

Watershed Management Research:

A Review of IDRC Projects in Asia and Latin America

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International Development Research Centre

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Working Paper Series

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Abstract

This report highlights insights from recent watershed projects of the Minga and Community-Based Natural Resource Management (CBNRM) Program Initiatives of the International Development Research Centre (IDRC). Its purpose is to aid new projects in drawing upon insights from past experiences and to further develop and consolidate good practices in participatory integrated watershed management research. Data for this paper were gathered from an in-depth review of project outputs from IDRC researchers and partner organizations, as well as personal interviews and communication with individual researchers. The review reveals watershed management research as an interdisciplinary effort at multiple scales within a long-term movement towards informed participatory decision-making at the watershed level. Despite its complexities and challenges, it can provide an effective framework for natural resource management. To achieve functionality it requires the best of many different areas of research and the effective involvement of diverse stakeholders. It is best addressed through a coherent programming, learning and institution-building framework rather than by individual separate projects. This perspective is being strengthened within IDRC and its partners.

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Executive Summary

Recent research funded by the International Development Research Centre (IDRC) has been at the forefront of new methods and paradigms of natural resource management (NRM) in the contexts of watersheds. In the movement towards more sustainable improvements in local livelihoods and more effective NRM practice, IDRC watershed projects have fostered important developments in integrating participatory and interdisciplinary research, building resilient institutions for NRM and scaling up practices and approaches for wider impact.

This paper is an attempt to synthesize key insights from projects of the Minga and Community-Based Natural Resource Management (CBNRM) Program Initiatives of IDRC involving countries across Latin America and Asia. An in-depth review of project outputs from IDRC researchers and partner organizations was completed, as well as some personal interviews and communication with individual researchers.

First, watersheds are useful units for NRM due to several biophysical and in most cases, social characteristics. Watersheds highlight the interrelations between key natural resources and human activity. Watersheds, together with aquifers, are the most important units for data collection and modeling in water management. Water is the primary resource that defines the boundaries of watersheds and links the various stakeholders through upstream-downstream flows. While increasing potential for conflict, these flows can also promote cooperation across political and cultural boundaries, and can link activities on multiple scales.

Second, land use is a primary concern in watershed management. Intensification of land use for agriculture and human activity has major effects on soil quality and water quality and quantity. Non-point-source pollution from intensive agriculture, livestock operations and human waste is the principal threat to water quality in rural areas. The loss of forest cover is a major cause of increased flooding, soil degradation and decreased recharge of aquifers.

Land tenure, both private and collective, was found to be a major determinant of livelihood potential and of participation in watershed management efforts. Common property resources (CPRs) are of central importance, especially for low-income inhabitants. The exclusion of women from decision-making is a major barrier to proper management as women are often the primary users of CPRs and have the best understanding of CPR interrelations and management practices.

Third, the complex interrelationships between human and resource dynamics in watersheds necessitate interdisciplinary research. The most effective projects are those that integrate biophysical and socio-economic research to high degrees throughout all parts of the project. They must also recognize that different actors have important roles to play, and efforts to make research participatory at all stages are essential in assuring applicability of results and long-term sustainability of management mechanisms.

It is essential for local stakeholders to be involved in designing the research process, framing objectives and assuring applicability. At the same time there is a strong need for consistent datasets and collection mechanisms in order to provide integrated analysis at the watershed level. Combining participatory research with rigorous, consistent data for modeling is challenging. As research becomes more action-oriented, it is also important for researchers to define their roles and objectives related to policy influence and institution building. Most successes in this area are found in facilitating linkages and capacity building, and through careful analysis of gender and power dynamics in the community.

Fourth, it is clear that integrated watershed management requires communication and coordination of research, decision-making and interventions across multiple scales. Democratic local governance is the foundation for participatory local resource management, and this in turn is the foundation for scaling up participatory approaches to the watershed scale. Achieving nested scales that promote partnerships and democratic processes at each level are best seen as long-term goals in which smaller projects can be placed. The most successful scaling *up* efforts have also included elements of scaling *out*, developing a wide base of support and common approaches. Mechanisms for cooperation across political boundaries need to be explored, such as payment for

environmental services. However, in any discussion of scale it is important to determine what level of integration is necessary for adequate management of a resource or issue to avoid unnecessary complexity.

Finally, participatory integrated watershed management requires strong institutions that bridge the gap between local applied research and the broader policy environment. Projects were most successful in helping build these institutions when they made major efforts to include relevant government bodies in research projects and management initiatives rather than creating parallel, competing processes. One of the most successful forms of organization for participatory watershed management is the multi-stakeholder forum. They have taken many forms with varying purposes, from simple consultations to real decision-making power. Creating and sustaining such forums is difficult and they are not the magic solution to participatory management. These forums can, however, provide a legitimate space for dialogue, conflict resolution and planning that does not commonly exist within current structures. Such fora must be accompanied by efforts to prevent entrenchment of the local elite and ensure equal voice and participation of relevant stakeholders. Watershed management institutions also must be able to weather the rapid changes that can occur in social and biophysical environments. Developing local partnerships and linkages to research resources in-country are essential for continuity beyond the term of a research project.

Further research is needed in several areas:

- Soft paths for water management and implications for rural watersheds
- Human and ecosystem health (non-point sources of pollution and cumulative effects)
- The effects of privatization and valuation of public resources on the complex interactions in watersheds
- Collective definitions of water rights and their effects on watershed management
- Developing better systems for the integration of biophysical and socio-economic data
- Understanding surface and groundwater interactions
- Urban-rural interface

Watershed management research is an interdisciplinary effort at multiple scales within a long-term movement towards informed participatory decision-making at the watershed level. Despite its complexities and challenges, it can provide a very effective framework for NRM. To achieve functionality it requires the best of many different areas of research and the effective involvement of diverse stakeholders.

Purpose and Methodology

This report highlights insights from recent watershed projects of the Minga and Community-Based Natural Resource Management (CBNRM) Program Initiatives of the International Development Research Centre (IDRC). Its purpose is to aid new projects, within IDRC and beyond, in drawing upon insights from past experiences and to further develop and consolidate good practices in participatory integrated watershed management research.

The two Program Initiatives have different regional foci: Latin America and the Caribbean, and Asia. Despite many socio-cultural, political, economic, historical and physical differences between the two regions, watershed research projects have experienced many similar issues. This report synthesizes these experiences into key insights, identifying issues that are unique to watersheds and also larger issues that have specific relevance to watershed environments.

Data for this paper were gathered from an extensive literature review of project outputs. Initial identification of relevant projects and resources came through consultation with CBNRM and Minga staff. Through a brief review of key project outputs a set of research questions were developed for in-depth review of projects. A search of IDRC databases and websites was carried out to further identify projects and outputs, and some supplemental interviews were completed with IDRC researchers.

There is ample room for a more in-depth exploration of the issues raised. It would be of specific relevance to the new Rural Poverty and the Environment Program Initiative of IDRC to include the watershed projects of People, Land and Water in Africa and the Middle East in order to expand the scope of the review and provide further comparisons between contexts.

IDRC Projects Reviewed

The countries involved in the projects include: Argentina, Bolivia, Chile, Colombia, Ecuador, Honduras, Nicaragua and Peru in Latin America; and Bhutan, Cambodia, People's Republic of China, India, Lao People's Democratic Republic, Nepal, Pakistan, Philippines and Sri Lanka in Asia.

Table 1 shows the project reviewed; all acronyms and abbreviations used can be found in the list on page 54.

Project	IDRC Project Number (<i>Timeline</i>)	Timeline
PARDYP in mountain watersheds of the Hindu Kush Himalayas, ICIMOD. (India, China, Nepal, Bhutan, Pakistan)	Phase 3: 101672 Phase 2: 100119 Phase 1: 040340	2003-2006 1999-2003 1996-2000
MANRECUR – Collaborative watershed management of natural resources, FUNDAGRO. (Carchí Province, Ecuador)	Phase 3: 100996 Phase 2 ½: 101188 Phase 2: 050355/ 98-8754 Phase 1: 050193/ 96-8751	2003-2005 2001-2002 1998-2002 1996-2000
CIAT - Hillsides (Laderas): Sustainable Hillsides Agriculture (Colombia, Honduras, Nicaragua)	100511: Experiences of local participation and incidence in policies from sustainable agriculture in hillsides 050210: Sustainable hillsides agriculture - Phase II 003523: Farmer participatory research for sustainable agricultural management of Honduran hillsides - Phase II	2000-2001 1997-2000 1997-2001
Agualtiplano – Virtual information centre on water in the altiplano (Peru, Bolivia, Chile, Argentina)	Phase II: 101420 Phase I: 004026	2002-2004 2001-2002
Andean water vision from an indigenous and peasant perspective (Colombia, Ecuador, Peru, Bolivia, Chile, Argentina)	101689	2002-2004
HIMALANDES (Peru, Bolivia, Ecuador, Nepal, China, Bhutan)	100700	2000-2002
Resource management in Nam Ngum watershed Phase 2 (Lao PDR)	003492	1994-1998
Tarim Basin desertification and water management (China)	Prep for Phase III: 101414 Phase II: 040410 Phase I: 040180	2002-2004 1998-2001 1994-1998
Watershed management Sri Lanka	938310	1994-1998
Regulation of rights in the Water Law (Bolivia)	101423	2002-2005
Mountain resource management (Nepal)	911042	1992-1997
SANE - Scaling-up of successful agroecological experiences in Latin America and the Caribbean (Peru, Honduras, Cuba, Chile)	100183	1999-2004
Conflict and collaboration in NRM: Small Grants Program (Phase 1) (Global)	100159	1999-2002
Small Grants Program: Fondo Mink'a de Chorlavi (Latin America and Caribbean)	100730	2000-2004
Learning by doing: Mainstreaming multi-stakeholder approaches to NRM (Andes)	101651 – Water and governance	2003
EPINARM (Bhutan)	100392	2000-2005
Resource management policy Ratanakiri (Cambodia)	Phase III: 100488	2001-2006

The Latin American and Asian Contexts

Synthesizing watershed insights from the Andes and Central America with those from Asia has highlighted some important differences in context. There are differences between the two generalized larger regions but also between individual countries within each region. It is important to keep these contextual differences in mind when comparing approaches and results.

Government Involvement and Decentralization

There are marked differences between countries in the level of central government involvement in local affairs. China, Bhutan and Lao People's Democratic Republic (PDR) have very strong government presence in many aspects of rural society (Duba and Ghimiray forthcoming). Nepal is quite different, currently with a very weak government but a strong civil society (Jianchu Xu, personal communication, August 2004). The general trend across Asia is towards decentralization, although in many countries the process is emerging only recently. In the Latin American countries involved, the power of governments has been greatly reduced over the past three decades of decentralization as other actors play a more active role in the economy and society.

Role of non-governmental organizations

Non-governmental organizations (NGOs) are gaining in strength and momentum in both regions. Nepal and the Philippines have reasonably strong NGO communities; those of China and Cambodia are growing stronger. Most of Latin America has a very energetic history of civil society involvement. Lao PDR and Bhutan are exceptions, both with limited NGO presence (Jianchu Xu, personal communication, August 2004).

Role of Religion

The nature of religious institutions, and their level of importance in community and government, affects the nature of management solutions. For example, the caste system in parts of South Asia has distinct dynamics and challenges, while the Roman Catholic Church has been an important factor in development and decision-making in Latin America. Syncretism of traditional and introduced beliefs is also an important dynamic in many countries, as are recently introduced religions such as evangelical Christian sects.

These dynamics have significant impact on community organizing and natural resource management (NRM) behaviour.

Conflict and Reconstruction

Several countries have recently experienced or are currently experiencing major internal conflicts. Nepal, Colombia, Nicaragua, Bolivia, Cambodia, and Sri Lanka are some examples. Conflict and post-conflict situations can make broad-based collaboration between stakeholders and government extremely difficult. Internal displacement also has important effects on local governance structures, as documented in the Philippines (Quizon 2003), Nepal (PARDYP 2003) and Cambodia (Kimhy 2003). Conflict is an important factor in NRM that must be well understood.

Institutional Setting of Watershed Projects

Thus relations between government, civil society, the religious context, international development organizations and recent and ongoing conflicts all determine the institutional setting in which watershed projects will tend to be based. In some countries, such as Lao PDR, Bhutan and China, projects tend to be based within government ministries. In some, such as Nepal, it is a mix of NGOs and government. In others, including most of Latin America, projects tend to be based in NGOs. Experiences working with government and civil society are therefore different, and care must be taken in applying general lessons to specific contexts.

The Watershed Approach

Why Watersheds?

A watershed can be defined as: *an area biophysically delineated by water flow, drained by a current or system of currents towards one exit point or gathering area.*

This is the basic unifying definition that carries across all the projects reviewed. Differences occur in the size of watershed(s) with which each project works. The range has been from 2000 ha to 250 km². Many projects also do local work within smaller units of ‘micro-watersheds’ (25-500 ha) inside the larger watershed.

During the last few decades, watershed management has gained recognition and importance in both environmental protection and the well-being of people living in watershed areas. For example, in its ‘Bhutan 2020’ policy document, the Bhutan government named watershed management as the “single most important strategy to maintain the resource base to support the national economy” (Jamtsho and Gyamtsho 2003: 1).

Watershed management projects begin with the proposition that some natural resources are best managed on a watershed basis. They commonly involve multiple scales and a mix of physical and social dimensions that require an interdisciplinary approach (as discussed further below). Watersheds are considered useful units of analysis and action because of several physical and social characteristics (Schreier et al. 2003; Vernooy 1999; 2004; Sanz 2000):

Physical

- *Natural System:* Watersheds delineate natural biophysical units and are ideal for monitoring natural processes.
- *Multiple Scales:* Watersheds form unique nested landscape hierarchies and highlight biophysical interdependencies across several scales.
- *Ideal for Process Studies:* Watersheds allow mass-balance, input-output and water-nutrient analysis, and allow assessment of cause and effect relationships.

- *Integrated Framework*: Watersheds integrate all land use effects, highlight linkages between land use and water and facilitate system analysis.
- *Assist in Addressing Complexity*: Cumulative effects can be measured, atmosphere-soil-water interactions can be identified and effects of diffuse sources can be assessed.

Social

- *Decision-Making Tool*: Watersheds as geographic units facilitate science-based decisions. They provide an effective basis for dynamic and adaptive management.
- *Transboundary Links*: Watersheds are delimited by watercourses that contain interdependent natural resources. This links countries and regions, both through upstream-downstream flow and contiguous coincidence along river borders.
- *Social Organization*: Through the social construction of watersheds, they can become a common meeting ground for communication, negotiation, planning and monitoring.

A Recent History of Watershed Management

The status quo in many watersheds is that individual landowners make management decisions related to the resources on their own land. They tend to focus on their particular needs and worries more than the larger resource perspective of water flow, movement of organic material in the soil and landscape diversity. Also, watersheds rarely coincide with jurisdictional boundaries, and several governing bodies are usually managing and regulating resources with little coordination or communication.

The objective of watershed management is to find ways of fostering coordinated actions among users, managers and decision-makers in watersheds for the daily management of resources, and thus to facilitate solutions to the problems of NRM that cannot be resolved effectively in an individual manner (Ravnborg et al. 1999).

Many initial watershed management programmes implemented by governments failed to stop degradation of their target environments and had minimal results in improving the

well being of local people. These failures were caused by the following factors (FAO 2003a):

- Programmes were too focused on natural resources conservation and not enough on productive livelihood options,
- Programmes were designed with little attention to human activities and to the priorities and needs of people,
- Programmes were neglecting the involvement of beneficiaries and their contribution in the planning and implementation of the watershed management interventions.
- Projects were frequently limited in span and scope and lacked long-term commitments needed to address underlying causes and long-term management issues in a satisfactory way.

Consequently, new concepts and approaches were developed to reverse watershed degradation and to improve local economies, recognizing the limits of formal scientific research and the benefits of participatory methods. This is where most IDRC watershed projects enter the picture.

