tries to bring about the best possible balance in the environment between natural resources on the one side, and human and other living beings on the other.

Recently, participation of people has become a core component of watershed management programmes. As FAO [Food and Agricultural Organization] rightly remarked, "*The pendulum appears to be swinging in support of empowerment of people with regard to conservation of natural resources. Application of the integrated participatory approach has created, in some instances, social environments where varied cultures are working together to manage their natural resources on watersheds*"[1]. Thus, the process of stakeholder centric watershed management programme has provided a stimulus for the recovery and valuation of traditional practices resulting in a mix of ancient and current natural resource management practices.

Against this context the present paper attempts to present certain specific models of sustainable watershed management successfully implemented in different parts of the world. The objective of the paper is to explore the methods, tools and strategies involved in these sustainable models.

[1] Larry C.Tennyson and Moujahed Achouri, The Next Generation of watershed programmes: An overview of FAO review, Watershed development coordination unit, 2004.

The five models selected here for analysis include the following:

1. **Ecological Economic Model** in Tonameca catchment in Mexico, which effectively utilized environmental goods and services for the improvement of livelihood of the coastal people in Mexico.
2. **The UNEP funded watershed project** in Dominican Republic where local people with the help of modern technology practiced biodiversity conservation and reduction of industrial pollutants of watershed.
3. **Magat watershed project** in Philippines, which successfully combined together finance capital, political capital, social capital and technical capital to improve soil conservation, land management, forest conservation and water management.
4. **Integrated Water Resource Management Approach** in Burkino Faso which used participatory approach to settle water related disputes and conflicts in the region
5. **Wuhua Watershed Project** in China in which government and public policy intervention towards integrated watershed development resulted in significant improvement in land use pattern, crop cultivation and economic benefit of the surrounding people.

The following sections present brief description of the projects.

Ecological Economic Model in Tonameca Catchment, Mexico

Environmental services play a vital role in improving socio-economic condition of the inhabitants of that particular ecosystem. However, the effective utilization of environmental services depends largely on management of the common pool resources by local stakeholders in such a way that maximum benefit can be derived without affecting the natural balance of the ecology. In Tonameca Catchment area of Mexico, this ***ecological economy*** is practiced with the active participation of local people to make use of the environmental services for better employment generation through fishing, eco tourism and forestry development.

Latin America is one of the least developed regions of the world with a poverty rate of 61%. Though the continent occupies 23% of the world's land with agricultural potential, 60 million people suffers from food insecurity. Poverty and lack of stable income support is most predominant in coastal regions of Latin America in which 90% of the land is common property resource. Management of common property resources always posed a challenge to Coastal zone administration which ultimately led to over exploitation of the resources and the related environmental imbalance. For example, over exploitation of water for costal agriculture caused increase in soil salinity and in Mexico alone 50000 hectares of agricultural land has been destroyed due to severe salinity. Fisheries represents for 120 million people a source of income and fish makes up about 19% of the total animal protein consumption in developing countries. However, 47% of fish stock is fully exploited and 28% is overexploited or depleted. It is argue that overexploitation of marine resources increased ecosystem and food web vulnerability to environmental pressures such as, temperature augmentation and eutrophication,

provoking a major depletion of populations and disequilibria in the food web. Environmental impacts due to tourism expansion are also numerous such as, pollution, sedimentation and erosion.
To tackle the problem it is indispensable to uphold a political, social, scientific and economic perspective of integrated river basin and coastal management and to implement holistic and inter-sector management policies. In order to build a management program it is essential to have an ecological and socio-economic diagnosis, in terms of natural resource availability for economic growth and socio-cultural characteristics. Thus, ***ecological economic models***, where variables from each discipline are really linked, represent a holistic diagnosis to support management policies based on non-declining of the capital stock and equity to sustain welfare. Sustainable agriculture, fisheries and tourism means maintaining the production in a long run minimizing impacts to the environment, equitable distribution and local welfare. In that sense, ecosystem services and goods need to be understood, identified and quantified in order to show their importance for the economy, the society and ecosystems health. Moreover, it is crucial to investigate the links between economic, ecosystem and social systems, intrinsic to ecosystem services and goods exploitation.

