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CAPRI TECHNICAL WORKSHOP ON WATERSHED MANAGEMENT INSTITUTIONS: A SUMMARY PAPER

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CAPRi Working Papers contain preliminary material and research results, and are circulated prior to a full peer review in order to stimulate discussion and critical comment. It is expected that most Working Papers will eventually be published in some other form, and that their content may also be revised.

ABSTRACT

The System-wide Program for Collective Action and Property Rights (CAPRi) sponsored a workshop on Watershed Management Institutions, March 13-16, 1999 in Managua, Nicaragua. The workshop focused on methodologies for undertaking research on watersheds, particularly those issues and tools that enable a more thorough understanding of the complex interactions between the biophysical factors and socioeconomic institutions of watersheds. Both social and biophysical scientists from CGIAR and other research institutions were brought together to present research and participate in focused discussions on methodologies for addressing collective action and property rights, scale, participation, and impact assessment. The forum also provided an opportunity for participants to visit and learn from a watershed project being implemented by the International Center for Tropical Agriculture (CIAT), and to discuss one another's ongoing watershed research project experience and explore opportunities for collaboration.

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Anna Knox and Subodh Gupta[1]

1. WORKSHOP PURPOSE AND OBJECTIVES

Watersheds are becoming a major focal point for CGIAR research on integrated natural resource management. Watersheds connect land units through lateral flows of water, nutrients and sediment, linking farmers, fishers and urban dwellers in intricate cause and effect relationships. Externalities between people who share a watershed depend upon both the biophysical attributes of the watershed and the institutions that shape people's interactions within the watershed. Watershed management is implemented at various social—spatial scales, from community management of small catchments such as San Dionisio in Nicaragua to transnational management of the Lake Victoria and Nile river systems.

A Technical Workshop on Watershed Management Institutions was held in Managua, Nicaragua from March 13 to 16, 2000. Twenty researchers from CGIAR centers and other institutions attended the workshop, which was sponsored by the System-wide Program on Collective Action and Property Rights (CAPRi) and hosted by the International Center for Tropical Agriculture (CIAT). The Ford Foundation and the Government of Norway provided funding for the workshop. The program consisted of four thematic presentations followed by facilitated small group sessions and plenary discussions, as well as presentations of ongoing watershed research by individual centers and institutions, and a one-day field visit to the San Dionisio watershed in central Nicaragua where CIAT undertakes collaborative research with local farmers.

The overall goal of the workshop was to improve the ability of watershed management research projects[2] to make an impact on the alleviation of poverty and

[1] All workshop participants have contributed to the ideas set forth in this paper. The authors would like to particularly thank Ruth Meinzen-Dick, Brent Swallow, John Kerr, Nancy Johnson, Olaf Westermann, Hans Schreier and Thomas Enters for their valuable suggestions and revisions to earlier drafts of this paper.

environmental degradation in developing country watersheds. The workshop had the following specific objectives:

To review experience of the CGIAR and other key organizations on watershed management research, particularly research on the institutions that affect watershed management:

- To identify the key institutional issues that arise with watershed management at various social—spatial scales;
- To identify or design new strategies and methodologies for linking bio-physical research on problems and technologies with socio-economic research on institutions; and
- To stimulate the development of comparable research spanning across the mandate resources and locations of the CGIAR.

As a "technical workshop," the purpose of the forum was to explore tools and methodologies that can contribute to more effective research. Specifically, this workshop brought together biophysical and social scientists to jointly assess approaches that are derived from different disciplines in order to advance a more holistic appreciation of watershed issues. Research approaches pertaining to four key watershed issues were addressed:

- institutions of collective action and property rights,
- scale,
- participation, and
- impact assessment.

This paper summarizes the presentations and key discussions of the workshop. The annexes contain a synopsis of the events and insights gained from the workshop field trip,

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[2] Watershed research projects are often distinct from watershed development projects. The former primarily refers to the process of deriving information about watersheds and watershed communities, usually for the purposes of enhancing future watershed development. The latter is primarily concerned with implementation of practices, methods or technologies in order to improve watershed management. It is often the case that these functions overlap and are carried out simultaneously or sequentially, by one organization or by collaborating organizations and institutions.

the workshop participant list, and descriptions of watershed research being undertaken by CGIAR and other international research centers.