Where watershed management was formerly viewed as primarily an ecological and technical issue, particular attention began to be given to social and economic aspects. Recognizing that management and conservation would not be sustainable unless people's wider concerns were taken into account, the *integrated concept* was developed as an interdisciplinary process where community problems and needs could be addressed. Projects embraced a mix of production-oriented and conservation approaches at both micro and macro levels, and the 'sustainable livelihoods' approach was introduced. To gain people's confidence and commitment, *people's participation* was recognized as a principal component in all phases of project development.

As in other areas of development research, watershed projects have confronted the need for institutional change and consolidation of new decision-making processes. Policy influence and organizational processes have become central aspects of movement

towards watershed-level management, and researchers have taken on new roles in supporting these objectives.

The importance of multi-scale approaches has been recognized in recent years. It has become clear that distinct dynamics occur at different scales, within both biophysical and socio-economic processes. Projects have begun to see the need to consider multiple scales simultaneously for effective analysis and action. Cooperation across jurisdictional boundaries is often essential for effective watershed management, and is thus one of the key organizational challenges taken on by new projects.

All these components are brought together into the *participatory integrated watershed management research* (PIWMR) approach emerging over the last decade. Watershed management has become an interdisciplinary activity. It engages both biophysical and socio-economic research at multiple scales. It tries to interweave local participation into all stages of planning and implementation, and it has become directly involved in the creation and support of institutions¹ and policy development mechanisms within collaborative approaches.

Water: The Linking Resource

Water is the principal motivating and integrating factor in watershed management. The concept of a watershed inherently integrates the 'upstream' with the 'downstream' through the flow of this central resource, in liquid form and as part of the general hydrological cycle. A number of villages in a watershed often share the same stream as their water source. Stream flows have high seasonal variability, and seasonal local water scarcity is a problem faced by many farmers in small watersheds (Jamtsho and Gyamtsho 2003; Merz et al. 1998). Although several projects² started out looking at other specific issues, such as soil or forest resources, focus consistently returns to water as an equal concern (PARDYP 2000).

¹ In this paper the term 'institution' is used to describe an established set of *de facto* and formal rules, practices and customs that involve multiple organizations and actors within a society. This is in contrast to the common usage of 'institution' to describe a specific organization.

² The term 'projects', unless otherwise noted, will always refer to the IDRC watershed projects reviewed for this paper.

Natural resources, especially water, are frequent sources of conflict in watersheds. As environments degrade and usage increases, water is becoming scarcer. This increases competition between users (farmers, industries, governments and communities), which has often resulted in conflict and even violence. For example, in the Calico River watershed in Nicaragua, conflicts continually arise regarding access and distribution of water, within communities and between communities (Vernooy 1997). In Ecuador's Carchí Province, water theft was a common problem – both by farmers and municipal governments, something specifically addressed through the Carchí Consortium (Waldick 2003).

The absence of clear frameworks and legislation for water rights has been a major cause of these conflicts. In Bolivia, severe water scarcity, intense social pressure and high-profile failures of privatization schemes (e.g., Cochabamba water war in 2000) have led to greater openness in developing new water rights legislation. The Consejo Interinstitucional del Agua (CONIAG, Inter-institutional Water Council) was created by law in 2002 as a space of dialogue and cooperation between the government and civil society to construct a legal, institutional and technical framework for the organization and regulation of water resource management (Van Damme 2003). The IDRC water rights project has begun a multi-stakeholder process supporting CONIAG by analysing the impact of models for assignation and regulation of water rights at the watershed level and identifying possible proposals for a future normative framework (Alurralde et al. 2003).

Pricing of water resources is an extremely contentious issue in many countries. In most watersheds fresh water is generally undervalued – a primary limitation to conservation and efficiency efforts (Schreier et al. 2003). How valuation of water translates into pricing mechanisms is the main point of contention. Motivations for pricing include the need for proper funding for water management efforts based on use, and the need for greater direct incentives for water conservation and irrigation efficiency (Daxiong et al. 1997). Arguments against increasing water prices, and against various public and private management mechanisms, stem from a vision of water as a collective resource

(CONDESAN 2003) and from calls for public subsidies recognizing the substantial spillover benefits of water supply.

As water is used in a multitude of uses (from households to factories to farms), and its supply is affected by so many different activities (e.g., forestry, mining and agriculture), water management overlaps many different industries and jurisdictions. In most countries 10-12 different organizations and agencies are responsible for managing some aspect of water. There are those responsible for managing water provision and use, those involved in monitoring and then regulatory bodies (Schreier et al. 2003). New management politics towards sectorization of NRM are starting to alleviate this in some ways (e.g., previously broad departments such as 'environment' are being broken into specific resource fields such as water or forests). When demand begins to outstrip supply, and conflicts arise, current institutional setting is usually not equipped to manage the resources equitably and effectively. Water management, a central part of watershed management, requires new institutions and spaces for participation that promote broad-based cooperation.

The Social Construction of Watersheds

The geographical boundary of a watershed is rarely if ever a boundary shared with spaces of social and political organization. Very few political jurisdictions or traditional land claims coincide with watersheds. Social organization occurs around many different geographical boundaries from municipal to ecclesiastical, but not around water flow. Watershed management thus requires the construction of a new basis for social connections. Ronnie Vernooy has termed this the 'social construction of watersheds' (Vernooy 1999). In other words, watershed management requires a collective vision and the adoption of coordinated natural resource use and management practices, developed around the geography of the watershed. Many projects have failed because there has not been a sense of a watershed as a site for both biophysical and social (inter)actions. Building this social sense requires some form of collective action (Vernooy 1999; Ronnie Vernooy, personal communication, August 2004).

Land Use and Tenure

Property Rights and Participation

Land tenure is a major determinant of livelihood potential and a major motivating factor for participation in watershed management activities. Secure property rights, entailing some level of exclusive access and control, allow better long-term planning, access to credit, management of risks, and greater incentives for investment in new technologies (Meinzen-Dick and DiGregorio 2004, Proaño and Poats 2000). In order to begin watershed management, it is important to identify the plurality of tenure types, such as government, private, community and joint ownerships that may exist *de jure* and *de facto*, and adjust participation-building strategies accordingly.

Experiences also show the need to ensure clear tenure *rights* before trying to solidify *responsibilities*. In some watersheds, the issue of land tenure is pronounced, as for example in the Hillkot watershed in Pakistan where 75% of the people are tenants, including two villages where no inhabitants own any land (PARDYP 2001). In the Philippines, before undertaking management activities, the local partner (the Center for Alternative Rural Technology) had to negotiate with government to ensure the security of land and resource tenure. Upland farmers were later granted 50-year land leases, while fishing communities were deputized as 'Fishery Wardens' to enforce fishing laws in municipal waters. It is argued that people will take care of their environment only if their rights to land and water resources are ensured (Quizon 2003). In the Xizhuang watershed of China, successful reforestation happened only after the transfer of forest tenure to local communities and the provision of user rights to communities and households (Xu et al. 2002).

The Importance of Common Property Resources

In the watersheds reviewed, both ecological and livelihood sustainability are strongly influenced by the status of common property resources (CPRs). Many inhabitants depend heavily on activities in common lands and forests for their daily needs (e.g., firewood, grazing, uncultivated crops and species), and degradation of CPRs causes losses of both ecological health and livelihood potential. The CPRs are a central part of the coping and adaptive strategies of the poor and play a major role in poverty reduction

(Beck and Nesmith 2001). Deterioration of governance systems within communities has in some cases (such as some projects in India) led to fragmentation and privatization of CPRs, and seriously affected the strength and harmony of traditional communities (Darlong and Barik 2003). Thus, watershed management efforts need to have a good understanding of the CPRs in the watershed, and broader research into CPR management is of major relevance.

Local Management

The common property discourse shifts emphasis from questions of resource availability to those of access, control and management. Management of CPRs *by local users* is often the most effective and sustainable over the long-term. Locally developed management solutions are the most responsive and most fully implemented, and poor people can be positive contributors to environmental regeneration (Beck and Nesmith 2001). At the same time, privatization, enclosure and elite capture³ of formerly common resources are eroding the ability of local people to manage CPRs, situations that would benefit from appropriate government intervention. Power issues at the local level play a key role in determining the distribution of benefits of CPRs and the ability to prevent resource degradation (Topal et al. 1999b).

Multi-stakeholder Cooperation

Improved management and utilisation of CPRs is determined to a significant extent by the structure, composition and degree of social cohesiveness of the user community. It is suggested that *heterogeneity* of social structure and composition within user groups significantly contributes to better management and utilization, and makes elite capture less likely (Bhuktan et al. 2002). This implies that a certain level of complexity is necessary for a stakeholder group to be most effective.

³ 'Enclosure' refers to the division and fencing-off of land previously open to general access (e.g., pasture). 'Elite capture' refers to the process through which the most powerful local actors (i.e., elite) use their power and influence to unfairly capture previously public or common land and resources as their own private property.

Women, Girls and Exclusion

Marginalization of women and girls can be a major barrier to effective management of CPRs, and should be a central aspect of watershed management research. The People's and Resource Dynamics Project (PARDYP) surveys found that women have a better knowledge of CPRs such as water, fodder, pasture and fuel wood species than do men, and have been reported to be better at managing ecosystem and conservation concepts. Women perform almost all activities related to forests, grass, and agriculture. However, their participation in local institutions and community-wide decision-making is almost negligible. The more important the decisions considered by the community, the less influence the women have on the decision-making process (Bhuktan et al. 1999; PARDYP 2001).

The gendered variance of impact from resource degradation is a most important issue. For example, in the middle mountains of Nepal, women are responsible for fetching water, cooking, cleaning, planting, weeding, harvesting, collecting fodder, and stall feeding and milking animals. As the major suppliers of basic food, water and fuel wood resources, women are impacted the greatest by environmental degradation. As resources degrade (e.g., low supplies of water because of seasonal droughts and pollution) women's workload increases dramatically, which negatively impacts families' well-being and many other aspects of development (Brown 1999). Women rise earlier and spend a greater proportion of their day working than do their male counterparts. Adult women typically worked 3.8 hours per day longer than the adult men (Brown 2003). These trends are mirrored elsewhere in both developing and non-developing countries (FAO 1996; SWC 2001; IFAD 2002; Lindén 2002).

Land Use and Watershed Sustainability

Soil is considered a living and dynamic resource whose condition is vital as much for agricultural production as for the functioning of the ecosystem. "Given its role as regulator in bio-geochemical nutrient cycles, as a modulator of water availability and quality, as well as its role in filtration and decomposition of contaminants, soil is a key natural resource for our future survival" (Trejo et al. 1999: 1). Land use has drastic

impacts on soil quality, and the quality of soil and water are principal indicators for impacts of land use on watershed health.

The ties between land use and watershed health have become clearer over the past decade as linkages between soil and water indicators have been better understood and major studies have been conducted. Changes in land use modify sediment transport, nutrient fluxes, stream courses, temperatures, animal populations, water balances and many other natural dynamics (Schreier et al. 2003). Agriculture, the principal productive activity in most of the watersheds of projects reviewed, can have significant effects on water quality. Heavy doses of fertilizer and intensive use of agricultural land have been demonstrated to have a strong negative impact. The main pollutants are microbes, phosphates and nitrates. Harmful fecal coliforms mainly come from human and animal waste. Phosphate and nitrate pollution mainly originates from agricultural practices (fertilizer), and eutrophication (drop in oxygen levels caused by increased algal growth due to excess nutrient enrichment of surface water) can now be observed in many lowland sections (Merz et al. 2003; Schreier et al. 1999).

In urban areas, *point-source* pollution and untreated storm flow are the major concerns. In rural areas, such as the middle mountains of Nepal, water quality deterioration is rather the result of *non-point-source* pollution by human waste and intensive agriculture with high mineral fertilizer and pesticide inputs. In certain locations, increasing numbers of livestock for dairy farming are adding to the non-point-source pollution problem. The dry season of water scarcity increases the effects of the pollution on human and animal health and, during the rainy season, feces and other pollutants are washed into the river system, also putting health at risk (Merz et al. 2003). Non-point-source pollution is becoming a major concern across the world, including Canada where problems of nitrate and pesticide contamination of streams and groundwater, cultural eutrophication and microbial health problems are increasing (Schreier et al. 1999).

Forests are another key resource of watersheds, interrelated with water and soil. Forests are the protectors and filterers of water, and the base of much of a watershed's diversity. Where forests have disappeared, runoff and flooding typically increases, and groundwater recharge may be negatively affected. Forests are placed in increasing

jeopardy as population and economic pressures rise. More and more upland forests are being cleared for agriculture, forestry production and other purposes (Figures 1 and 2). Water sources and springs are becoming increasingly unprotected and erosion is a major problem in many areas (Xu et al. 2002).

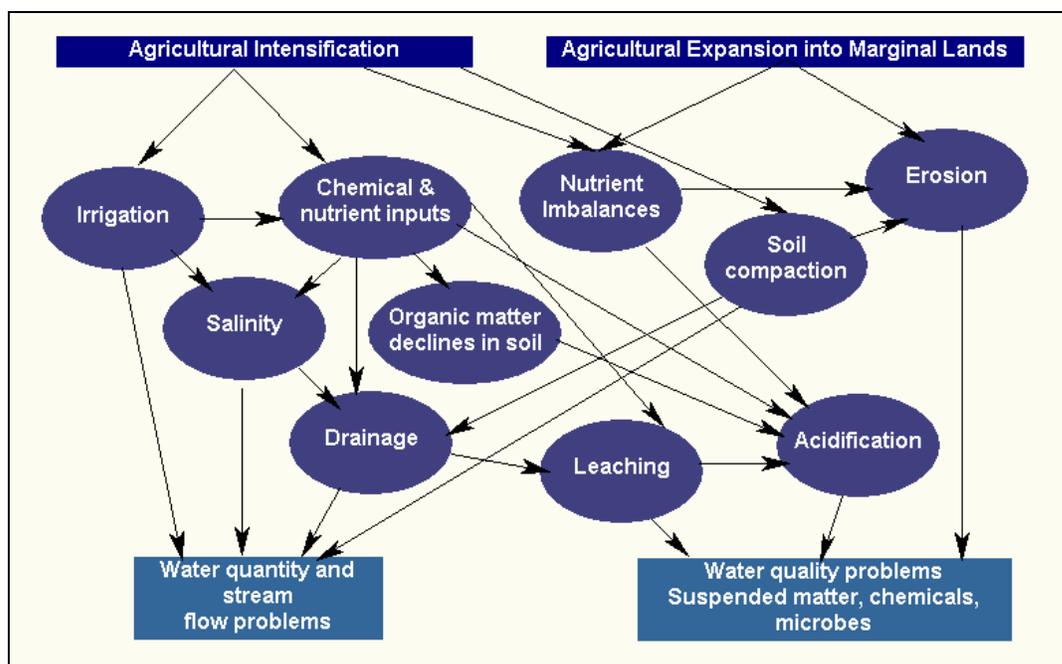


Figure 1: Land Use Impacts on Water – Agriculture (from Schreier et al. 2003)

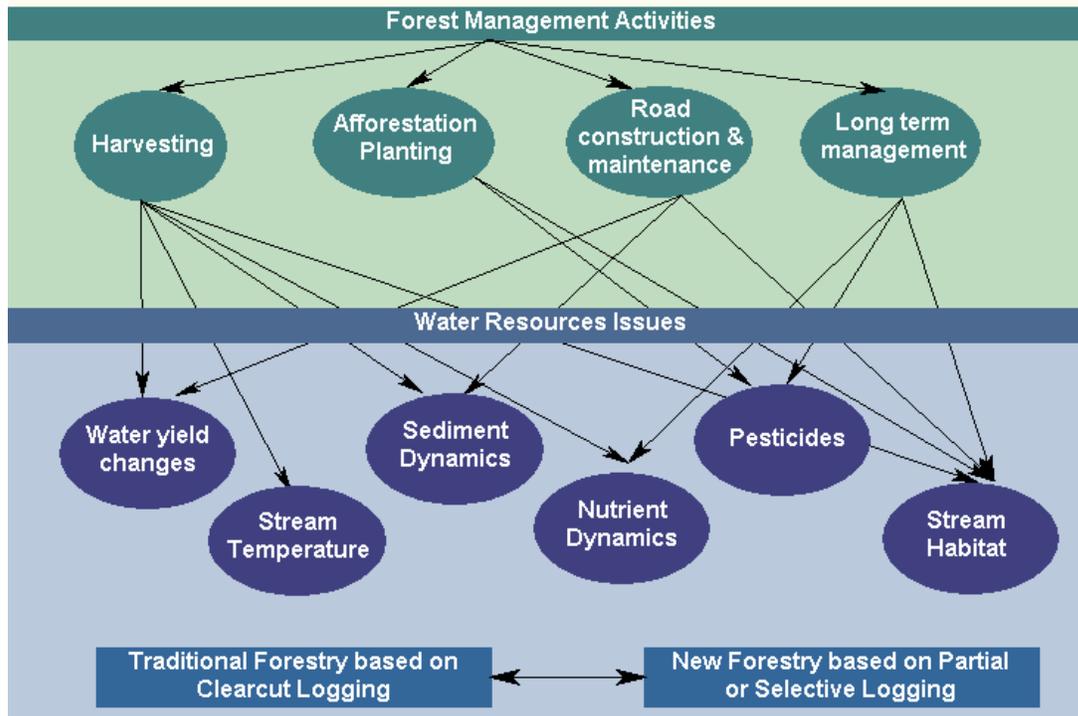


Figure 2: Land Use Impacts on Water - Forestry (from Schreier et al. 2003)

Interdisciplinary, Participatory Research

Interconnections Require Interdisciplinary Approaches

Developing the necessary understanding of people and resource dynamics for effective watershed management is an extensive task. These dynamics are interconnected and experiencing rapid changes. Within this context, interdisciplinary research is essential. Insights and tools should be incorporated from many different disciplines, including landscape ecology, systems theory, economics, actor-oriented rural sociology and learning theory. Many different actors have roles to play in the process including farmers, local leaders, extension workers, researchers, NGOs and government agencies.