Tonameca Watershed Project

Tonameca watershed is located in the state of Oaxaca, South Pacific coast of Mexico. Tonameca watershed covers 49 800 hectares with a total population of 28 000 habitants and around 52 habitants per km^2 within six municipalities. Only Tonameca municipality has 15 546 habitants, where 96 % are zapotecs, and 5000 individuals speaking zapotec language. Land regime is 99% communal and welfare conditions are critical showing for the catchment, 41% of household with electricity, and 31 % with water supply[2].
The ecological economic model is proposed for a coastal catchment, where environmental goods and services, such as, mangrove forest and water, are used for ecotourism, agriculture and fisheries. The model is composed by an ecological diagnosis describing the land use changes, lagoon and river water quality, fertilizer run off, mangrove ecosystem food web and impacts of fertilizer in mangrove and phytoplankton biomasses as well as, the repercussion on the mangrove food web. Derived from the ecological diagnosis restrictions are included in the production function of agriculture, fisheries and ecotourism. Assuming that environmental quality is part of social welfare and 90 % of land is common property profits of the 3 main activities are maximized in order to improve social welfare in the catchment[3].

The first stage of the project is to establish link between the economic and ecological variables. Agriculture production inputs are water, land and fertilizers that produce changes in water quality disturbing the mangrove ecosystem and economic activities depending upon it, such as ecotourism and fisheries. Water quality is the relationship between upland activities and the coastal lagoon. Lagoon water quality has an effect on phytoplankton and fishes biomass, as well as on mangrove biomass habitat for many

[2] Avila-Foucat1 V. S., D. Raffaelli and C. Perrings, Ecological economic modelling for integrating environmental services in the welfare of commons: a case study in Tonameca catchment, Oaxaca, Mexico"
[3] ibid.

species. So after establishing the relationship between ecological variables which influence economic activities, the project focuses on ecological diagnosis. This diagnosis aims to concentrate on land use change, water quality and fertilizer run off. Geographical Information System was used to scientifically diagnosis these factors and its impact. Using software called ***Ecopath,*** the immediate and long term effects of these changes were analyzed and presented. The ecological economic model aims linking coastal and river watershed management, as a way to confront the impacts generated locally and from upland activities, as well as, to contribute to ecosystem services valuation and to integrate economic, social and ecological disciplines using an ecological economic modeling**.** After proper analysis, the model recommended certain measures for the sustainable use of environmental services in eco tourism, fisheries and on the whole the livelihood of the people.

The UNEP funded watershed project in Dominican Republic

The Haina river basin is one of the main industrial conglomerations of the country with over one hundred medium to large size industries. These include the main electricity generating plant, the petroleum refinery, and the only vehicle battery factory in the country. The region is highly contaminated by these industrial activities, as well as the solid and liquid wastes generated by the communities. At the same time, the waters of the basin are one of the main potable water sources of Santo Domingo city. The government has very limited capacity to address these problems. The government has announced Haina river basis as a national hotspot. But the contamination of potable water posed a serious threat to the people[4].

It is against this context we should look into the UNEP funded watershed management project in Haina river basis. The project aims to obtain tangible results in the reduction of pollutants in the hydrographic basin of Haina river. The principal intervention was on the industrial sector with the implementation of programmes aimed to reduce contamination by developing recycling and reutilization mechanisms; a heavy metal contamination survey to provide information to guide policy and strategic planning; and overall integrated management programmes. It is expected that the implementation of this project will improve, mitigate and help to resolve the environmental situation of the zone with respect to the deleterious effects of local industry. There are many benefits related to the implementation of this project resulting from the integrated management of the industrial Haina river basin[5].