WHY ARE PROPERTY RIGHTS AND COLLECTIVE ACTION IMPORTANT TO WATERSHED MANAGEMENT?

Many of the critical challenges confronting watershed management—for example, organizing local communities, internalizing environmental externalities, negotiating use rights over resources, or resolving conflicts among stakeholders—are central to the research mandate of CAPRi. Because watershed management practices often involve long time horizons for producing benefits as well as large spatial scales for implementation, issues of both property rights and collective action have been identified as important factors in the adoption of watershed management technologies (Knox, Meinzen-Dick, and Hazell 1998).

Collective Action

Collective action is action taken by a group, either directly or on its behalf through an organization, in pursuit of members perceived shared interests (Marshall 1998). Collective action is undertaken voluntarily by its participants, which distinguishes it from the collective efforts by groups of paid workers. There may be little need for collective action when it comes to adopting individual, farm-level technologies such as High Yielding Variety (HYV) seeds, unless broader crop and ecosystem management such as soil conservation or pest control require coordinated action. Where natural resource management issues involve a higher level of spatial integration, the need for collective action becomes more evident. Forestry, irrigation, and fisheries management are spatially more extensive so that the need for collective action is greater. Collective action may also be required when there is a common threat. For example, if one farmer builds a fence to prevent animals from grazing his or her fields, it is likely to be expensive and may not be effective without the support of others. Collective action may lead to either 'social fencing' such as imposing fees for crop destruction, or setting aside alternative grazing land for cattle. These alternative solutions are viable only if there is collective action to support new rules.

Collective action involves organization to design rules and undertake action, participation in the process, and enforcement of rules that are perceived as being beneficial to the group. Many of the benefits may be non-material, however there is evidence that material benefits also influence the emergence of collective action. In a case of shepherds in India, collective action materialized during a period when the price of meat was going up. The anticipated benefits from meat sales led them to organize and collectively purchase grazing land and invest in growing good quality fodder suggested by scientists.

Property Rights

A 'property right' is defined by Bromley (1991) as "the capacity to call on the collective to stand behind one's claim to a benefit stream". Property rights require institutions (or rules) to back claims, though not necessarily government-backed legal institutions. Entitlements can be defined either by cultural norms or customary rights. Property rights need not constitute ownership of a resource, but could instead be understood as a bundle of rights, including access to a resource (e.g. the right to enter a farmer's field) or withdrawal of benefits from a particular resource (e.g. water from a stream or fruit from trees). There are also rights to control, exclude, and manage a resource, part of a resource, or multiple resources (Schlager and Ostrom 1992).

In addition to their spatial characteristics, natural resources also embody temporal features when it comes to their production and management. Whereas some economic activities involving natural resources produce returns in a short period, others do so over or after a long period of time. Property rights that offer security of tenure are important when it comes to providing incentive for investment in natural resource management technologies that generate returns over a longer period. Many watershed management activities fall into this category.

In addition to duration of tenure, assurance is also important. If there is the risk that someone else may capture the benefits of an investment in a resource, the incentive to invest is reduced. It is important to note that secure rights need not be exclusive but could also be held in common or overlap with different resource users. Whereas property rights can affect investment in or use of a resource, the converse is often true as well. This can be illustrated by a case in the Philippines in which the government transferred forestland, on which families had lived for several generations, to a university. The fact that farmers have been cultivating and investing in this land for years has been the primary basis on which they have asserted their claim to the forest. The farmers have received widespread support from local and international NGOs, demonstrating the extent to which the legitimacy of their claim is recognized.

WORKSHOP THEMES

Institutions of Collective Action and Property Rights

Watershed systems are highly complex. Resources are frequently characterized by multiple uses and multiple users. Both resources and the institutions for managing them span multiple scales, while lateral movements of water, sediment, nutrients and other substances such as chemicals from pesticides and fertilizers mean that the actions of one or a few persons tend to have far-reaching effects. Hence, there is a need for forums for negotiation and mechanisms for conflict resolution among the different stakeholders. Rules for sharing the resources comprise property rights, which are often useful in resolving conflicts and creating incentives for investment for watershed development. At the same time, there is need to have institutions for collective action, whether they be embodied in formal organizations or in more informal forms of cooperation, to respect property rights as well as act collectively for betterment of the community.