Management entails using data to make decisions and take action. This requires research that is both multidisciplinary and integrated enough to holistically present realistic options that will have the desired impact within the interconnected environment at multiple scales. The most successful projects are those that use interdisciplinary approaches from the very beginning, addressing issues within their full context.

Inter-disciplinary vs. Multi-disciplinary

‘Multidisciplinary research’ involves parallel inputs from different disciplines without requiring consultation between them. ‘Interdisciplinary research’ implies interaction between different disciplines in relation to the research problem and throughout the research process, beginning ideally with the definition of the problem (Kapila and Moher 1995).

The multidisciplinary approach is most common, with projects tending to divide work along disciplinary lines with little real integration, as evidenced in the early Nepal and China teams of PARDYP and Manejo de Recursos Naturales (MANRECUR, Natural Resource Management) Ecuador. Most have attempted to integrate their findings at the moment of report writing, after having collected data on their own and analysed the data from their perspective. This has not been successful on the whole, because the frameworks and analysis used have been too diverse. This lack of integration has been a barrier to developing realistic cross-discipline conclusions and intervention options.

Dick Van Dusseldorf lays out the main components of interdisciplinary research (van Dusseldorf 1992, cited by Kapila and Moher 1995): (1) studying the same object (2) at the same time (3) by members of different disciplines (4) in close cooperation and (5) with a continuous exchange of information, (6) resulting in integrated analysis of the object under study. If the goal is integrated watershed analysis, then a team made up of a range of disciplines (for example: soil scientist, agronomist, and livestock specialist, and community facilitator) should work together on a common problem from the start of the project. The team physically works together, they see degraded land together, see fodder options together, observe livestock together, discuss production costs and profitability together, and most importantly discuss with farmers and community members all aspects of the area or topic. With the local people, they come up with solutions together, implement actions together, then monitor and evaluate the action together.

This interdisciplinarity also requires clear qualitative and process indicators for concrete and identifiable goals that conceptually integrate the different disciplines and their methodologies. Systematically registering this allows interactions to be better identified and tracked. Integration of socio-economic and biophysical aspects of watershed management should also be part of a larger participatory planning process that includes strategies for sharing, applying and promoting the data and knowledge that accumulates.

Biophysical Is Not Enough

In practice, the 'watershed' concept has been first and foremost a biophysical concept for most projects. Research teams usually approach watershed management starting from concrete biophysical issues such as hydrology, soil degradation and forestry management, and thus are usually heavily characterized by geographers, geologists and meteorologists.

However, project teams soon discover that the biophysical approach is insufficient to resolve the problems faced in their watersheds. They find that addressing the underlying causes of resource use and land-cover changes also requires changing the fundamental ground rules that define who is involved in decision-making, what power these different

actors exercise and how they are held accountable for their decisions. This requires that social factors be given equal attention (e.g., Bhutan in Duba and Ghimiray forthcoming).

At the same time, watershed problems cannot be addressed with solely social science research either. In order to manage water, for example, researchers must know how much water is available, its variability seasonally and temporally, and the effects of land management on both water quality and quantity (Sandra Brown, personal communication, August 2004). Productive innovation options are also an important part of ensuring practical benefits of management efforts and catalyzing local participation, innovations that require biophysical research.

Where to Start

Four central guiding questions need to be answered, at the beginning and throughout a project:

1. *Why are we doing this research? For whom and for what purpose?*
2. *What data are needed to achieve these purposes, both a minimum set and an ideal set? What level of quality, precision and rigor is needed?*
3. *How will the data be gathered? What methods are the most effective and appropriate given our purpose?*
4. *How will the data be analysed and how will the analysis be used?*

Clear answers to these questions can provide a solid guiding framework for a project's work.

Making it Participatory

From the very start, projects must decide *who* will answer the questions above, and *how* the answers will be reached. Participatory research has important political implications, and it is important for projects to answer five fundamental questions regarding participation:

- Who participates? Why? Who chooses the participants and how?
- Who benefits?

- Who is excluded? Why?
- What are the risks and costs?
- Who facilitates? How best to facilitate?

These questions may seem simple, but they are usually problematic. They define what Ronnie Vernooy has called the ‘art and politics of participation’ (Ronnie Vernooy, personal communication, August 2004). Despite many years of discussion in research realms regarding participatory methodologies, designing and implementing an effective project on solid participatory foundations still requires a great deal of thought and adaptation to local context.

Agency, which is the fundamental principle of participatory research and development, must begin at a project’s foundations. The most successful participatory approaches are those that allow the research to be designed by stakeholders and not independently by researchers (for an example from Bhutan, see Jamtsho and Gyamtsho 2003). Some of the most successful techniques in doing this have been:

- *Outcome mapping*⁴ with stakeholders to define scope and activities of projects – e.g., Bolivia Water Rights Project.
- *Participatory Rural Appraisals* (PRAs) – used in many projects, including PARDYP in Asia and MANRECUR in Ecuador.
- *Farmer Participatory Research* and *Participatory Technology Development* – e.g., CIAT-Hillsides projects of Central America, and PARDYP in China.

Movement towards participatory techniques usually means pulling in skills not present in initial research teams. People are needed who are able to work at community organization levels, individuals with a strong practical orientation rather than an academic one. While technical specialists may be skilled in reductionist-type analysis, they need to acquire facilitation skills, which are very different. Facilitation is an art

⁴ Outcome Mapping is a methodology for planning, monitoring and evaluating that looks at both development results and internal performance, helping a project design interventions in relation to the broader context, assess within its sphere of influence, focus changes in the behavior of partners (as outcomes) and recognize various contributions to the achievement of results. For more information, see www.idrc.ca/evaluation/outcome.html.

requiring skilful listening, asking the right questions, fostering group synergy, and assisting in problem diagnosis and mission definition (Vernooy and Ashby 1999).

The Role of the Researcher

As projects shift their focus towards the farmer or community member as ‘client’, ‘participant’ and even ‘co-researcher’ rather than as an object of research, the project becomes more directly involved in their needs. The participants themselves begin to set the project priorities, and the research organizations must decide the limits to their role within this context. Because IDRC watershed projects are ‘research’ projects, there has been a tension between the role of ‘researcher’ and the role of engaging in action-oriented development activities. This question has arisen strongly from the incorporation of more participatory research techniques, such as PRAs and participatory action research (PAR).

Researchers should spend time clearly defining their roles, for both their own and the community’s sake, in relation to three key areas of activity:

1. Implementation of applied research,
2. Institution building, and
3. Policy influence.

Each area entails a movement beyond purely diagnostic activities.

The real experience of most projects was that they began with the main areas of expertise of the project team. As projects progressed, they then brought in different skills to address broader issues. For example, the PARDYP project adopted a framework that has gradually been moving from basic research to applied research to policy influence to broader networking. By phase 3 (years 7-9) of the project, their role has taken the shape outlined in Figure 3.

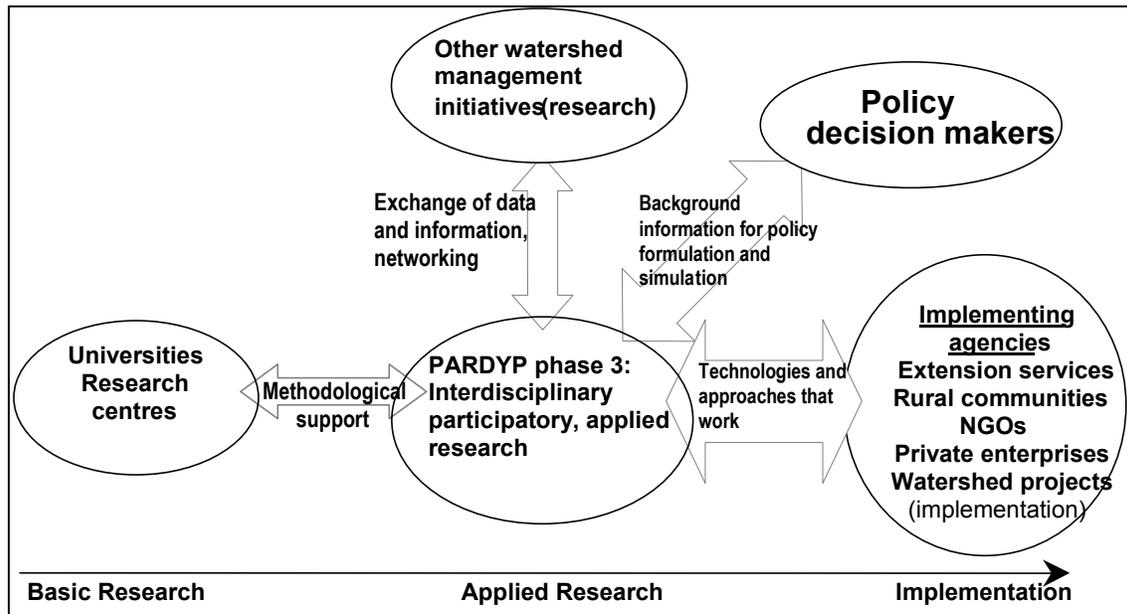


Figure 3: People and Resource Dynamics Project (PARDYP) Phase 3 Research Role (from Bhuktan et al. 2002)

While research may begin with practical and technical work (often essential for catalyzing local participation), eventually its focus should shift from ‘doing’ to ‘facilitating’ and helping establish linkages between local user groups and external resources, organizations and service providers (Bhuktan et al. 2002; Krause and Meléndez 1999). It is wise to identify the limits of the project’s role while creating links with other actors that can maintain activities beyond the project’s duration (Bhuktan et al. 2002; Krause and Meléndez 1999; Carson et al. 1999).

Benefits of a Problem-Oriented Approach

Another approach, adopted by the CIAT-Hillsides project in Central America, is to base in-depth research on specific problems faced by stakeholders in the watershed. The project used assessment tools such as PRAs and community resource and poverty mapping to identify key issues, and then expertise was brought in to help address them. The makeup of the research team was flexible and directed towards linking with relevant extension researchers and community practitioners in-country. Starting with community-

defined desired outcomes led to an interdisciplinary framework with clear logical flow (see Sanz 2000; Vernooy et al. 2001).

Relations with Traditional Knowledge and Social Structures

Through integrating participatory approaches into both biophysical and socio-economic research, projects have discovered that the diversity of approaches and realms of knowledge require even broader disciplinary scope. Participatory research engages directly with traditional knowledge (see Box 1) and structures. These often present not only different understandings of issues, but often entirely different systems of meaning. Fully participatory approaches will have to bridge the gaps between knowledge systems.

Box 1. What is traditional knowledge?

(Xu et al 2002)

1. Cosmivision: Cultural values and beliefs
2. Knowledge
 - i. Technical knowledge
 - ii. Teaching-learning
3. Practices
 - i. Management
 - ii. Innovations
4. Organizations and Institutions
 - i. Rules and Norms
 - ii. Decision-making processes

Traditional knowledge should be treated more as an asset than a limitation. Proper understanding of local life reveals underlying values, ways of thinking and time-honoured survival strategies that can shape and strengthen management solutions. If proposed solutions do not build this understanding, they stand a high risk of rejection.

“That is not to say local people always know best; romanticizing tradition can [prevent necessary changes]. But local practices always spring from some rationality, and it is this rationality that needs to be understood. Moreover, local knowledge and traditional practice are not static; they may not change fast, but neither do they change randomly. They change when, and only when, people see the value of change” (Brooks 2002: Part 4, Section 3).

Are Customary Institutions Sufficient for Watershed Management?

Some projects found that traditional management and regulatory mechanisms, when preserved and practiced, are adequate foundations for participatory NRM. However, the changes that have occurred in population, demographics, culture and value systems,

government policy and economic forces have increased resource demand and eroded the effectiveness of such mechanisms in recent years (Darlong and Barik 2003). Traditional management systems need to be modified to address these changes. For example, agriculture uses 70% of all freshwater in an inefficient manner. As the demand for water increases, users must become more efficient (Hans Schreier, personal communication, August 2004).

It is also true in some cases that traditional management systems need to be changed because of the increasing demand from different users and increased climatic variability. Researchers can play a role in strengthening community capacity, a process that can help preserve community traditions while still addressing pressing concerns. Researchers can be a catalyst for adaptation by introducing new tools and concepts appropriate for the local context. They can bring formal-sector research findings and guiding principles to complement innovations of community members.

Researchers can help community members develop the skills necessary to be active within new government and legal contexts, where they need to be able to present their situation and policy alternatives, and negotiate for their rights (Sovanna 2003).

Indicators and Data Management

Working with multiple stakeholders and disciplines, watershed projects can face many different understandings of key concepts and indicators. Research must bridge the gaps between these understandings to maintain consistency and develop relevant data frameworks. This is difficult because different groups have access to different kinds of data, and may even disagree on what constitutes a 'fact' and how it should be measured.

Defining Indicators

Keeping the principle of stakeholder agency in mind, the definition of indicators is a key step in the planning process that should be done in a participatory manner. This process usually requires some experienced facilitation, as a clear flow must be maintained from research needs to data collected to predicted applications of the data and final outcomes. External expertise can bring awareness of tools and possibilities for analysis that community members did not realize existed. Local community members can bring

already developed understanding of local dynamics, and essential input into how to make research the most applicable. This can be part of a larger community outcome mapping exercise, as done in the Bolivia Water Rights project (Alurralde et al. 2003).

It is important to remember that multi-stakeholder processes require indicators that are useful for users with diverse skills and background, including agricultural producers, extension workers, researchers and policymakers. Indicators should (Trejo et al. 1999):

1. Be easy and practical to measure in the field,
2. Be precise and easy to interpret,
3. Be economical,
4. Present good correlations between processes of the ecosystem, plant and animal productivity, and other human activity, and
5. Be ideally components of a larger database to more easily identify these correlations and to develop models for planning and analysis.

An example of using correlated indicators at multiple scales is shown in the Central America project of the Centro Internacional de Agricultura Tropical (CIAT, International Center for Tropical Agriculture) - Hillsides project. Simultaneous work at various scales can use soil and water quality interrelations to detect impacts of land-use changes on the larger watershed. The use of watersheds as units of study is useful as these generally have clearly demarcated physical limits and the effect of changes in soil use can be measured in the water. Changes generated in the soil by production systems within a watershed can be detected at the parcel scale through *soil* quality indicators, but the effect of soil use on the watershed scale can be detected through *water* quality (e.g., content of pesticides or nitrates). The challenge is in establishing sufficiently robust correlations between the soil indicators and water quality indicators in each setting, an important scientific role for researchers (Trejo et al. 1999).