The project identified that industrial sector has affected the environment, biological diversity and the welfare of people in the basin through various ways including:

- The production of liquid effluent (through the discharge of water used in the industrial process as well as liquid chemical contaminants from the industry)
- The production of industrial solid wastes (which are inadequately handled through a land-fill treatment system which is leaching effluent into the water table)

[4] www.unep.org

[5] ibid.

- Industrial atmospheric emissions (with the high potential for harmful fall-out of chemicals, particularly heavy metals.

Principal among these benefits are the following:

- Improving the quality of basin-related ecosystems
- Protecting and conserving biodiversity within the river and the coastal zone
- Reducing diseases resulting from the deterioration of the environment
- Reducing morbidity and mortality rates of the population related to pollution and poor water quality
- Strengthening capacity, infrastructure and understanding within the public and private sector
- Providing an effective model for replication within the country and in the region[6]

The main stages of the watershed project involve the following:

1. Creation of a Haina River Basin Management Committee (HRBMC) with appropriate stakeholder participation
2. Establishment of an effective monitoring and compliance capacity guided by the HRBMC
3. Survey of existing discharge, solid waste disposal and air emission practices in the Haini Industrial area and river basin
4. Baseline data collection and analysis for water and air quality (focusing on known point-source pollution but with adequate controls), extending to the coastline where appropriate
5. Based on justifications from data, development of amended legislation and a proposed compliance plan (including new requirements for all further industrial developments with an emphasis on EIA and regulations on discharge and emission standards.
6. Adoption of a long-term and sustainable mechanism for monitoring of industrial discharges and emissions linked to the policy-making and legislative process.
7. Identification of recycling and re-utilization mechanisms for cooling water, other liquid wastes.
8. Identification of mechanisms for better handling, processing and disposal of industry-related solid wastes.
9. Identification of mechanisms for reduction in emissions and in contaminants related to emissions.
10. Adoption of appropriate and effective mechanisms by existing industry, and adoption into legislation of standard requirements for mechanisms in new industrial developments
11. Develop and implement a strategy for clean-up within the Haina River basin (removal of solid wastes from ravines, removal of contaminated soils where feasible, ensuring channels have effective water flow where appropriate, etc)

[6] www.unep.org/proposals

12. Develop and distribute appropriate awareness materials with an emphasis on sensitising the industrial private sector along with the policy level within Government.

Results

1. A reduction in the contamination emitted by the industrial sector, improvements to water quality within the basin, and the creation of a sustainable management programme for the hydrographic basin.
2. A significant and measurable improvement in water quality and industrial solid waste handling along with a reduction in emission-based contaminants to the atmosphere
3. An effective use of data and information to guide policy and decision-making with an effective feedback mechanism to ensure that policy and decision-makers can acquire necessary information quickly and accurately
4. Significant improvements within legislation and regulations addressing industrial siting, discharges, emissions and waste products through an effective and accountable Environmental Impact Assessment mechanism supported by compliance monitoring and enforcement.
5. A measurable improvement in understanding and support for the projects aims and objectives within both the private sector and the government.[7]

It is expected that in the long-term, the project will develop sustainability for improvements to discharges, emissions and wastes through the EIA and legislative process. Clearly this will require political will and support, and an understanding of these requirements within the private sector.

Magat watershed project

The Magat watershed is located in the northern part of the Philippines covering major portions of Nueva Vizcaya and part of Quirino and Isabela provinces of Region. It has a total area of 234,824 hectares almost 98% of which covers all the 15 municipalities.Nueva Vizcaya .Around 2% of the watershed area covers one municipality (Diffun) in the southern part of Quirino and two municipalities (Cordon and Ramon) in southern Isabela. Watershed management practiced in Magat started in 2003. In 2003, the Department of Environment and Natural Resources (DENR) and the Japan International Cooperation Agency (JICA) prepared the Master Plan Study for Watershed Management in Upper Magat and Cagayan River Basin[8]. The Master Plan came up with different recommended watershed initiatives for the improvement of biological, physical,