Scale

In planning and implementing watershed management research projects, one needs to consider scale. The issue invokes questions such as how to identify the appropriate scale for collecting data and conducting research, and how to integrate that with research activities being undertaken at different scales in order to derive a more holistic picture of the system.

Of particular importance is reconciling the issue of socially-defined versus physically-defined boundaries. Once we go beyond the level of the research plot, institutional or geographical coincidence between a land-use decision and its consequences may disappear. Watersheds or sub-watersheds rarely correspond to village, district, or other social or administrative unit. Optimal management in terms of the physical environment may not correspond to any decision-making body in a community. To deal with such externalities, collective action within existing institutions, or via the creation of new institutions, becomes critical for management of watershed resources. Institutional options will vary according to the scale (size) of the watershed. As yet, little research has been undertaken at the meso scale, involving multiple communities or watersheds.

Both within and beyond the level of the study of individual watersheds, there are questions of how to scale up the results of the research. How can we operationalize the concepts of representativity and extrapolability? How do we map organizational issues with biophysical phenomena that exist at different scales and overlap with one another?

Participation

Recent evidence suggests that participatory watershed development projects are more successful than externally managed, top down projects (Kerr et al. 1998). While it is not always clear what is meant by the term participatory, it does appear that local involvement in the design and implementation of a project makes it more likely to achieve it goals. Does this finding also apply to watershed *research* projects? Numerous other challenges confront the researcher who sets out to adopt a participatory approach. What is the appropriate role for and level of participation in projects? Does local participation only extend to participation in generating and sustaining collective action for watershed management activities, or does it also extend to planning the research agenda and implementation? Who within the communities participates? Does the appropriate level of participation depend on the specific circumstances and goals of the project or activity within a project?

Another important issue is how to reconcile the goals of researchers with the goals of participants. Is there an inherent conflict between research and development goals? Is action research a better approach to conventional, extractive research? The conflict between project goals is just one of the many conflicts that may arise in a watershed management project, especially a participatory project. Do researchers know enough about conflict resolution to deal with it in a meaningful way, or are institution building and strengthening best left to NGOs or others experienced in these matters?

Effective research on watershed management needs to be multi-disciplinary, multi-scale and multi-partner in order to gain a full appreciation of stakeholders' perceptions of the different benefits and costs of various activities as well as the political and institutional context of watershed management. However, such holistic and participatory projects are usually costly. Are there effective measures to contain costs? Are high costs justified in light of the benefits produced by these approaches?

Impact

There is a great need to evaluate the impact of watershed management projects. To date little has been done in this area (see Rhoades 1998 and Kerr et al. 1998 for a few notable exceptions).

Because they include social and institutional as well as economic and biophysical components, watershed management research projects present special challenges to evaluators. Not only must a wide range of economic and ecological changes be recognized and documented, but indicators must be identified to measure and value—often in the relatively short run—social outcomes such as improved capacity of communities to work collectively in the sustainable management of resources. And even if a project is able to accurately assess changes that have occurred in its study community, it must then determine to what extent the project contributed to those changes. In many cases the same variables that a project seeks to affect also influences its success, such as when an intervention requiring collective action may be very successful in a community that is already high in social capital. Observed collective action cannot necessarily be attributed to the project however, since the same project, if implemented in a community with low social capital, would have different results. Questions of causality and representativity are usual dealt with through replication and controls. Are these realistic concepts in the context of watershed management research projects, and if not what other options do we have of assessing impact?

If assessment techniques are inappropriate, they can produce misleading information and result in flawed project interventions and policies. For example, if resource management outcomes are not attributed to collective action, is it because collective action did not take place, or because somehow the assessment approach failed to capture it? If collective action contributes to improved resource management outcomes but its influence is mistakenly overlooked, promising solutions may fail to materialize. Furthermore, impact needs to be linked to the entire *process* of developing watershed management, not simply isolated components, so that future decisions take into account the full scope of past experience and performance.

2. COLLECTIVE ACTION, PROPERTY RIGHTS AND SCALE: PRESENTATION BY BRENT SWALLOW

Drawing on key insights from the paper *Effects of scales, flows and filters on property rights and collective action in catchment management* (Swallow, Garrity, and van Noordwijk 2000), the objective of the presentation was to illuminate how collective action and property rights issues are shaped by the effects of scale, lateral flows and externalities embodied in watershed management.