Need for a Consistent Dataset and Collection Mechanism

Local definition of indicators must be balanced with the need for consistent mechanisms for data collection and analysis. This was a common concern of many projects because without consistent data it is difficult to bring together information and identify larger

dynamics across large areas like watersheds. Often several different government agencies and organizations are gathering data in a watershed, and it is essential for them to be able to share this information and use it in analysis. Common methodology, scientific consistency and rigor, and compatible software/storage method are required (Van den Brand 2000). Projects faced major problems in interpreting data because of differences in software, scale, classifications and measurement techniques.

One of the best examples of consistent datasets and collection frameworks is the Himalayan-Andes Watershed Comparison project. In all eight watersheds a common and specific research framework was used to analyse the watershed, as shown in Figure 4.

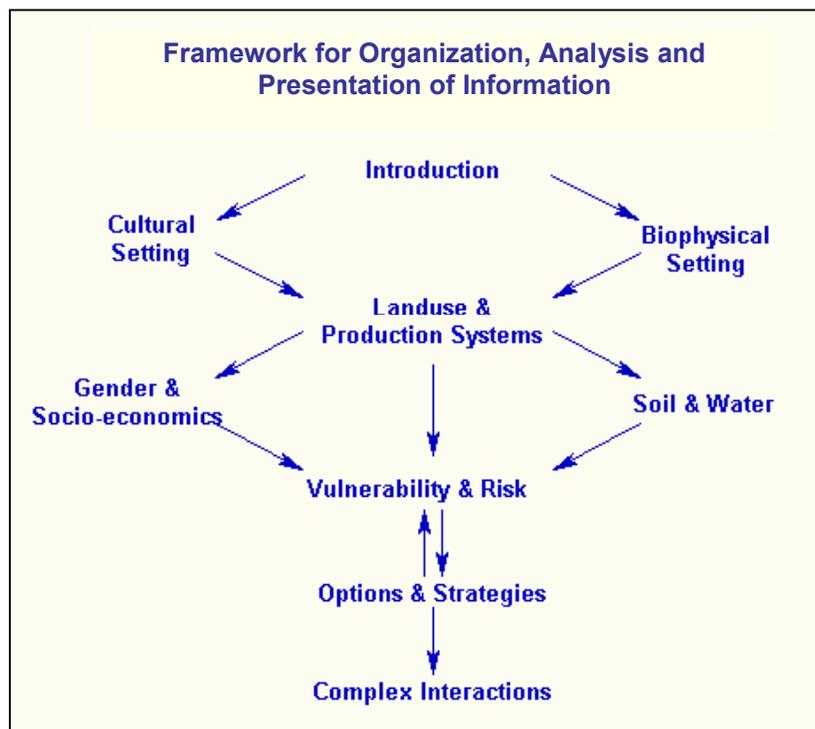


Figure 4: Research Framework of the Himalayan-Andes Watershed Comparison Project

The project then reached an agreed upon set of indicators for each part of the framework. Research was carried out eight watersheds in the Himalayas and Andes, gathering data developed by local projects, and organized into the above framework.

As a primary goal of the project was to provide insights to watershed management around the world and provide resources to researchers, each watershed management organization produced a CD-ROM presenting their findings, and an overall comparison and synthesis CD was also developed. Through consistent data collection and analysis frameworks, the project was able to identify a set of transferable options and approaches applicable to all watersheds (such as water source identification and protection), as well as general trends such as livelihood constraints from water quality (Schreier et al. 2002).

How can a project combine data consistency with local participation in research design? In practice, only a few projects succeeded in combining locally defined indicators with a larger scientific methodology and data set. The others achieved common data sets through indicators defined by the researchers.

The Honduras CIAT-Hillsides project implemented a unique approach to linking information. The team characterized 90 Honduran villages using locally identified indicators (e.g., land tenure, livestock, housing and work) to derive locally relevant rankings of 'well-being', geographic representations of poverty and biophysical factors (Ravnborg et al. 1999; Baltodano and Mendez 1999). They then linked this database to national databases using neural networks, and generated a map of the 'well-being' composition of all Honduran villages. The result is an example of a common knowledge base that can bridge the communication gap from international and national perspectives to local community perspectives (Sanz 2000; CIAT 1998).

Watershed Modeling

The ability to model people and resource dynamics at the watershed level is a valuable tool. It allows greater understanding of current issues and pre-implementation testing of possible interventions. This should be a long-term goal of most data collection and analysis (Schreier et al. 1993). A key element of such models is large-scale (e.g., 1:5,000-1:20,000 scale) geo-referenced data, the lack of which has limited policy and program planning in the past. Large-scale spatial information is crucial for community-level planning and useful for effective dissemination of research results to communities (Shrestha 2001). These models, if made sufficiently accessible and practical, can provide stakeholders with the understanding and confidence needed for effective participation in

planning processes (Failing et al. 2004). The data sets generated can empower groups to increase bargaining power on how best to use the resources to suit their needs.

It is important to remember that these models are only as good as the data used to build them. The above discussion about common data collection mechanisms is central to good modeling, and local people must be involved in design and implementation of the research to assure the relevance and applicability of any model to the local context.

Most models make use of geographic information systems (GIS). These have been used traditionally for biophysical data, whereas integrated management requires the inclusion of socio-economic data. The University of British Columbia has done some exemplary work trying to develop integrated analysis models - some developed by Hans Schreier's team with PARDYP and Mountain Resource Management in Nepal (see Brown 2003), and the Bolivia Water Rights project is attempting something similar in generating integrated hydrographic demand-supply models for watersheds (Alurralde et al. 2003).

The Tarim Basin project in China used the systems dynamics (SD) method and adapted an integrated resource planning/ demand side management (IRP/ DSM) tool that was originally developed for use with electrical utilities in North America to make a dynamic simulation and comprehensive analysis of water supply- demand balance under different scenarios of combined natural water inflows and socio-economic factors. Game theory and behavioural analysis were employed to analyse the process of water rights allocation under four sets of conditions (gaming sub-models). The project concluded that the SD IRP/ DSM methodologies used in the study constitute a powerful tool for developing an equitable and efficient water distribution scheme (Tyler 2001).

A common problem, however, is that most modeling tools are not truly participatory and accessible without technical intermediaries. Projects often do not put enough thought into making GIS tools truly responsive to local needs. GIS can take away levels of agency from local people rather than strengthening agency. It is important to remember that local people must first be involved in determining and understanding what information is really needed and how it relates to specific outcomes before a GIS tool is chosen.

Participatory Data Collection

Projects have found that in order to develop the long-term data set needed for proper analysis, local community members must be involved in collecting the data. Partnerships are often required with government agencies and universities for training and coordination (Van den Brand 2000). Facilitating this process involves the earlier discussion of indicator definition, emphasizing ease of measurement and low cost of chosen indicators. Also, motivation for participation in data monitoring is directly related to the role and influence that community members have in the larger research process.

MANRECUR-Ecuador has completed several years of participatory monitoring of water for irrigation in the El Angel watershed, carried out by men and women who are paid to measure the irrigation channels once a week. These data are then collected by a local member of the Carchi Consortium team and added to the database. The data have been used to analyse potential resource and land uses, model the hydrological balance, and design rehabilitation activities. These measurements have been instrumental in opening spaces for dialogue on issues of water use, conflict and management.

PARDYP-Nepal has done some innovative work using GIS and global positioning system (GPS) outputs for participatory community forest mapping. PARDYP initiated detailed forestry mapping by introducing orthophoto⁵ images along with intensive field verification in collaboration with District Forest Offices (Shrestha 2001). Women were trained to read maps and use GPS equipment, and helped validate maps and delineate forest boundaries. Local government forestry officers and technicians in the district forest office were first trained how to use and apply enlarged orthophotos to map resources accurately. Forest officials then explained the application to local forest user groups, for whom it was the first time they had got a pictorial overview of the forest they were managing. Thirty-six out of 40 Forestry Users Groups (FUGs) in the watershed have used this tool to prepare inventories of natural resources, resolve conflicts between FUGs, prepare forest management plans and plan reforestation activities (Nakarmi and Shah 2000)

⁵ Orthophoto images are reproductions made from aerial photographs in which image displacements caused by the camera tilt and topographic relief have been geometrically corrected. Orthophoto images are photographic maps, with which both scale and planimetric details and areas can be calculated accurately.

Box 2 gives an example of watershed modeling in Bhutan.

Box 2. Participatory Applied Research in the Lingmuteychu Watershed, Bhutan

(Duba and Ghimiray forthcoming; Jamtsho and Gyamtsho 2003; Van den Brand 2000)

The Bhutan government introduced a national irrigation policy in the late 1980s. It provided one-time support for canal construction and required beneficiaries to form community water user associations (WUAs), which were expected to continue maintenance. However, the incompatibility of WUA guidelines with community realities has severely limited their functioning. In the Lingmuteychu watershed, problems of water scarcity, conflicts over water use and community demands for maintenance support opened up opportunities for the research team to initiate participatory water management research, strengthening the WUAs' capacity and role.

Diagnosis was done in each community in the watershed using focus group discussions, Participatory Rural Appraisal tools such as resource mapping, seasonal calendars and transect walks. Water engineers spent 3 months in the village to observe, learn and analyse traditional water management systems. Technical and institutional interventions were developed based on discussions and participatory diagnostics with the WUAs. These interventions included support to community members in improving irrigation structures, reclaiming eroded and degraded areas, using less intensive irrigation practices for rice cultivation and switching to shorter duration rice varieties that could be planted late in the season when more water was available. These were demonstrated on experimental plots and material support was provided for further implementation.

Water conflicts

Farmers' water rights and sharing system were studied concurrently with taking measurements of their water management practices. An unanticipated key issue that emerged was a conflict over water resources between upstream and downstream users. The water sharing systems in the watershed are not based on equity and efficiency, but rather on historical rights and a firm-come first-served basis. This created major inequity between upstream and downstream users. To redress this issue, the team held separate discussions with both upstream and downstream communities first, and then brought them together for dialogue. The research team facilitated the dialogue process as a neutral observer, facilitator and mediator. Finally, the upstream community released water to downstream farmers but this system did not become permanent.

Simultaneous to the discussions between upstream and downstream communities, the water research team leader brought the issues of inequitable sharing in traditional water systems to the national-level Agriculture Policy and Planning Division. A policy was developed promoting the principles of equitable access to water resources and presented to the communities for feedback. The community in the upper watershed was more willing to negotiate on seeing the legal support for entitlements by the community in the lower watershed. Currently, the communities are continuing the negotiations in a forum at the watershed level.

Results/outcomes

The irrigation water flow to the fields has been improved. Lands fallowed due to over-sedimentation were re-planted. The WUAs are now more active: they conduct regular meetings and ongoing monitoring of water canals, and attend training. All the stakeholders gained better understanding of water problems, issues, needs and perceptions. The experiences in Lingmuteychu have also been vital in formulating the National Water Policy, and now a Water Act, which will provide legal basis for water use rights.

Multiple Scales in Watershed Management Research

Good watershed management is neither ‘community-based natural resource management’ nor management at regional levels but is a combination of *both*. It engages multiple scales⁶ in terms of *spatial complexity* (plot – farm – micro-watershed – watershed) as well as *organizational complexity* (individuals – household – user-group – community – municipality – province – country – international system). Watershed people and resource dynamics are connected across all these scales, and yet there are also dynamics unique to each scale both biophysically and socio-economically.

These unique yet interconnected dynamics necessitate both ‘vertical’ (often referred to as ‘scaling up’) and ‘horizontal’ (‘scaling out’) linkages. *Scaling up* is a process that bridges levels and involves a greater number of stakeholders in order to enhance capacity for problem solving, decision-making and coordinated action. *Scaling out* expands the impact of innovations that have achieved success in a limited context, to benefit a greater number of people over a greater area (Carter and Currie-Alder 2004). Strengthening horizontal and vertical linkages helps fill institutional and organizational gaps, and promotes innovation and sharing of successful practices. Building links between local user committees would be an example of horizontal linkage, while links between the local committees and a national research and technology transfer centre is an example of a vertical linkage (Vernooy and Ashby 1999).

‘Scaling up’ should not mean that regional management *replaces* local management. Scaling up means engaging *more* levels to address issues that cannot be addressed at smaller scales. The idea is to engage *multiple scales simultaneously*. For this reason, some projects do not refer to ‘scaling up’ but rather to multiple scale or ‘*scale nested*’ approaches (Sandra Brown, personal communication, August 2004). Box 3 gives an example of a scale-nested approach in PARDYP.

⁶ Note: the use of the word ‘scale’ here should not be confused with the cartographic concept of scale in terms of resolution or units of measurement (e.g., 1:200 scale). The term ‘scale’ is used in terms of size of area and extent of integration.

Box 3. Scale Nested Approach in the People and Resource Dynamics Project (PARDYP)
(Bhuktan et al. 2002; Sandra Brown, personal communication, August 2004)

Why nested scales?

PARDYP stresses the importance of multi-scalar approaches because both biophysical and socio-economic processes change with scale and therefore it is important to consider different scales simultaneously. This has taken the shape of a 'scale-nested' approach, where activities deal with unique dynamics relevant to each scale and yet are connected and coordinated across multiple scales. At each scale there is opportunity for scaling out. Both the products and processes generated at various scales by the four country projects are relevant within and outside the Hindu Kush Himalaya Region.

What has it looked like?

Watershed-based work of PARDYP is undertaken at a range of levels: *plot*, *micro-watershed*, *watershed* and *regional*. The nature of research and development interventions differs depending on the level. For example, more soil erosion measurements are done at the *plot* and *sub-catchment* levels, but a bigger emphasis is placed on learning and synthesis at *watershed level* and a thrust on sharing and policy dialogue is more evident at the *regional level*. Scaling up or out therefore has different connotations and implications at different sites. Often the size of the watershed unit used is determined by the objective of watershed development. Large macro-watersheds may be relevant in planning of command area development for irrigation projects. On the other hand, micro-watersheds of 500 -700 ha would be adequate for planning soil, water and biomass regeneration treatments.

Networking around watershed management then also occurs at different levels for different audiences and for different purposes. In China, networking around the PARDYP site is a means of promoting expansion from a small watershed to a larger watershed within the country. In Nepal, networking aims at better utilisation of lessons by other stakeholders within the same watersheds. In India, the focus on the process and partnership dimensions stand out. Each site has to evolve its own objectives, given the local realities. The role of the PARDYP Regional Co-ordination office is also conditioned by these location-specific realities and might evolve and change over time.

Achieving Community-Based Management Before Scaling Up

Experiences over the last few decades have shown that local participation in planning and research is essential for effective management of natural resources (e.g., see the multi-country study of Pretty and Hine 2001). This should not be forgotten during attempts to increase the scale and scope of a project or program.

Decentralization is a key ingredient, at its best a process of reforming the institutional environment including legal systems and power relations, entailing movement towards more democratic governance and a more micro-economic focus (Bardhan 2002). Ideally, it can improve participation by engaging the disenfranchised in the political process. In practice, however, decentralization is rife with power dynamics that entrench local elites and prevent democratic decision-making. Decentralization programs have major problems of corruption and ineffective management, and decentralization in itself is not

sufficient to achieve more democratic governance. Both decentralization and democratic, participatory local management are needed. This is the foundation of CBNRM and of the scaling up process.

Scaling *up* projects ironically must first make sure that management is scaled *down*. Using the name ‘watershed’ in a project can be a temptation to impose a level of scale that works against effective participation rather than for it. *CBNRM must come before watershed NRM*. Without this flow, scaling up can become simply another name for centralized management.

Participatory Approaches at the Watershed Level

Applicable, context-sensitive scaling up requires broad participation of actors across the entire integrated area (Ranaboldo et al. 2004). Maintaining such participation in research and management requires tremendous investment in human resource development, local education, communication and partnership building. It requires quality interaction and considerable investment at local level, both of which pose challenges to scaling up and scaling out (Snapp and Heong 2003). How then do watershed-level research projects move forward?