[7] For more details of the project please visit website of UNEP

[8] Dulce D. Elazegui and Edwin A. Combalicer,Realities of the Watershed Management Approach, The Magat watershed, http://dlc.dlib.indiana.edu/

and socio-economic conditions of the entire area in consonance of improving water quality and quantity as well. The Plan considers water as a very important resource and product of the watershed. The watershed management initiatives contained in the Master Plan address land use planning, forest management, rehabilitation and restoration, soil conservation, livelihood, capacity building and cost sharing mechanism in watershed management. Direct responsibility for management of the watershed rests with the government.[9] In Magat, most projects are led by government through the Regional Environment and Natural Resources Offices (ENRO) of Region. Watershed management initiatives in Magat range from short-term to medium-term projects spanning from one year to ten years. Projects are funded by the national government and international organizations, e.g., Asian Development Bank, International Tropical Timber Organization (ITTO).

The activities undertaken by the Magat watershed project include the following:

- Integrated Social Forestry Program
- Community Forestry Program
- Forest Land Management Program
- Tree Farm/Plantation Development Establishment of Soil & Water Conservation Measures
- Protection of Natural Forest Protected Areas Management/Biodiversity Conservation
- Community Based Forest Management Program
- Construction of Check dams and Small Impounding Structure
- Construction of Check dams and Small Impounding Structure
- Establishment of Vegetative Measures
- Small Water Impounding Dams
- Ecological Restoration of Environment
- Participatory Approach to Reforestation
- Mass Production of Indigenous species Using Vegetation
- Bamboo Propagation and River Bank Stabilization

These programmes were implemented with the active involvement and participation of local people. In each projects, beneficiaries were allowed to work with the technical experts. The activities include replanting of burned areas, maintenance of mango plantation, and distributing seedlings, fertilizers and pesticides, and providing technical assistance to 100 ha- pilot community forestry. The reforestation program on "Grow a Family Tree for Legacy also known as Tree Resources for Education, Enterprise and Legacy Program or Tree for Legacy Program, was open to individuals, groups and organizations. It is a multi-sectoral program led by DENR and the Provincial Government of Nueva Vizcaya covering more than 2,000 ha.The Barobbob Watershed Resource Management Project is sub-watershed-specific project of Magat with an area of 439 ha. Barrobob watershed, a protected area, provides potable water to about 2,000 households in the municipalities of Bayombong and Solano, and irrigation water to about

[9] ibid.

400 ha of rice fields. The Lower Magat Forest Management Project is promoting applications for tenurial agreement such as Agro-forestry Land Management Agreement, Community-Based Agro-forestry Land Management Agreement through appropriate land use[10].
More over, The Center for People Empowerment in the Upland (CPEU) showcases sustainable agroforestry technology in its five model sites covering 1,132 ha within the Magat watershed and neighboring areas. There were reports that the CPEU sites in Isabela and Quirino were integrated into Community-based Forestry Management (CBFM) projects and are now serving as provincial model sites of CBFM. CPEU also serves as training centers for DENR staff, people's organizations (POs), non-government organizations (NGOs) and other entities.

In developing intellectual capital for the watershed development programme, the Nueva Vizcaya State Institute of Technology (NVSIT), formerly the Nueva Vizcaya Agricultural College and the Isabela State University played a vital role. The institute provides technical expertise through out the implementation process without undermining the intellectual capital of the people. Thus in spirit the watershed development and management initiative was a combined result of the intellectual capital of the people and technical experts. More over, the project encouraged and promoted participation of the private sector and entrepreneurs. They also lead and provide assistance to communities, e.g., capability building and empowerment of people's organizations, linkage with institutions, and access to social services, technologies and funds for forest land development and generation of alternative livelihood opportunities. There are 18 Peoples' Organizations which actively took part in the implementation and monitoring of the project. So most watershed management projects in Magat adopted a collaborative approach incorporating private-public and community capital effectively. Naturally it gained nationwide recognition as best watershed management model.