DEFINITIONS: WATERSHED, CATCHMENT

The terms ‘catchment’ and ‘watershed’ are often used synonymously although they are actually different. While a ‘catchment’ is a basin-shaped area of from which rainwater can drain to a common outlet point, a ‘watershed’ is a hump-backed land unit that forms the upper drainage area of one or more catchments, with hydrologic linkages to lower parts of the catchment(s). Although the terms were used interchangeably during the workshop, it is important to realize that the terms may evoke different concepts among different groups.

Many common fallacies exist concerning watersheds and the rationale for watershed management:

- Soil erosion is additive. *In fact,* the amount of soil that erodes from an area of land in a particular time period depends upon the size and configuration of the area. Soil eroded from a hillside area is often deposited further down the catchment where it may in fact have more value.

- Agriculture is the major sources of soil erosion. *In fact*, there are a sufficient number of studies that establish that roads, footpaths and degraded grazing areas are the main contributors of erosion.
- There is only a short lag time between detachment of soil in one location and its vertical movement through the catchment or water system. *In fact*, there is often a gap of decades between the detachment of soil from an upland area and its deposition in a water system.
- Water shortages are caused by deforestation. *In fact*, because trees consume water, deforestation may cause increases in total water supply and decreases in the dry-season flow of water.

Catchments are natural units that embody many scientific practicalities for applying a watershed approach to natural resource management. However, social and administrative boundaries may limit their appropriateness as management units. Whereas rivers and streams form social and administrative *boundaries* because they are visible and relatively fixed in space and time, they are the natural centers of *catchment* areas, so that often the two scales do not coincide. The best solution to this contradiction may be to work within social boundaries, applying a watershed approach.

Concept of Scale in Watersheds: Hierarchy and Extent

There are two ways to conceptualize the scale issues that emerge in watershed approaches: hierarchy and extent.

The *hierarchy approach* of ecology views each system as both a component of some higher-level system and a product of several lower-level systems. Scaling up in this approach is concerned with a shift in emphasis from a lower level to a higher level, while scaling down shifts emphasis from a higher level to a lower level. Some of the key implications of hierarchy theory for watershed management are as follows:

- Some issues need to be addressed using a hydrologic conception of watersheds, while others require a social-administrative conception.
- Principles developed for the management of small, micro-catchments are not likely to be relevant for the management of river basins.

- Institutions for managing river basins constrain institutions for managing micro-catchments.
- Institutions for managing micro-catchments may be irrelevant for managing river basins.

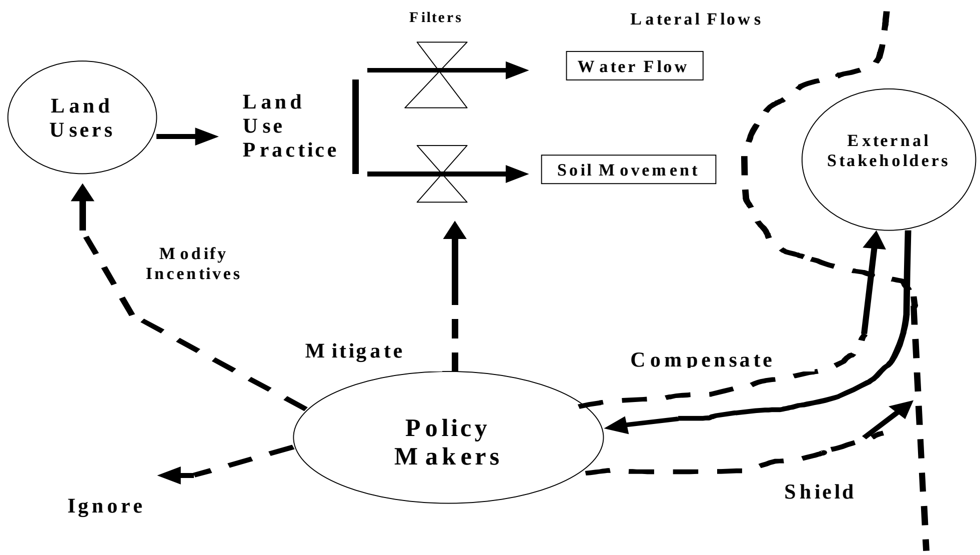
Characteristics of scale surrounding catchments can be based on hydrology, social or ethnic groupings, or administrative boundaries.