First, scaling up should not be a goal in itself. The goal is to enable effective management of human and resource dynamics. Large-scale management can become burdensome if the problem does not need to be dealt with on an integrated scale, and so the first step is to make sure that the issue needs a larger scale to be dealt with properly. The key is to identify strong and weak interactions in relation to specific concerns, and use these to determine the appropriate boundaries or ‘scale’ of inclusion (Brooks 2002).

Second, it is important to emphasize the long-term nature of scaling up participatory approaches. Some properly scoped very-specific research projects can be inserted into this process and completed in short time periods. However, large-scale integrated watershed management research cannot start from scratch and finish in 2 years. Every watershed is different and few processes are universal. Each setting has to understand the complex space and time dependence of people and resource dynamics (Schreier et al. 2003). The organizational process requires building step by step from participatory

bases to institutions and regional coordination. It has only been into the 6th or 7th year of projects that real integration at the watershed level begins to be achieved.

Third, scaling out participatory approaches requires partnerships and wise investments in capacity building that can be disseminated with greater impact. It does not require thousands of government workers going into every small village in the country. Participatory research is possible on a large scale, but governments and researchers must let go of the idea that *they* need to be the ones to do it. They can better engage boundary partners in the process, and help develop and support a nested tree of stakeholders spanning multiple scales to communicate and coordinate management.

One approach has been to promote and improve farmer-led innovation through facilitating community research groups. This has been done with Comités de Investigación Agrícola Locales (CIALs, Local Agricultural Research Committees) in Central America, Ecuador, and other countries around the world. In Nicaragua, community watershed visioning was catalyzed through participatory mapping and local training in monitoring tools. Combining community watershed visioning, participatory mapping and monitoring with community-led research groups and landscape-level experiments has led to local empowerment to address larger-scale questions (Vernooy and McDougall 2003).

Farmer-to-farmer dissemination is a type of scaling out that was highly successful in many projects. The Bhutan project has had great success with farmer-led study tours for other farmers to demonstrate successful implementation of technologies, crops, methods and organization (RNRRRC 2003a).

PARDYP projects in Asia have been successful in using GIS tools to combine local-level participation with watershed-scale analysis and management. When a GIS database is sufficiently developed, including biophysical and socio-economic data, it can serve as a tool for both macro and micro levels. Local people are trained in use of the technology (e.g., GPS locators, orthophoto) for fundamental surveys and monitoring (Brown et al. 2000). The training can be done through strategic partnerships, and data management

can be centralized. This method requires an interdisciplinary approach and relies heavily on technical training and technical intermediaries.

The challenge again with GIS is to make it responsive and applicable. The danger is to let the data drive the process, when the tool should come instead as a natural aid for achieving locally defined goals. Farmers frequently perceive landscape monitoring with GIS tools as having limited relevance. Indicators used for agronomic performance or watershed sustainability may be quite different from sustainability indicators chosen by farm communities, such as increased market access, employment options or control of water management. It is a challenge to fully understand farmers' perspectives and priorities. A range of indicators and technology trial designs that rigorously link farmer assessment with researcher assessment need to be carried out to ensure relevance to diverse stakeholders (Snapp and Heong 2003).

What to Scale Up

In Latin America, the Sustainable Agriculture Networking and Extension (SANE) project used the framework of five dimensions for scaling up (Table 1).

Scale within biophysical research has very different implications. 'Scaling up' biophysical analysis often is a matter of scaling *out* data collection and then identifying macro-level dynamics. Most field measurements take place in specific locations – in this sense they are almost all 'local level' measurements. It is what these indicators mean and how they are used that determines the appropriate scale of analysis and intervention. For example, point-source pollution is detectable and managed on a very localized level. Flooding, on the other hand, is detected at various locations across a large area, and interventions are more complicated because mitigating flooding can involve changes to land use practices across the entire watershed. As well, different dynamics come into play at different scales. All macro dynamics are caused by micro factors but the dynamics are not easily visible or assessable on the micro level. It is extremely important for researchers to understand the links between micro- and macro-level dynamics, and to make sure that the necessary research is done to identify possible micro interventions to address macro problems.

Table 1: Five Key Dimensions of Scaling Up (Ranaboldo et al. 2004)

Scaling up dimension	Variables
1. Technical-productive development	<ul style="list-style-type: none"> - Collect and validate technologies generated by the producers themselves - Adaptively manage and modernize production in the farm setting - Integrate technical teams with local farmers (experimenters)
2. Organizational development	<ul style="list-style-type: none"> - Establish and strengthen organizations of producers - Generate proposals - Diversify membership, for example with (micro) business people, among others - Develop knowledge, dexterities and adequate abilities in the rural people (leaders)
3. Institutional coordination	<ul style="list-style-type: none"> - Involve academic, governmental or other pertinent actors - Create/fortify interactive spaces of inter-institutional coordination - Train technicians and professionals in pertinent matters - Evaluate/show the technical/economic viability of agro-ecological alternatives - Develop provision of pertinent services (credit, certification, etc.)
4. Commercial development	<ul style="list-style-type: none"> - Monitor the markets of the agro-ecological products - Train managers in commercial management and aspects of market - Identify pertinent market niches - Diversify the market of agro-ecological products - Give value to rural agro-ecological products (transformation, certification, etc.) - Coordinate agro-commercial chains toward the consumers
5. Political coordination in local, regional and national settings	<ul style="list-style-type: none"> - Create/strengthen spaces of interaction with local, regional and national governments

Transboundary Issues

None of the countries involved in Minga and CBNRM watershed projects are politically organized nationally or domestically around the concept of watersheds. Territories of original indigenous communities do not coincide with watershed or municipal boundaries. Thus scaling out and scaling up often enter the realm of transboundary cooperation. That political boundaries can hinder conservation objectives is globally recognized, particularly in areas where wildlife is highly migratory, and where boundaries split river basins, watersheds and other ecosystems between countries (Murphy et al. 2004).

At the same time, given the current divisions, transboundary cooperation has been heralded as an opportunity to promote better management of natural resources, bring local socio-economic development and facilitate peace and co-operation. There are often major economic and political motivations to address resource issues across boundaries, primarily for 'downstream' territories. One example is flooding in lowland areas of the Himalayas. In highland areas of Nepal, improper management and land use creates high levels of land degradation, and this degradation causes greater water run-off during precipitation. This run-off then causes severe problems in stream bank erosion and larger flooding in downstream plains countries such as Bangladesh. Micro-level land use decisions in Nepal affect macro-level flooding and economic impact in other countries (Dangol et al. 2002).

Mechanisms for transboundary cooperation are slowly developing. Transboundary NRM almost always requires government involvement. This presents a challenge as such transboundary management can infringe on traditional definitions of sovereignty, creating resistance to integration and to the use of watersheds as a unit of management (for an example from Bolivia, see CGIAC 2000). Another challenge is to prevent transboundary cooperation from becoming centralized, high-level decision-making with little regard for community management processes. Mechanisms must be developed to promote transboundary cooperation while strengthening community-based management. Transboundary cooperation needs to be seen as more of a scaling *out* than a scaling *up*. Some possible mechanisms involve some type of economic compensation to upstream or natural areas for the provision of environmental services.

Payment for Environmental Services

Environmental services are those that are provided – fundamentally but not exclusively – by wild areas (forest, wetland, paramo, coral reefs, flood plains, savanna, etc.). They include, among others: (i) mitigation of greenhouse gas emissions, (ii) conservation of biodiversity; (iii) protection of hydrological resources, in terms of quality, distribution in time and quantity of water; (iv) scenic beauty; and (v) mitigation of impacts of disasters associated with natural phenomena (Espinoza et al. 1999).

A system of payment for environmental services is seen as an innovative tool for financing investments in conservation and sustainable land use. At the level of watersheds, hydrological services are particularly relevant: the producers of the uplands of the watersheds can receive important incentives for ensuring the quality and quantity of water that the lowland users of the watershed make use of (FAO 2003a).

Payment for environmental services related to water supply touches on the topics of water rights and privatization. State, civil society and private sector actors create some markedly divergent positions in this area, from some who say, “water is life and water doesn’t have a price,” to others that say, “water has to be priced in order to be negotiated in the market.” Any system must be careful that this payment for environmental services does not violate public rights, and the questions of ‘who will benefit?’ and ‘who will be excluded?’ must always be asked. Some ways forward mix the views of water as a right and a good, which is to say, basic consumption for life as a right and excess above this as a good (Silva 2004).

Payment for water-related environmental services in watersheds must be based on an in-depth understanding of the socio-economic context. Payment mechanisms must take into account the conflicts that exist, the presence of several municipalities, and multiple large- and small-scale producers with different interests. The questions of ‘who will pay’ and ‘who will receive’ are complicated when water is used for various purposes (irrigation, domestic use, drinking), and the watershed often does not divide easily between ‘producers’ or ‘caretakers’ and ‘users’. What will the money be spent on and how can financiers be confident it is used to maintain and improve water management? The other key question is ‘who will implement the payment mechanisms?’ There is competition between local, provincial and national bodies and a need for transparency in selecting the executing agents. Monitoring and evaluation of the services provided are essential, and payment mechanisms should be designed with long-term sustainability in mind (Proaño and Silva 2004).

Environmental Services in the El Angel River Watershed, Ecuador

While the idea of payment for environmental services has been discussed marginally in various IDRC watershed projects, the only solid proposal for an environmental services

payment system is from the MANRECUR project in the El Angel Watershed, Ecuador. The proposal basically involves the creation of a 'Reward Fund'. The central objective is to contribute to the conservation of upland zones and buffer zones found in micro-watersheds that supply water for irrigation in the midland and lowland zones of the larger watershed. The Irrigation Committees and the Irrigator Association are the principal contributors, and will help monitor the implementation of the management plan of uplands micro-watersheds supplying water to the different irrigation channels.

The activities that are part of this plan will include conservation, mitigation, reforestation and personnel contracts for community park rangers, creation of micro-businesses compatible with environmental conservation, ecotourism, youth ecological groups, and formation of CIALs to search for new options for production and protection (Silva 2004; Proaño and Silva 2004).

Building Institutions for Responsive Planning and Decision-Making

Institutions for Watershed Management

From the previous sections of this report we can start to visualize the principal characteristics of institutions necessary for watershed management. They must be democratic and participatory, based on a foundation of broad-based grass-roots involvement. They must be supported by interdisciplinary scientific research that helps develop real applicable options for land use and management activities. They must span multiple scales, integrating community-based management with regional coordination through responsive nested hierarchies. Here we will explore how to help these institutions form, how they influence policy, and the characteristics of some successful examples.

Identifying and Involving Stakeholders in Watersheds

Watershed management institutions involve multi-stakeholder processes, and researchers hoping to help build such institutions must begin by identifying the stakeholders. Many projects spend too little time on this, and their research consequently suffers from decreased participation and applicability while increasing the risk of strengthening existing inequalities between stakeholders. Identifying stakeholders and understanding how they relate to one another are complex tasks in diverse environments like watersheds that containing many different direct and indirect users with competing interests. As stakes and stakeholders can also change over time, stakeholder analysis should be a continual or iterative process over the course of a project (Vernooy and Ashby 1999; Ravenborg et al. 1999). It is most relevant to define stakeholders by their interdependency in use and management of specific natural resources. They may belong to different socially and politically defined units but all have an interest or 'stake' in the same resource. These interests can form a base for construction of common social identity, and generate momentum towards collective action and participation in management mechanisms.

Without sufficiently broad-based stakeholder involvement, most management activities cannot be effective. For example, in the Cabuyal River watershed of Colombia, the watershed users' organization decided to stop burning forests around natural springs. This decision was violated as a result of not all stakeholders being included in the decision-making process. The users' organization had to begin again with a much broader base of participation (Sanz 2000). It is also often necessary to involve actors from outside the watershed that have major influence on resource use, economic activity and the policy context. These outsiders may have different interests than those living in the area, and this will require bridging gaps and negotiating internal versus external interests in the watershed (e.g., hydroelectric dam project in Lao PDR).

Danger of Entrenching the Local Elite

The scourge of CBNRM is the risk of elite-capture and exclusion of legitimate stakeholders. Inequitable power relations can interfere with effective management and endanger its long-term sustainability. With the goal of improving local livelihoods, NRM needs to be an equitable process. However, achieving this is very difficult in the context of these broader power relations. It is crucial to legitimize fair bargaining voice for each stakeholder (RNRRC 2003b).

For example, in the Lingmutey Chu watershed in Bhutan, although all households are intended to have equitable access to forest resources under community forestry users groups (CFUGs) management guidelines, poor households are not able to contribute the required inputs (e.g., labour). The CFUGs have not yet developed rules that would enable involvement and grant equitable access to the poor (Duba and Ghimiray forthcoming).

Caste⁷ is a central socio-economic factor for community dynamics in South Asia. Participation of all castes is necessary to achieve integrated management but many barriers exist that prevent this. For example, milk is an important alternative income-generating product for inhabitants of the Jhikhu Khola watershed in Nepal, but the

⁷ The term 'caste' is used here specifically to describe the mostly Hindu-based caste system of southern Asia, unique from general 'class' structures in its deep religious and culture foundations.

marketing of milk is primarily restricted to the Brahmin caste and very few low caste people participate in the trade. PARDYP found that the more heterogeneous user groups were in terms of caste, the more effective their management of natural resources (Bhuktan et al. 1999).

Identifying gender dynamics such as workload differences and decision-making roles is also essential given the importance of both men's and women's contributions, as discussed in the section on land tenure. Degradation of key resources such as water has greater impact on the workloads of women. Migration and privatization of common property also commonly cause gender-specific impacts on workloads. Failure to identify these gender issues can both further entrench current inequalities and reduce effectiveness of management and research.

Project location also must be chosen with care because the temptation is to set up pilot projects in regions that have better local resources and that already have institutions in place to facilitate the process. These areas usually coincide with higher levels of education and local authorities with greater funds to support infrastructure and projects. Market-based solutions are also somewhat easier in these locations because residents have higher capacity for paying for environmental services and water supply (IAEI 2004). Projects need to consider the scope and time span of their activities, as these may determine what resources or local capacities need to be present. However, it is important to remember that the goal of research design is not to avoid difficulties in order to achieve easy results, but rather to do research with the most relevance and impact.

Start with Tangible Environmental Issues

Projects had difficulty involving local stakeholders in longer-term research and organizing unless it was tied to more immediate payoffs. On its own, participatory research using formal methods was not found to be sufficiently engaging for very poor farmers whose primary concerns were more likely to be in achieving immediate household food security. Without including short-term benefits or tangible social development goals, farmer interest would wane (Humphries et al. 2000). It is important to start on locally relevant environmental issues that people understand.

The Center for Alternative Rural Technology (CART) project in the Philippines had success focusing on felt environmental issues that directly affected poor people's livelihoods, for example illegal logging, illegal fishing and pollution. It did not, for instance, focus on large general issues such as 'biodiversity conservation,' which may not have sufficiently motivated poor communities to act (Quizon 2003).

Lowland or 'downstream' users are often the most likely to become involved in management efforts because they experience the downstream effects of mismanagement. While CART started its work among upland farmers, it later realized that fishing communities downstream were the most affected by environmental problems. Hence, it later organized fishing communities to form the 'core' of a sustained environmental movement. Once a 'critical mass' or constituency was created, others followed (Quizon 2003).

Capturing Conflict as a Catalyst

Most natural resource conflicts in watersheds arise between upstream and downstream users as a result of upstream water use, forest clearance and land use impacting downstream water supply and flood protection. Resource competition is increasing between subsistence and commercial uses, between rural and urban uses, and between uses for national development and for local livelihoods, seen in hydropower developments in Laos (Hirsch et al. 1999) and logging in the upper Xizhuang watershed in China by State forestry farms (Xu et al. 2002).