The nature of coordination, e.g., meetings, consultations, and joint activities among various entities involved in these projects, is facilitated by the project coordinator and is usually on a project need basis. Stakeholders had no prescribed frequency of meetings or consultations within a year but emphasized the need for information and awareness campaign on the importance of sustainable management. Meetings, e.g., on a provincial basis to discuss possible means of managing the area is one strategy for this.In 2003, there was an attempt to create the Watershed Management Council (WMC) to determine the need, functions, structure and membership, rules and regulations within which institutions operate, and roles and responsibilities of stakeholders inside and outside the watershed. The WMC would thus ensure a regular coordination among stakeholders. 19 Stakeholders have expressed a favorable response to it but the legislative process is taking some time.
Political leadership has played a very vital role in protecting the watershed. The resourcefulness and responsiveness of local government executives to social, economic, ecological concerns within the watershed paved the way to a range of solutions. Local government institutions have accorded high prioritization of watershed management in their budget and were able to build on opportunities such as those provided by the Local

[10] ibid.

Government Code and other policy reforms in the forestry/upland sector.In managing conflict, appropriate incentive schemes and regulatory measures encouraged stakeholders' participation to engage in ecologically sound practices in watershed resource utilization and protection.

Thus we can conclude that favorable policy and political environment, enabling social and institutional mechanisms, adequate financial support, and capable and committed actors played a vital role in making the project successful.

Integrated Water Resource Management Approach in Burkino Faso

Managing conflict is essential to the sustainable management of common-pool resources, such as water. One approach towards managing water conflicts is the Integrated Water Resources Management Approach by Watershed Basin (IWRMA), which uses participatory approaches to help resolve conflict. The IWRMA refers to a system of decisions and actions about water restoration and conservation. Recent research supports the notion that the IWRMA is perhaps the only approach that is able to efficiently integrate all stakeholders, as well as structural (economic, social, legal) and environmental factors, into the decision-making process (McNitt and Kepford, 1999; Petersen,199; in Black, P.E., 1996).

In Burkina Faso, because of insufficient water for socioeconomic activities and serious scarcity problems, there are often conflicts between water uses and between water users such as drinking water supply, agriculture (land irrigation, farming, breeding), fishing, health, hydroelectric power, industrial production, and small-scale village production (restoration, flourmilling, production of local drinks, and brick-making). In Burkina Faso, rains are the only source of groundwater and surface water resources[11].

The conflict over water is acute in Nakanbe river basin. The area of Nakanbe river basin covers entirely or partially 22 provinces out of a total of 45 in Burkina Faso. It has a population of about 3,723,627 people, or 33% of the entire population of Burkina Faso. It constitutes multiple interests related to water because of various hydro-agricultural achievements and diverse socio-economic activities related to water.
In the great hydrosystems of Nakanbe River Basin such as Kanazoe, Ziga, Bagré, Loumbila Dams, and Bam Lake, conflicts generally arise over quantity and quality of water, land management issues, and regional planning precisely because of divergent interests between various water uses. However, in the village setting, especially at hand-pumps and modern wells, water conflicts often arise between women and female adolescents or between women, girls and stockbreeders because of the water's insufficiency for all users. These conflicts are often related to disputes or quarrels between two or more end-users.
As a result of the complexity of water conflicts related to cultural, economic, legal and social issues it was very difficult to use the traditional approach of water resources

[11] Nlombi Kibi1, Resolving Water Conflicts Through Participatory Decision Making : A Case Study From The Nakanbé River Basin, Burkina Faso, http://dlc.dlib.indiana.edu/

management where decisions are taken outside the community or without consulting the beneficiaries, and the solutions are often imposed by the technocrats.Hence, the main objective of the project was to design a participatory methodology for resolving water conflicts between large, medium and small water users[12].