The *extent approach* to scale is closer to the economics approach of “scale economy”. For watershed management, the area of the watershed is measured in terms of hectares of land, or in kilometers in the case of river network, or by number of households in the case of socio-economic units. Measuring the average value of soil loss per unit may require an extent approach. The larger the extent of a land area, the lower the average soil loss per hectare.

Methods to Offset or Mitigate Externalities

Lateral flows of materials such as water, soil and nutrients across a landscape have the potential to create externalities. Land users can change lateral flows and thereby affect another person positively or negatively. The dynamics of the lateral flows and the use of filters to respond to externalities are depicted in Figure 1.

Figure 1: Responding to externalities.



Source: van Noordwijk, M., J. Paulsen, and P. Gricksen. 2000. Filters, flows and fallacies: Methods for quantifying external effects of land use change. *Agricultural Ecosystems and Environment*. Forthcoming

A filter is a biophysical technology that checks, diverts or stops a lateral flow of water, soil, nutrients and chemicals. Filters can be spatially limited or very large. They can also embody multiple uses, such as boundary markers. A wetland is an extreme example of a multi-use filter. By intercepting lateral flows, filters offset externalities. Studies of vegetative strips in Indonesia found them to be effective in reducing soil erosion by 60-90 percent. Vegetative filters may also filter out phosphorous and nitrogen streams. Crops also function as filters, such as rice paddies that trap and store sediments before they are deposited in streams.

At the policy level, several options exist for addressing the negative externalities associated with lateral flows:

- Use the tax system to change land use practices to ones that pose lesser or no externalities.
- Ignore the problem. Often this is the best alternative if the cost of dealing with the system is greater than the action itself.

- Mitigate lateral flows by installing filters, rather than changing land use. Such policies are often allied with conservation programs.
- Shield external stakeholders, e.g. install wetlands to deal with downstream flooding.
- Compensate those affected negatively, or tax those who create externalities.

Collective Action Experiences in Southeast Asia and the Lake Victoria Basin

In the Philippines, ICRAF is involved in the formation of local organizations to implement a program modeled after Landcare in Australia. Organization membership and size are self-selected, with villages or sub-villages functioning as the lowest administrative level. There are about 300 Landcare groups in the villages of northern, central and southern Mindanao, with some forming registered federations at the municipal level. Many groups were effective in adopting conservation farming practices such as natural vegetative contour buffer strips and cultivation of fruit and timber trees. A triadic partnership creates a forum for addressing watershed management issues. The partnership comprises the local government for policy formulation, local Landcare groups for planning and implementing watershed programs, and ICRAF as an information broker on technical, institutional and policy matters. Such a partnership has the potential to enable communities located on state forestlands to develop more coherent land management programs while also strengthening their capacity to negotiate agreements with forest departments.

In Kenya, collective action for watershed management has been fostered using a focal area approach. A focal area is an area of land of 200-300 hectares with 200-300 households, defined largely along social and administrative boundaries around a catchment area. Within the focal areas, community members form catchment committees for managing landscape resources, and the Ministry of Agriculture provides technical support. ICRAF is now working with the Ministry in the selection of focal areas so those impacts on the problems of the Lake Victoria water system are addressed most effectively. The approach works well in terms of being cost effective and resulting in a high uptake of technology. About 100,000 new farms per year are reached.

The success of collective action observed in Kenya and in the Philippines is partly attributed to perceptions of tenure security that enable small farmers to feel assured of the benefits from investment in their own land. Size is another important factor. People often preferred to work on small units and build on to these if necessary. Success was achieved when the group size was small and the group was formed at the sub-village level. Landcare experience in Australia and the Philippines and the experience in the catchment committees in Kenya lend support to the approach of building from the village up. In the case of Kenya, respect for social over hydrological boundaries is believed to enable better collective action outcomes.