Some conflicts can find their solution along paths of institutional change that are favourable for watershed management. When solutions look for agreements that benefit all sides, there is substantial interest in participation and innovation. A common situation is one that arises when the management of a watershed by its users enters into conflict with the political authority. Positive results can happen when the conflict is resolved by the watershed area forming administrative, management, and political organizations or changing the decision-making structures that exist. Many stakeholders have learned that opposition, conflict and confrontation are sterile if they are not backed up by clear proposals on specific themes that permit collaboration and alliances. Generic demands do not allow them to overcome political conflicts. It is much more effective to have a

practical proposal to support, and not simply a general opposition to the status quo (Grupo Chorlavi 2004).

The main conflicts identified by almost every project relate to access to and use of water. Conflicts arise between communities, between individuals and between producers and industries competing for the same limited water source.

A major achievement of the Carchi Consortium in Ecuador was the development a 'Commons Management Plan' for the community of Libertad. The negotiation of water conflicts between users was the main entry point. The MANRECUR project intervened in a role of 'participatory researcher – mediator', while the Consortium intervened as a platform of results analysis and as a coordinator of solution alternatives (Crespo and Faminow 2002).

In the Bhutan watershed also, problems of water scarcity, conflicts over water use and demands for maintenance support by communities opened up opportunities for the research team to initiate participatory water management research with communities (Duba and Ghimiray forthcoming).

Policy Influence

Achieving effective management of natural resources in watersheds almost always requires changes in government policies and legal mechanisms. Policy influence has been a goal of all projects reviewed, even though some adopted this goal only as the project progressed. Influence was most effective when projects kept this goal in mind from the start and developed their objectives and strategies accordingly. Researchers need to spend a significant amount of time with stakeholders, framing the proposed research in terms of desired outcomes, assuring the usefulness and accessibility of collected data so that the research has the desired policy results (Nakarmi and Shah 2000).

In order to influence policy, it is a common conclusion that watershed management initiatives should try as hard as possible to integrate current governance structures into their process rather than create parallel competing institutions. This will result in more

sustainable results for the long term. The reasons for this (RNRRRC 2003b; Van Damme 2003; Krause and Meléndez 1999) are that:

- Some form of government intervention and support is important for conflict management and legitimization of local institutions;
- Parallel structures lead to duplication, needless complexity and confusion;
- Formal local government structures can provide viable entry points for broad-sector collaboration;
- Access to legal mechanisms is fundamental, including securing tenure and resource rights as well as developing formal regulatory mechanisms; and
- Government involvement is usually necessary for cooperation across jurisdictional boundaries.

For example, in the Tarim Basin of China, the project determined government involvement to be a prerequisite for community-based water resource management. If only researchers and local farmers implemented new water management schemes, without any effective endorsement from local water administrations, they would run afoul of the existing system and cause conflicts with local authorities. This would greatly limit the ability of new water management schemes to perform their planned roles, and farmers' confidence would be eroded (IAEI 2004).

IDRC watershed projects have faced a wide variety of state structures and governance dynamics that have necessitated different strategies for engaging government actors. Four basic approaches to influencing policy have been used:

1. Civil society or local actors can do research and generate proposals that are then presented to decision-makers (e.g., CIAT-Hillsides, Honduras).
2. Decision-makers can be directly involved as principal actors in the research and development of proposals (e.g., PARDYP, China and Bhutan).
3. Decision-makers can be members of a larger management body involving many different stakeholders (e.g., the Carchí Consortium, Ecuador).

4. Projects can attempt to change the basic structures of decision-making towards more participatory frameworks and mechanisms (e.g., Lao PDR – see Shore 2000).

When the Government Does Not Support the Project

Working with government is slow and frustrating, and policymakers often prove to be less than satisfactory partners. The many reasons for this include vast bureaucratic jungles of regulations and procedures, overlapping jurisdictions, low pay scale, lack of motivation of government staff, and institutional inertia maintaining the status quo, all of which are present to varying degrees across both regions (for an example from Ecuador, see Poats and Proaño 2004).

However, projects can still develop in circumstances where the governing authority is not involved or even in cases where it appears originally to be opposed to the initiative. In this type of situation, one route to gaining government support can be through starting work with the least controversial issues that make up the watershed project. These are usually activities that deal with environmental or economic questions that negatively affect the clientele of the public authority, and that serve as mechanisms for strengthening a network or alliance promoting watershed management processes. As grass-roots support builds, and benefits to direct clientele of the public authority are demonstrated, projects can achieve a reversal of the initial opposition or indifference (Grupo Chorlavi 2004).

In Ecuador, a pilot project involving Community Park Rangers and the implementation of a Community Management Plan without major government involvement precipitated much greater collaboration and appreciation for the MANRECUR project and Carchi Consortium by the Ministry of Environment (Poats and Proaño 2004). In most situations some concrete projects can be started relatively quickly that will serve immediate purposes but also the larger purpose of building social capital and momentum towards collaboration with initially reluctant stakeholders.

Multi-Departmental Cooperation Within Government

Responsibility for activities related to watershed management is usually distributed among a number of government departments at more than one level. Most departments implement their activities in isolation, and the result is that there is no collective responsibility to implement watershed resource development programs in a systematic and methodical manner. For example, in Sri Lanka, this lack of cooperation has meant that watershed management continues to be approached in an ad hoc manner from a narrow perspective in only some selected areas (Pathahawaheta D.S. Division 1998).

Research projects can provide intermediary facilitation to promote dialogue and cooperation, and to introduce watershed management concepts and approaches into agencies without previous experience. Introducing these approaches through the standard planning process can be exceedingly difficult when it moves outside the agency's traditionally defined mandate, and appropriate support is needed. Government structures are also normally top-down and will need time to develop responsive processes (and human resource skills) that truly listen to community members.

It is also important for projects to develop strategies to help governments maintain these mechanisms and skills over election periods. This often requires gaining legal recognition of the new management or decision-making framework, legitimizing the processes that have developed.

In Cambodia, the Seila project worked towards multi-departmental cooperation by assisting the provincial government in formulating projects and supporting research studies. The project worked with the Provincial Rural Development Committee (PRDC), chaired by the governor and comprised of all department heads. As an inter-departmental body it acted as a forum where departments could meet, discuss in an open and fair manner and make joint decisions (Sovanna 2003).

Multi-Stakeholder Forums

One of the most successful approaches to building institutions for watershed management has been the multi-stakeholder forum. These forums can provide a legitimate space for dialogue, conflict resolution and planning that does not commonly

exist within current management structures. They also provide a method for involving government by integrating government actors into the management process rather than integrating the management process into government. Forums can be independent councils where government agencies are part of a larger management and decision-making team (Hans Schreier, personal communication, August 2004).

For example, the Carchí Consortium in Ecuador is one such successful forum. It is a space for discussion, learning and communication among diverse actors that live and work in the watershed, including organizations and government bodies related to environmental issues, led by the MANRECUR project. It has some specific characteristics that have contributed to its achievements and growth:

- The Consortium provides access to information by local people and organizations that did not previously have access, and it is an important space for diffusion of research.
- It facilitates *rapprochement* between interested actors of the watershed, and permits coordinated research, projects and actions.
- It fosters new forms of relationship through participatory and 'democratic' methodologies, generating higher expectations for involvement and greater trust.
- It has involved key state agencies that can inform, express opinions and influence the resolution of conflicts. The other participants also influence these state agencies.
- It demonstrates new forms of local governance on small scales. It is an important boost towards decentralization and the exercise of citizenship.
- It permits the identification and growth of local leaders.
- It is an important platform for introducing and strengthening the participation of women.

The Consortium has a recognized legitimacy with local governments, gained in the last few years through the roles it has played in resolving water conflicts, and the availability and value of its research (Crespo et al. 2002; Poats 2002; Carter and Currie-Alder 2004).

As multi-stakeholder forums gain recognition and authority in watershed management, legal recognition becomes a necessity for legitimate collection of funds, and for recognition and enforcement of decisions made in the forums. For example, community-based organizations in Bhutan such as Water Users Associations had no legal standing on which to base their role in the watershed until the development of the 2002 Cooperative Act (Jamtsho and Gyamtsho 2003). It is valuable to investigate the legal requirements of different levels of involvement from the start of a project, and begin actions early to promote new legislation where needed.

Responsiveness and Resilience

Watershed management must constantly deal with variability and change. This is true for socio-economic, political and biophysical factors. Tightly focused organizations are essential for specific tasks and can escape the effects of many changes, but effective management at the watershed level requires long-term, broad-based cooperation. Consolidating this cooperation into resilient frameworks and institutions is extremely difficult. Organizational momentum and social capital must be maintained and strengthened by building capacity for adaptation.

In the biophysical realm, NRM has conventionally been based on reducing and controlling variability in order to contain and avoid negative impacts. But experience shows that if variability is reduced and natural patterns of disturbances are disrupted, they accumulate and return at a later stage at a much broader scale (e.g., forest fires). Diminishing variability tends to increase the potential for larger-scale, less predictable and less manageable disturbances, which can have devastating effects on ecosystems and reduce their capacity to provide essential environmental services (Ashby 2003).

New approaches to NRM are attempting to work *with* variability instead of attempting to control it. To achieve this, projects need to purposefully strengthen institutional *responsiveness*. Institutions (clarifying again that ‘institution’ refers to large societal sets of norms, practices and organizations) must be sensitive enough to detect changes and adjust how they operate in short periods of time and seize opportunities as they arise. They must have continuity over the long term to build institutional memory and learning, addressing more and more aspects of complex systems as time passes. This requires

processes and frameworks that enable planning for change, and that enable solutions to be identified and implemented as specific constraints arise. For example, the regular event of political elections can drastically affect the institutional context, but possible changes can be predicted and planned for.

Supporting Long-term Management

It is the human resources of organizations that provide much of the adaptive capacity and resiliency of management institutions, and strategies for retaining these human resources are important. Projects usually involve large investments in staff training yet this investment is often lost to a project as staff members move on (Bhuktan et al. 2002; PARDYP 2001). This is not necessarily a bad thing, as the expertise they carry with them can be applied in other areas of influence and increase dissemination of skills and understanding to other sectors involved in the larger institutional context. Multi-stakeholder forums can play a role in maintaining broader institutional memory and learning while allowing for staff movement between individual organizations. The Carchí Consortium, for example, is an important space where leadership and other skills are developed and strengthened while individuals can participate as members of different organizations over time. Training programs should be strategically directed towards this larger institutional context, including both more transient staff and core staff of organizations.

Many projects are developing strong partnerships with other institutions to address capacity gaps in their own team and project scope. Partnerships also serve the purpose of broadening involvement and maintaining post-project continuity. Operational linkages – handing over operational responsibilities - would enhance sustainability and expand the potential for impact through scaling out (Bhuktan et al. 2002). The involvement of professionals from the local community also can help sustain management work in the long term, unlike outside experts and hired consultants who tend to provide only short-term services. Where possible, projects should try to include local professionals who see themselves as direct stakeholders in the local community (Quizon 2003).

Farmer-to-farmer dissemination and exchanges enable effective communication and learning between peers. Even international exchanges are possible and can build local

farmer confidence and leadership for innovation. In the Philippines, CART supported study tours among different communities and among different sectors. The tours included sharing of production technologies as well as organizational strategies. Local communities began to approach local government offices, NGOs and other institutions for assistance on their own. Moreover, the community recognition given to local innovators and management practitioners has encouraged them to become local promoters and facilitators (Quizon 2003).

Concluding Remarks

IDRC projects have demonstrated that watershed management research at its best will bring together researchers and practitioners from a wide variety of biophysical and socio-economic disciplines. Watershed management is often a struggle to integrate the conceptual frameworks and methods that these different fields of study bring, all within the final goal of a sustainable improvement in local livelihoods. Because of the geographic size of watersheds, management research will necessarily engage multiple scales and their corresponding biophysical dynamics and arenas of political and social action.

This paper has shown that strong biophysical and socio-economic research is an important foundation for management and needs to be better integrated into decision-making processes. Such research helps identify interrelations, causes and relevant factors, and helps develop locally appropriate interventions. Many projects have tried to integrate this research into participatory decision-making processes, both to be guided by this decision-making and to provide it more direct support. The absence of effective processes already in place often leads researchers to directly assist in building watershed management institutions that can be responsive to local needs and make use of relevant research. This was shown to be a very long-term and challenging process. Multi-stakeholder forums are one of the more successful approaches but still need further exploration. It was clear, however, that responsive and effective management at the watershed level must begin with responsive and democratic management at the community level, and only then can scaling up become more than simply centralization.

Introducing participatory methods into research has proven challenging in terms of project design and implementation but it has led also to some of the most important innovations in watershed management. Ideally, questions of participation, benefit and exclusion should be addressed from the start of research design. Local inhabitants and researchers can define and jointly monitor specific outcomes and indicators, and research is now becoming interdisciplinary enough to engage these objectives holistically and provide solid options for intervention. Gender dynamics were shown to be significant factors. Resource degradation and changes in land tenure affect women and girls

differently than men and boys. Also, the exclusion of women from decision-making can be a major limiting factor as women are often the primary direct users and have the best understanding of resource dynamics in the watershed.

Finally, this paper has shown that watershed management is a complex and long-term process. As such it is best addressed through a coherent programming, learning and institution-building framework rather than by individual separate projects. This perspective is being strengthened within IDRC and its partners. Research supported by IDRC around the world continues to be at the forefront of innovation and application, and their experiences in the future will continue to provide important insights and lessons with broad applicability.

Issues for Further Research

Watershed management research projects tend to begin within a certain area of expertise, often to address a specific issue or group of issues that is the catalyst for action and organizing. As projects become more interdisciplinary and engage more of the complexities of watershed dynamics, they begin to include more inter-linked disciplines that emerge as key factors. Some new approaches to research and management that have much to offer are emerging from various parts of the world. IDRC projects and researchers have put forward several of these areas needing further exploration.

The Soft Path for Water Management

An important emerging paradigm in water management is the so-called 'soft path' developed over the last few years. The soft path places a strong emphasis on demand management, efficiency, precise decentralized management to address different classes and locations of end use, and higher degrees of reuse. This is contrasted with hard paths, which rely on developing additional sources of supply, high-capital structural approaches and centralized management (RMI 2004; Wolff and Gleick 2002). The potential benefits of this approach to water management have been demonstrated to be substantial (Brooks 2003). Research needs to be carried out on the application of the

soft path approach to rural watershed management. What would it look like? What are key inputs? How can it be promoted?

Pollution and Human Health

There is a large need to address ecosystem and human health issues associated with water in rural watersheds. Tracking these issues is essential for a fuller understanding of how water affects local livelihoods. This includes water-borne diseases and all aspects of water pollution, especially non-point source pollution and cumulative effects. About 20% of the world's population has no access to safe water and the situation in many areas is getting worse not better. Much more research needs to be done on these issues as increased climatic variability has increasing impacts on health (Schreier 2004).

Role of International Financial Institutions

The impact of international organizations on local watershed management has yet to be explored in detail. Specifically, the influence of international financial institutions on management trends and choices of intervention options would be an important area of investigation, as would be the interface between local and foreign cultures in project contexts.

Effects of Privatization on Common Property Resource Management

Privatization and other changes to property rights systems can often entrench local power structures and further marginalize the poor and the rural women (Darlong and Barik 2003). Research is needed into how to assure that processes to change land tenure systems can take place in such a way that poor and marginalized members of society do not lose pre-existing claims or access. At the same time, more research is needed into how traditional tenure and resource management systems address equity issues, including gender equality, and how they deal with marginalized groups or 'outsiders'.

Collaborative Definitions of Water Rights

More research needs to be done exploring processes of collective definition of water rights. How have such processes affected action and negotiation? The Andean Water Vision is one important example, which emphasizes water as a common good with its

entailing rights and responsibilities and calls into question the commodification of water and the use of private investment in resolution of water problems (CONDESAN 2003). How are such collective definitions of water rights put into practice? What are the effects of these collective definitions of water rights on watershed management? How can communities' recognition of collective rights translate into legal or practical recognition by more powerful players, and what role can research play in this process?

Understanding Surface Water and Groundwater Interactions

The processes affecting groundwater recharge are still not well incorporated into decision-making. It is important to develop clear relationships between specific land use options and their effects on recharge of underground aquifers in local contexts. This is essential for developing accurate descriptions of water balances and appropriate management guidelines. Research needs to be done on how to bring these concepts into general management practice, including possible incentives and how to promote general understanding of these issues by inhabitants.