In the village setting, specifically during the dry season, various conflicts occur between women, girls, female adolescents, young boys, stockbreeders, farmers, merchants-women, brickmakers, and outsiders to the village. These conflicts can concern quarrels or disputes between any users, who often do not respect the water collection schedule at handpumps. The disputes may also take place between other users and stockbreeders when this last need to supply their animals with water because there is generally a lack of watering holes beside handpumps. Water conflicts are also related to ethnic or religious problems such as not following ancestral beliefs (for example taboos about symbolic hours for not collecting water in the village - before 5:00 am or after 6:00 pm) important to one ethnic group can be the source of disagreements or quarrels between the two ethnic groups. In these different conflicting situations, the mechanism to resolve water conflicts requires acknowledging the multidimensional nature of this problem, thus placing the end-users at the center of the process. It also requires the involvement of stakeholders in the process.

The water conflict management project started with the identification of all stakeholders in this area. The community stakeholders included farmers, stockbreeders, fishermen, women, girls, men, boys, merchants, village construction workers, administrative and local village authorities (for example, administrative delegate, chief of village, chief of clan or chief of land). The decision-makers stakeholders included government managers (mainly people in charge of General Office of Hydraulic and Regional Offices of Hydraulic), local and regional public authorities and partners in development, as donors, experts, and researchers. This step helped the RPT to develop local collaboration and partnerships.

The next step was to explore the real reason behind water conflict. During this step they used the participatory process to develop an appropriate participatory communication strategy. This participatory communication strategy consisted of the following five points:

1. Identifying communication needs,
2. Matching each communication need with one or more communication objectives
3. Identifying the different stakeholder groups,
4. Choosing appropriate communication activities
5. Defining topics and messages related to behavior change for collecting water

In this strategy, the group used several activities including dialogue and an effective circulation of information among the community stakeholders with simple, accessible and local communication tools. Some of them are:

- Informal discussions
- Roundtable discussions which involved all the stakeholders

[12] ibid.

- Meeting and forum discussions between target groups or all stakeholders
- Theatrical representations
- Video documentaries
- Council meetings (village, departmental and regional levels)
- Village General Assembly for the election of members of WMCs,
- Radio transmissions.

The roundtable discussions allowed a consensus about the conflicts and how to solve them. Throughout the process, an important place was made for the exchange between all stakeholders, which made it possible to find compromise, both for conflict identification and selecting solutions.

Next step is to identify and classify different types of conflicts. The team identified 3 types of conflicts in the region- *Social, technical and socio-sanitation conflicts*. *Social Conflicts* are conflicts that stem from cultural, ethnic, or religious considerations. They may also include land ownership. *Technical conflicts* are conflicts related to the amount of water available for the users, and its quality. They can also relate to the state of the hydraulics infrastructure. *Socio-sanitation conflicts* are conflicts caused by the contamination of surrounding hand pump areas due to poor hygiene which can cause diseases related to lack of safe drinking or malnutrition. In this case, the users themselves are not directly in conflict situations, but rather a given conflict takes place following poor water use or the presence of animals around a hand pump, which can contaminate water.
The evaluation and selection of solutions to resolve water conflicts was carried out in a participatory way on various levels by the technical team and the community stakeholders. To arrive at a consensus on the solutions to retain, they organized many meetings with target groups, regrouped stakeholders according to certain interests, or with all stakeholders. They assisted and supported community stakeholders to reach a consensus regarding which solutions to implement from solutions suggested by diverse village meetings, roundtable discussions, and meetings restitution of the roundtable. Interestingly majority of the problems were solved through this participatory approach.

The project also took keen interest in stakeholder participation in implementing solutions. Stakeholder participation in the implementation solutions depended of the nature of solutions to be implemented. In the case of solutions aimed the changing mentalities, behaviors and habits, participation occurred during the communication activities (for example meetings, forum discussions, theatrical representations). In the case of the implementation of support Solutions, the participation of end-users, took the form of participation in physical and technical work needed to repair or build new hydraulics infrastructure (handpumps). The technical team managed this participation together with the village population. There are 4 types of solutions which was agreed by all stakeholders:

1. Solutions related to changes mentalities, behaviors, habits of end-users
2. Restructuring of Water Management Committees
3. Enhance communication activities in the villages
4. Establishment of feed back mechanism

The experience of the project shows that with in one year, they were able to settle the water conflict in the villages. The success of the project reveals that all participatory decision making approach must build capability within local communities to expect results over the long run. This should normally allow populations to take their responsibility and autonomy[13].

Wuhua Watershed Project in China

Wuhua county is located at the mid-eastern part of Guangdong Province, China. The county has serious erosion and watershed degradation problem. Population density is 280/km^2, and the average arable land per capita is only 0.1 ha. Soil and water erosion in the county is responsible for weak geo-morphology, poor soils and vegetation, Hyrological problems, irrational land-use and many socio-economic problems. Although the soil and water conservation work in the province began in 1949, this sector received high priority only since 1982. Accordingly, the provincial Government passed many related resolutions to effectively execute soil and water conservation program in Wuhua county[14].

The Comprehensive management system of small watersheds (5-40 km) has been very popular in Wuhua county. At present, the county has 62 small watersheds under the comprehensive management system. Planning and selection of these watersheds were carried out by a multi-disciplinary team of technicians, NGOs, village leaders and farmers. Under this system, local county Government and farmers provide financial support, where as Provincial Government provides necessary materials, tools and equipments to implement the program at a small watershed level. People's participation in land management is through various contractual arrangement such as Family Contract System, Collective or Group Contract System, Sub-lease Contract System, Professional Contract System and Specialized Contract System. Because of these systems of people's participation, soil and water conservation works in China have been carried-out successfully. These systems have significantly improved the rural economy and standard of living of farmers of Wuhua county. This is achieved by soil and water conservation techniques which give quick economic benefits.

The concept of small watershed based development is practised successfully in Wupi river watershed of Wuhua county. The overall plan for the management of a small watershed emphasizes on comprehensive erosion control measures including measures for hill slope and gully stabilization. regulating river system and rearranging farm lands. Principles of soil erosion control have been further developed by combining soil erosion control measures with the optimum utilization of biological measures. Under these principles, short-term, medium-term and long-term objectives have been formulated.

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[13] ibid.

[14] Wu Deyi A case study of successful watershed management in Wuhua County, Guangdong Province, China, **www.capri.cgiar.org**

Short-term objective is to upgrade agricultural production, medium-term objective is to increase fruit production and long-term objective is to develop forestry and eventually to combine ecological and economic benefits. The focus on economic benefits is based on the fact that the people would participate activity in soil erosion control works only if it results into quick economic benefits to them[15].

Soil and water conservation program in the Wuhua county by various contractual arrangements with the farmers has transformed the small watersheds into marketable commodity production systems bases. In mountainous areas, cash crop trees are planted in terraced farmlands. Pineapple, plum, shatian, shaddock, litchi, pepper, mango, tea, banana, carambola, papaya, citrus, agro-forestry, livestock, and aquatic products have been produced with high market value. The per capita food produced has remained same due to reduction in agricultural area, but the per capita income has increased 4-5 folds. This is a result of the success of the various contractual arrangements made by the Governments for people' participation in the small watershed based natural resources management by leasing the lands from 20-50 years duration.

Conclusion

The integrated nature of watersheds provides a strong rationale for using them as the basis for managing, restoring, and rehabilitating ecological systems. Watershed management is based on the premise that many environmental problems , habitat loss and degradation, etc. are best addressed at the watershed level because the context specific nature of the problems often requires complex policy solutions that require the expertise and authority of multiple agencies located at different levels of government. Common themes in many watershed and ecosystem management programs include:

- Approaching problems from an integrated or systems perspective;
- Improving institutional performance;
- Improving the integration of government policies;
- Enhancing the coordination of various governmental and nongovernmental programs;
- Broad public participation;
- The involvement of key stakeholders in government decision making; and,
- Having a stronger scientific basis behind government policies

The above case studies reveal that watershed management needs maximum use of local participation, local knowledge about indigenous soil taxonomy, biodiversity, soil and water conservation structures and traditions and experimental ethic of the local communities.

[15] ibid.

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