Urban-Rural Interface

The approaching flashpoint for conflict in NRM is the interface between rural and urban areas in watersheds. Trends in both Asia and Latin America are increasing the size of cities, which is increasing water usage, meat consumption, industrial pollution and demand for electricity. Urban areas are coming into conflict with the rural inhabitants and producers that are competing for the same resources of water and land. Pollution regulation (both point-source and non-point-source) and payment for environmental services are becoming more prominent as emphasis on source protection increases. Urban and rural areas need better frameworks to manage demand in response to limited supply, and new democratic mechanisms for urban-rural conflict resolution and cooperation are urgently needed.

Acronyms & Abbreviations

CART	Centre for Alternative Rural Technology project, the Philippines
CBNRM	Community Based Natural Resource Management
CFUG	Community forestry user group, Bhutan
CIAL	Comité de Investigación Agrícola Local (Local Agricultural Research Committee)
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CONIAG	Consejo Interinstitucional del Agua (Inter-institutional Water Council), Bolivia
CPR	Common property resource
DSM	Demand side management
FAO	Food and Agriculture Organization of the United Nations, Rome
FUG	Forestry Users Group, Nepal
FUNDAGRO	Fundación para el Desarrollo Agropecuario (Foundation for Agricultural Development), Ecuador
GIS	Geographic information systems
GPS	Global positioning system
HIMALANDES	Comparative Watershed Study of the Andes and Himalayas
ICIMOD	International Centre for Integrated Mountain Development, Nepal
IDRC	International Development Research Centre, Canada
IRP	Integrated resource planning
MANRECUR	Manejo de Recursos Naturales (Natural Resource Management) Project
NGO	Non-governmental organization
NRM	Natural resource management
PAR	Participatory action research
PARDYP	People and Resource Dynamics Project
PDR	People's Democratic Republic (re: Lao PDR)
PIWMR	Participatory integrated watershed management research
PRA	Participatory Rural Appraisal
PRDC	Provincial Rural Development Committee, Cambodia
SANE	Sustainable Agriculture Networking and Extension project
SD	Systems dynamics method
WUA	Water users association, Bhutan

Bibliography

Allen, R.; Schreier, H.; Brown, S.; Bikram Shah, P. 2000. The People and Resource Dynamics Project: the first three years (1996-1999). Proceedings of workshop held in Baoshan Yunnan Province, China, 2-5 March 1999. International Centre for Integrated Mountain Development, Kathmandu, Nepal. 333 pp.

Alurralde, J.C. 2004. Segundo informe técnico de avance (16-II/2004) Project Regulation of Rights in the Water Law (Bolivia). Comisión para la Gestión Integral del Agua en Bolivia (CGIAB), La Paz, Bolivia. 132 pp.

Alurralde, J.C.; Molina, J.; Villarroel, E. 2003. Primer informe técnico de avance (I-VII/2003) Project Regulation of Rights in the Water Law (Bolivia). Comisión para la Gestión Integral del Agua en Bolivia, La Paz, Bolivia. 75 pp.

Arce, B. 2003. Modeling the effects of water availability on crop-livestock production systems in Ecuador's El Angel watershed. Ph.D. diss., Cornell University, Ithaca, New York. Available in <http://idrinfo.idrc.ca/archive/corpdocs/118323/BlancaArce.pdf>.

Ashby, J. 2003. Introduction: uniting science and participation in the process of innovation – research for development. Chapter 1. *In* Pound, B.; Snapp, S.; McDougall, C.; Braun, A., ed. Managing natural resources for sustainable livelihoods: uniting science and participation. Earthscan/International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-43431-201-1-DO_TOPIC.html.

Baltodano, M.E.; Méndez, M.A. 1999. Identificación de niveles de vida para la construcción de perfiles locales de pobreza rural. Guía 5. Instrumentos metodológicos para la toma de decisiones en el manejo de los recursos naturales. Centro Internacional de Agricultura Tropical, Cali, Colombia. 179 pp.

Bardhan, P. 2002. Decentralization and governance in development. *Journal of Economic Perspectives*, 14(4), 185-205. Available in <http://globetrotter.berkeley.edu/macarthur/inequality/papers/BardhanGovt.pdf>.

Beck, T.; Nesmith, C. 2001. Building on poor people's capacities: the case of common property resources in India and West Africa. *World Development* 29, (1), 119-133.

Beltran, J. A.; Tijerino, D.; Vernooy, R. 1999. Desarrollo de procesos organizativos a nivel local para el manejo colectivo de los recursos naturales. Guía 9. Instrumentos para la toma de decisiones en el manejo de los recursos naturales. Centro Internacional de Agricultura Tropical, Cali, Colombia. 147 pp.

Bhuktan, J.P.; Bieler, P.; Gonsalves, J.; Guenat, D. 1999. PARDYP Phase 1 Final Report (Oct 1996 – Sept 1999). International Centre for Integrated Mountain Development, Kathmandu, Nepal. 85 pp.

Bhuktan, J.P.; Bieler, P.; Gonsalves, J.; Guenat, D. 2002. External review: final report. People and Resource Dynamics Project (PARDYP) Phase II. International Development Research Centre, Ottawa, Canada. 86 pp.

Brooks, D. 2002. In focus: water. International Development Research Centre, Ottawa, Canada. http://web.idrc.ca/en/ev-9440-201-1-DO_TOPIC.html

Brooks, D. 2003. Another path not taken: a methodological exploration of water soft paths for Canada and elsewhere. Final report submitted to Environment Canada, March 2003. Friends of the Earth, Ottawa, Canada. 67 pp.

Brown, S. 1999. Gender and resources in the middle mountains of Nepal. Institute for Resources and Environment, University of British Columbia, Vancouver, Canada. CD-ROM.

Brown, S. 2000. The use of socio-economic indicators in resource management. *In* Allen, R.; Schreier, H.; Brown, S.; Bikram Shah, P., ed. The People and Resource Dynamics Project: the first three years (1996-1999). International Centre for Integrated Mountain Development, Kathmandu, Nepal. pp. 15-25.

Brown, S. 2003. Spatial analysis of socio-economic issues: gender and GIS in Nepal. *Mountain Research and Development*, 23 (4), 338-344.

Brown, S.; Schreier, H.; Shah, P.B. 2000. Soil phosphorus fertility degradation: a GIS based assessment. *Journal of Environmental Quality*, 29 (4), 1152–1160. As summarized in Pound, B.; Snapp, S.; McDougall, C.; Braun, A., ed. 2003. *Managing natural resources for sustainable livelihoods: uniting science and participation*. Earthscan/International Development Research Centre, Ottawa, Canada. 260 pp.

Brown, S.; Shrestha, B.; Merz, J. 2003. *Women, water and workloads: a case study in Nepal*. Institute for Resources and Environment, University of British Columbia; International Centre for Integrated Mountain Development, Kathmandu, Nepal. CD-ROM.

Burley, L. 2001. *Research institutions in the Americas with programs related to conflict and environment*. International Development Research Centre, Ottawa, Canada. 44 pp.

Bustamente, R. 2002. *Legislación del agua en Bolivia. En Aguaitiplano. Recursos hídricos en el altiplano*. Centro A.G.U.A, La Paz, Bolivia. CD-ROM.

Carson, B.; Grieder, C.; Jodha, N.S. 1999. *Review mission report. People and Resource Dynamics in Mountain Watersheds of the Hindu Kush-Himalayas (PARDYP)*. PARDYP, Kunming, China. 27 pp.

Carter, S.; Currie-Alder, B. 2004. *Scaling up natural resource management: insights from research in Latin America*. International Development Research Centre, Ottawa, Canada. 23 pp.

CGIAC (Comisión para la Gestión Integral del Agua en Cochabamba). 2000. *Conclusiones preliminares, tema 1: gestión integral de cuencas*. In *La gestión integral del agua en Cochabamba. Síntesis de un foro electrónico (28 de febrero al 15 de abril del 2000)*. CGIAC, Cochabamba, Bolivia. Available in <http://www.aguabolivia.org/PublicarX/GESTION/TEMA7CON.htm>.

CIAT (Centro Internacional de Agricultura Tropical). 1998. *Agricultura sostenible en laderas (Latinoamérica) II: informe técnico interno: enero 1 - diciembre 31, 1997*. Programa de Laderas, Centro Internacional de Agricultura Tropical, Cali, Colombia. 36 pp.

CONDESAN (Consortio para el Desarrollo Sostenible de la Ecorregión Andina). 2003. The Andean vision of water: the perspective of the indigenous farming population. International Development Research Centre, Ottawa, Canada. Available in <http://www.condesan.org/memoria/agua/AndeanVisionWater.pdf>.

Crespo, M.; Faminow, M. 2002. Informe final de evaluación. Proyecto: Manejo Colaborativo y Uso Apropiado de Recursos Naturales en la Ecoregión del Río El Ángel, Carchi. Fundagro, Quito, Ecuador. 49 pp. Available in <http://web.idrc.ca/uploads/user-S/10317757460101188-evaluacion.pdf>.

Dangol, P.M.; Merz, J.; Weingartner, R. 2002. Flood generation in the middle mountains of Nepal. People and Resource Dynamics Project / International Centre for Integrated Mountain Development, Kathmandu, Nepal. Available in <http://web.idrc.ca/uploads/user-S/10938733881FloodGeneration2.doc>.

Darlong, V.T.; Barik, S.K. 2003. Achieving effective research and policy links in relation to community based natural resource management systems in India. *In* Regional Workshop on Community Based Natural Resource Management, 4-7 November 2003. National Resources Training Institute, Lobeyasa, Bhutan. CD-ROM.

Daxiong, Q.; Jiankun, H.; Suhua, Y.; Zulin, S.; Shuhua, G.; Xiusheng, Z.; Lifan, X.; Wenqiang, L.; Dahai, L. 1997. Final technical report – Tarim Basin Desertification and Water Management. Institute of Techno-economics and Energy System Analysis (ITEESA), Tsinghua University, China. 111 pp.

Duba, S.; Ghimiray, M. (forthcoming). Walking the extra mile: from field learning to influencing NRM research and policy in Bhutan. *In* Tyler, S., ed., Community based natural resource management in action. International Development Research Centre, Ottawa, ON, Canada.

Espinoza, N.; Vernooy, R. 1998. Las 15 micro-cuencas del río Calico, San Dionisio Matagalpa: mapeo y análisis participativos de los recursos naturales. Proyecto Laderas Centro América, Centro Internacional de Agricultura Tropical, Managua, Nicaragua. 99 pp.

Espinoza, N; Gatica, J.; Smyle, J. 1999. El pago por servicios ambientales y el desarrollo sostenible en el medio rural. Serie de Publicaciones Regional Unit for Technical Assistance, Instituto Interamericano de Cooperación para la Agricultura, Central Region. Available in <http://www.rimisp.cl/boletines/bol16/doc1.zip>.

Failing, L.; Horn, G.; Higgins, P. 2004. Using expert judgment and stakeholder values to evaluate adaptive management options. *Ecology and Society*, 9(1), 13. Available in <http://www.ecologyandsociety.org/vol9/iss1/art13>.

FAO (Food and Agriculture Organization of the United Nations). 1996. Women, agriculture and rural development. United Republic of Tanzania. Fact sheet. Sustainable Development Department, Food and Agriculture Organization of the United Nations, Rome, Italy. <http://www.fao.org/waicent/faoinfo/sustdev/WPdirect/WPre0010.htm>.

FAO (Food and Agriculture Organization of the United Nations). 2003a. Antecedentes. III Congreso Latinoamericano de Manejo de Cuencas Hidrográficas "Desarrollo Sostenible en Cuencas Hidrográficas". Foro Regional sobre Sistemas de Pago por Servicios Ambientales Arequipa, Perú, del 9 al 13 junio de 2003. Available in <http://www.rlc.fao.org/prior/reclnat/foro.htm>.

FAO (Food and Agriculture Organization of the United Nations). 2003 b. Concept note: preparing the next generation of watershed management projects/development programmes. Conference - Integrated Watershed Management: Water Resources for the Future, 22-24 October, Porto Cervo, Italy. Available in <http://www.waterresources2003.org/documenti/The%20Next%20Generation%20of%20Watershed%20ManagementProjects.pdf>.

Frias, G. 2003. Invasión forestal. International Development Research Centre, Ottawa, Canada. 65 pp.

FUNDAGRO (Fundación para el Desarrollo Agropecuario). 1998. Informe final de actividades. Proyecto Manejo de Recursos, Carchi, Ecuador 1996 – 1998. Consorcio Carchi-Ecoregion Rio Angel. FUNDAGRO, Quito, Ecuador. 86 pp. Available in <http://idrinfor.idrc.ca/archive/corpdocs/113217/96-8751.pdf>.

Grupo Chorlaví. 2004. Sistematización de experiencias de desarrollo territorial rural. E-Conference: desarrollo territorial rural, 17-28 May 2004. Fondo Mink'a de Chorlaví, Santiago, Chile. Available in <http://www.fondominkachorlavi.org/desarrolloterritorial/docs/sintesis.doc>

Hill, C.; Paulson, S. 2001. Workshop on Gender in Environment and Natural Resources Management, March 2001, Ottawa, Canada. International Development Research Centre, Ottawa, Canada. 63 pp.

Hirsch, P.; Phanvilay, K.; Tubtim, K. 1999. Nam Ngum, Lao PDR: community-based natural resource management and conflicts over watershed resources. Chapter 2 *In* Buckles, D., ed. Cultivating peace: conflict and collaboration in natural resource management. International Development Research Centre, Ottawa, Canada. Available online at: http://network.idrc.ca/ev.php?ID=27967_201&ID2=DO_TOPIC.

Huang, G. H.; Liu, L. 1999. A hybrid GIS-supported watershed modeling system: application to the Lake Erhai Basin, China. *Hydrological Science*, 44 (4), 597-610.

Humphries, S.; Gonzales, J.; Jimenez, J.; Sierra, F. 2000. Searching for sustainable land use practices in Honduras: lessons from a programme of participatory research with hillside farmers. AgREN Network Paper No. 104. Agricultural Research and Extension Network, Overseas Development Institute, London, UK. 20 pp. Available in http://www.odi.org.uk/agren/papers/agrenpaper_104.pdf.

IAEI (Institute of Agricultural Economics and Information). 2004. Proposal for 3rd phase IDRC project Tarim Basin Water Management and Desertification, June 2004. Community-Based Water Management in Tarim Basin, IAEI, Tsinghua University, China. 38 pp.

IFAD (International Fund for Agricultural Development). 2002. Women's workload in livestock development. Gender and household food security. International Fund for Agricultural Development, Rome. Available in http://www.ifad.org/gender/learning/sector/agriculture/w_ld.htm.

- Jamtsho, K.; Gyamtsho, T. 2003. Effective watershed and water management at local level: challenges and opportunities. *In* Regional Workshop on Community Based Natural Resource Management, 4-7 November. Natural Resources Training Institute, Lobeyasa, Bhutan. CD-ROM.
- Kapila, S.; Moher, R. 1995. Across disciplines: principles for interdisciplinary research. International Development Research Centre, Ottawa, Canada. 15 pp.
- Kimhy, L. 2003. Building training capacity for CBNRM: lessons learned from Cambodia. Paper presented at the CBNRM Regional Workshop, Bhutan, 4-7 November. Natural Resources Training Institute, Lobeyasa, Bhutan.
- Krause, B. M.; Meléndez, G. 1999. Informe de evaluación externa, fase II 1997-1999. Proyecto Manejo Comunitario de los Recursos Naturales en Laderas (CIAT - Laderas). Centro Internacional de Agricultura Tropical, Cali, Colombia. 56 pp. Available in <http://web.idrc.ca/uploads/user-S/10358173410melendez-eval.pdf>.
- Lindayati, R. 2000. Community forestry policies in selected southeast Asian countries. Working paper. International Development Research Centre, Ottawa, Canada. 159 pp.
- Lindén, K. 2002. Larger total workload behind women's poorer health. Women, Work and Health, 3rd International Congress, 2-5 June, Stockholm. Available at <http://www.arbetslivsinstitutet.se/wwh/articles/22.asp>
- Meinzen-Dick, R.; Di Gregorio, M., ed. 2004. Collective action and property rights for sustainable development. 2020 Focus Briefs No. 11. International Food Policy Research Institute, Washington D.C. 36 pp. Available in <http://www.ifpri.org/2020/focus/focus11/focus11.pdf>.
- Meltzer, J. 2001. Assessment of the political, economic, and institutional contexts for participatory rural development in post-Mitch Honduras. Minga Working Paper No. 1. International Development Research Centre, Ottawa, Canada. 52 pp.
- Merz, J.; Shrestha, B.; Dhakal, M.P.; Dongol, B.S. 1998. Water issues in a rural watershed of the middle mountains of Nepal – a case study of the Yarsha Khola watershed. International Centre for Integrated Mountain Development, Kathmandu, Nepal. 10 pp.

Merz, J.; Nakarmi, G.; Shrestha, S. K.; Dahal, B.M.; Dangol, P.M.; Dhakal, M.P.; Dongol, B.S.; Sharma, S.; Shah, P.B.; Weingartner, R. 2003. Water: a scarce resource in rural watersheds of Nepal's middle mountains. *Mountain Research and Development*, 23 (1), 41-49.

Ming-Dong, P.L. 2002. Community-based natural resource management: a bird's eye view. Internship report. International Development Research Centre, Ottawa, Canada. 47 pp.

Moench, M.; Dixit, A.; Janakarajan, S.; Rathore, M. S.; Mudrakartha, S. 2003. The fluid mosaic: water governance in the context of variability, uncertainty and change. Nepal Water Conservation Foundation, Kathmandu, Nepal. Available in http://web.idrc.ca/uploads/user-S/10492953541Fluid_Mosaic21.pdf.

Murphy, C.; Suich, H.; Slater-Jones, S.; Diggle, R. 2004. 'Big can be beautiful' – ensuring regional transboundary conservation supports local community resource management in the proposed Okavango/Upper Zambezi TFCA, southern Africa. Paper presented at the 10th Annual Conference of the International Association for Studies in Common Property (IASCP), 9-13 August, Oaxaca, Mexico.

Nakarmi, G.; Shah, P.B. 2000. Linkage between local research and public policy: an observation from Jhikhu Khola watershed Nepal. Internal Report, People and Resource Dynamics Project, Nepal. 6 pp.

PARDYP (People and Resources Dynamics Project). 2000. Lessons learned and resource dynamics. Available in <http://www.ires.ubc.ca/projects/pardyp/lessons.htm>.

PARDYP (People and Resources Dynamics Project). 2001. PARDYP Annual Report 2001. International Centre for Integrated Mountain Development, Kathmandu, Nepal. 86 pp. Available in <http://idinfo.idrc.ca/archive/corpdocs/117585/report2001.doc>.

PARDYP (People and Resources Dynamics Project). 2003. PARDYP Annual Report 2003. International Centre for Integrated Mountain Development, Kathmandu, Nepal. Available in http://web.idrc.ca/es/ev-64547-201-1-DO_TOPIC.html

Pathahawaheta D.S. Division. 1998. An assessment of watershed resources degradation and identification of strategies and techniques for improvement, protection and management of watershed resources in the Central Province, Sri Lanka. Bopitiya Watershed – Pathahawaheta D.S. Division, Kandy District, Sri Lanka. 68 pp.

Poats, S. 2000. Gender and natural resource management with reference to IDRC's Minga program. International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-1645-201-DO_TOPIC.html.

Poats, S. 2002. Proyecto Manrecure Puento: Informe final: la planificación estratégico del manejo participativo a diferentes escalas de los recursos naturales en la cuenca alta del río Mira, Ecuador. 21 diciembre 2001 a 21 junio 2002. Fundación para el Desarrollo Agropecuario, Quito, Ecuador. 38 pp.

Poats, S.; Proaño, M. 2004. Segundo informe semestral septiembre 2003 - febrero 2004 "Manejo colaborativo de recursos naturales en cuencas Andinas en el norte del Ecuador". Proyecto Manrecur, Tercera Fase, Corporación Grupo Randi Randi, Quito, Ecuador. 19 pp.

Pound, B.; Snapp, S.; McDougall, C.; Braun, A., ed. 2003. Managing natural resources for sustainable livelihoods: uniting science and participation. Earthscan/International Development Research Centre, Ottawa, Canada. 260 pp.

Pretty, J.; Hine, R. 2001. Reducing food poverty with sustainable agriculture: a summary of new evidence. Final report from the SAFE-World Research Project, Centre for Environment and Society, University of Essex, Colchester. Executive summary available in <http://www2.essex.ac.uk/ces/ResearchProgrammes/SAFEWexecsumfinalreport.htm>.

Proaño, M.; Poats, S. 2000. ¿Abundancia o escasez? Concesiones, conflictos, poderes y políticas en el manejo de agua en la cuenca del río Angel. Proyecto Manejo de Recursos Naturales (MANRECUR). Consorcio para el Desarrollo Sostenible de la Ecorregión Andina (CONDESAN), Ecuador. Documento presentado en el 16° Simposio de Producción en el 4° Simposio Latinoamericano sobre Investigación y Extensión en Sistemas Agropecuarias, 27-29 noviembre. 17 pp. Available in <http://idrinfo.idrc.ca/archive/corpdocs/117542/abundancia.doc>.

Proaño, M.; Silva, M. 2004. Propuesta de un modelo de retribución de los servicios ambientales en la subcuenca del río El Ángel, Carchi- Ecuador (primer borrador para discusión). Proyecto Manejo de Recursos Naturales (MANRECUR) III, Corporación Grupo Randi Randi, International Development Research Centre, Ottawa, Canada.

Quizon, A. 2003. From advocacy to affirmative action: the case of task force Macajalar in northern Mindanao, Philippines. *In* Regional Workshop on Community Based Natural Resource Management, 4-7 November. Natural Resources Training Institute, Lobeysa, Bhutan. CD-ROM.

Ranaboldo, C.; Venegas, C. 2004. Escalonando la agroecología: procesos y aprendizajes de cuatro experiencias en Chile, Cuba, Honduras y Perú. Versión del 10 de marzo de 2004. Sustainable Agriculture Networking and Extension, Segunda Fase (SANE II). Available in http://web.idrc.ca/en/ev-64887-201-1-DO_TOPIC.html

Ravnborg, H.M.; del Pilar Guerrero, M.; Westermann, O. 1999. Metodología de análisis de grupos de interés para el manejo colectivo de recursos naturales en microcuencas. Guía 4. Series Instrumentos metodológicos para la toma de decisiones en el manejo de los recursos naturales. Centro Internacional de Agricultura Tropical. Cali, Colombia. 133 pp.

RMI (Rocky Mountain Institute). 2004. A 'soft path' for water. RMI, Snowmass, CO. Available in <http://www.rmi.org/sitepages/pid278.php>.

RNRRC (Renewable Natural Resources Research Centre- Bajo Branch). 2003a. Bhutan CBNRM workshop summary November 2003. *In* Regional Workshop on Community Based Natural Resource Management 4-7 November, Natural Resources Training Institute, Lobeysa, Bhutan. CD-ROM.

RNRRC (Renewable Natural Resources Research Centre- Bajo Branch). 2003b. Bhutan CBNRM workshop theme 2 summary. *In* Regional Workshop on Community Based Natural Resource Management 4-7 November, Natural Resources Training Institute, Lobeysa, Bhutan. CD-ROM.

Rothman, D.S.; Robinson, H. 1997. Growing pains: a conceptual framework for considering integrated assessment. *Environmental Monitoring and Assessment*, 46 (1-2), 23-43.

Rusnak, G. 1997. Co-management of natural resources in Canada: a review of concepts and case studies. International Development Research Centre, Ottawa, Canada. 23 pp.

Sanz, J.I. 2000. Technical report for the Sustainable Hillside Agriculture Project II. Centre file: 96-8756-01/50210. Centro Internacional de Agricultura Tropical, Cali, Colombia. 74 pp.

Schreier, H.; Shah, P.B.; Nakarmi, G.; Shrestha, B.; Subba, J.K.; Pathak, A.R.; Brown, S.; Carver, M.; Kennedy, G.; Srivastava, L. 1993. Resource dynamics, production and degradation in a middle mountain watershed: integrating bio-physical and socio-economic conditions in the Jhikhu Khola watershed with GIS and simulation models. First Annual Report (Phase II), Mountain Resource Management Project, Nepal; International Centre for Integrated Mountain Development, Kathmandu, Nepal. 56 pp.

Schreier, H.; Hall, K.J.; Brown, S.J.; Wernick, B.; Berka, C.; Belzer, W.; Pettit, K. 1999. Agriculture: an important non-point source of pollution. Chapter 4.7. *In*: Gray, C.; Tuominen, T., ed. 1999. Health of the Fraser River aquatic ecosystem Vol. I: a synthesis of research conducted under the Fraser River Action Plan. Environment Canada, Vancouver, BC, Canada. 17 pp. Available in http://www.rem.sfu.ca/FRAP/S_47.pdf.

Schreier, H. et al. 2002. Comparative watershed study (Andes - Himalayas). Collaborative Himalayan Andean Watershed Project. International Development Research Centre, Ottawa, Canada. 9 CD-ROMs.

Schreier, H.; Brown, S.; Bestbier, R.; Brooks, D. et al. 2003. Water and international development. Institute for Resources and Environment, University of British Columbia, Vancouver, Canada. CD-ROM.

Shore, K. 2000. Promoting a community-based approach to watershed resource conflicts in Laos. IDRC Reports. International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-5252-201-1-DO_TOPIC.html.

Shrestha, B. 2001. FUG's empowerment and capacity building of foresters for community forest utilization and management. Component 1 *In* People and Resource Dynamics Project 2001 Annual Report by Component. International Development Research Centre, Ottawa, Canada. pp. 26-29.

Sick, D. 2002. Managing environmental processes across boundaries: a review of the literature on institutions and resource management. Working Paper 3. International Development Research Centre, Ottawa, Canada. 49 pp.

Silva, M. 2004. Experiencia de las reuniones del grupo de discusión sobre pago de servicios ambientales (GSA). Proyecto Manrecur III – Hito 2, Producto 6, Anexo del Segundo Informe Semestral. Corporación Grupo Randi Randi, Quito, Ecuador. 4 pp.

Snapp, S.; Heong, K.L. 2003. Scaling up and out. Chapter 4. *In*: Pound, B.; Snapp, S.; McDougall, C.; Braun, A., ed. 2003. Managing natural resources for sustainable livelihoods: uniting science and participation. Earthscan/International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-43436-201-1-DO_TOPIC.html.

Sovanna, N. 2003. Key issues and lessons in building capacity and strengthening local governance, in mainstreaming natural resource and environment management through the Cambodian Seila Program. *In* Regional Workshop on Community Based Natural Resource Management, 4-7 November, Natural Resources Training Institute, Lobeysa, Bhutan. CD-ROM.

SWC (Status of Women Canada). 2001. Women still work more than men [Press release, March 12, 2001]. Status of Women Canada, Ottawa, Canada. Available in http://www.swc-cfc.gc.ca/newsroom/news2001/0312_e.html.

Topal, Y.S.; Mishra, A.K.; Kothiyari, B.P. 1999a. Causes of out-migration and its socio-economic implications: some evidences from Bheta Gad Garur Ganga watershed in the Indian central Himalayas. *IASSI Quarterly*, Vol. 18, No. 2.

Topal, Y.S.; Bhuchar, S.K.; Pant, P.; Kothiyari, B.P. 1999b. Sustainable management and utilisation of common property resources: a case study in the Bheta Gad-Garur Ganga watershed in the Central Himalayas. *In* Allen, R.; Schreier, H.; Brown, S.; Shah, P.B., ed. 1999.

The People and Resource Dynamics Project: the first three years (1996-1999). International Centre for Integrated Mountain Development, Kathmandu, Nepal. pp. 109-122.

Trejo, M.; Marrios, E.; Turcios, W.; Barreto, H. 1999. Metodo participativo para identificar y clasificar indicadores locales de calidad de suelo a nivel microcuena. Guia 1. Instrumentos para la toma de decisiones en el manejo de los recursos naturales. Centro Internacional de Agricultura Tropical. Cali, Colombia. 255 pp.

Tyler, S. 2001. Post-project summary: CBNRM – Tarim Basin desertification and water management, China – Phase II. International Development Research Centre, Ottawa, Canada. 221 pp.

Van Damme, P. 2003. Disponibilidad, uso y conservación de los recursos hídricos en el altiplano Boliviano. *In* Aguaitiplano: recursos hidricos en el Altiplano. Centro de Investigación, Educación y Desarrollo, Lima, Peru. CD-ROM.

Van den Brand, L. 2000. Final report of the Water Management Research Advisor. Renewable Natural Resources Centre, Ministry of Agriculture, Bajo, Wangdue, Bhutan. 20 pp.

Van der Linde, H.; Oglethorpe, J.; Sandwith, T.; Snelson, D.; Tessema, Y. 2001. Beyond boundaries: transboundary natural resource management in sub-Saharan Africa. Biodiversity Support Programme, Washington, D.C. Available in <http://www.eldis.org/static/Doc13323.htm>.

Van Dusseldorf, D. 1992. Integrated rural development and inter-disciplinary research: a link often missing. *In*: Bakker, J.I., ed. 1992. Integrated Rural Development Review, University of Guelph, Guelph, ON, Canada. pp. 35-58.

Vernooy, R. 1997. Memoria del Taller Manejo Sostenible de Cuencas: una introducción. San Dionisio, Sub-cuenca del Río Calico, Matagalpa, 10 de Septiembre 1997. Centro Internacional de Agricultura Tropical. Managua, Nicaragua. 40 pp.

Vernooy, R. 1999. Mapping, analysis and monitoring of the natural resource base in micro-watersheds: experiences from Nicaragua. International Development Research Centre, Ottawa, Canada. 10 pp.

Vernooy, R.; McDougall, C. 2003. Principles for good practice in participatory research: reflecting on lessons from the field. Chapter 6. *In*: Pound, B.; Snapp, S.; McDougall, C.; Braun, A., eds. 2003. Managing natural resources for sustainable livelihoods: uniting science and participation. Earthscan/International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-43440-201-1-DO_TOPIC.html.

Vernooy, R.; Ashby, J.A. 1999. Case study - new paths for participatory management in the Calico River watershed, Matagalpa, Nicaragua. Chapter 13. *In* Buckles, D., ed. 1999. Cultivating peace: conflict and collaboration in natural resource management. International Development Research Centre, Ottawa, Canada. Available in http://web.idrc.ca/en/ev-27985-201-1-DO_TOPIC.html

Vernooy, R.; Baltodano, M.E.; Beltrán, J.A.; Espinoza, N.; Tijerino, D. 2001. Towards participatory management of natural resources: experiences from the Calico River watershed in Nicaragua. *In* Lilja, N., Ashby, J.A., Sperling, L. 2001. Assessing the impact of participatory research and gender analysis. Consultative Group on International Agricultural Research, Cali, Colombia. pp 247-262.

Waldick, L. 2003. Water management in Ecuador's Andes Mountains. IDRC Reports. International Development Research Centre, Ottawa, Canada. Available in http://www.idrc.ca/en/ev-29422-201-1-DO_TOPIC.html

Wolff, G.; Gleick, P.H. 2002. The soft path for water. Chapter 1. *In*: Gleick, P.H.; Burns, W.C.G.; Chalecki, E.L.; Cohen, M.; Cao Cushing, K.; Mann, A.; Reyes, R.; Wolff, G.H.; Wong, A. 2002. The world's water 2002-2003: the biennial report on freshwater resources. Island Press, Washington, D.C. pp. 1-32. Available in http://www.pacinst.org/publications/worlds_water/worlds_water_2002_chapter1.pdf.

Xu, J.C. et al. 2002. Xizhuang watershed, China. CD-ROM. *In* Schreier, H. et al., ed. Comparative watershed study (Andes - Himalayas). International Development Research Centre, Ottawa, Canada. 9 CD-ROMs.

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