Property Rights Issues in Southeast Asia and the Lake Victoria Basin

Experiences from Southeast Asia illustrate the problems that arise when property rights are ill-defined. In Thailand, ethnic groups have occupied the upland catchment areas of Mae Chaem for generations. They have been allowed only weak rights to land and resources because their land use has been perceived to be at odds with the management plans of the Royal Forest Department. Until 1990, people in the Philippines who lived on public land were declared to be squatters, resulting in overlapping claims of the Forest Department and local communities. In the Sumber Jaya catchment area of Indonesia, the management of upper watershed areas is still dominated by the state, with the Forest Department managing 70 percent of the land area where local people, classified as illegal squatters, live. Although the Forest Department is willing to include users in environmental management and biodiversity conservation, local people are barred from harvesting timber. The forest fires of 1997-98 further exacerbated the conflicts surrounding these property rights issues.

Property rights are different in the Lake Victoria Basin compared to Southeast Asia. Tenure security exists on agricultural land that is registered, but rights to other parts of the landscape are unclear and often contested. For example, wetlands and riverbank areas are *de jure* state property, but *de facto* open access. Over-exploitation, low investment and degradation are the results.

Property rights issues in watershed resource management

It is a commonly held belief that ill-defined property rights on plots and farms lead to erosion due to lack of incentives for improved management. To address the problem and provide incentives for investment, long-term tenure security at the plot and farm level is needed. However, title often has little or no relation to tenure security, especially in Africa. Nevertheless, local institutions that allocate land to small holders typically provide greater tenure security to those who clear the forest from the land. The result is that efforts to exert tenure security cause land degradation in the short term, but may result in greater investment in land improvement in the long term.

Property rights to filters on riverbank areas and some wetlands are often held by the state (unlike those on farms or farm boundaries which are often private property and hedgerows which often embody elements of common property). However, the capacity of the state to manage filters tends to be so weak that the areas become *de facto* open access. Filters can therefore be highly contested, with no general agreement on who has rights to them, or responsibility to maintain them.

PARTICIPANT COMMENTARY ON THE PRESENTATION

A number of participants provided feedback on the presentation, which stressed the importance of the following:

- understanding how local agro-climatic factors affect the impacts and management of filters,
- identifying the causes of soil erosion and considering a range of contributors and stakeholders, rather than assuming that agriculture is chiefly responsible for increasing sedimentation,
- positioning human welfare improvement as the main goal for watershed management,
- considering the extent to which improved watershed management can actually replace large-scale irrigation, especially in dry areas.

WORKING GROUP SESSION I

Workshop participants divided into two groups in which they were asked to discuss the key problems or issues encountered by watershed research projects, and cluster them according to whether they related to property rights, collective action, both issues, or neither. In the process of identifying issues and problems and clustering them according to whether they related to property rights and/or collective action, both working groups discovered that both of these institutions play a significant role in how researchers and project managers understand and address watershed management issues.

Watersheds embody diverse stakeholder interests due to the nature of ecological interdependencies and interactions within them and their consequent vulnerability to environmental externalities. Examples of such externalities include lowland flooding, downstream pollution from agricultural practices, smoke from burning practices, sedimentation from irrigation systems, and conjunctive use of scarce water resources. These can have ramifications for resource availability, resource quality, labor demands, incomes, food security, and human and animal health. Beyond a biophysical appreciation of resource flows, research and development projects focusing on watersheds need to identify: stakeholder groups, how management systems function to allocate resource rights and benefits, and the distribution of costs and benefits among stakeholders.

Development researchers and practitioners need to be cognizant of the impact of watershed management activities on women. Introducing technologies and practices that ignore the needs and priorities of women or increase women's workloads can produce negative welfare outcomes. Assuring the participation of women in the decision-making and implementation of watershed management may not only address empowerment objectives, but also improve environmental outcomes. One participant highlighted the findings of NGOs undertaking watershed projects in India that show women are often better watershed managers.

When costs, benefits, assets and rights are unevenly distributed and resource users have competing interests, negotiation and conflict resolution mechanisms are critical. More clearly defined property rights are expected to lessen the incidence of conflict. But do researchers and practitioners understand the essential elements of effective conflict resolution? Can collective action in designing the rules for conflict mediation and participating in the process ensure more equitable outcomes?

The enforcement of property rights often implies the need for local collective action, particularly if the state is unable to supply sufficient enforcement. However, most property rights institution (even ones that are enforced by the state) carry an implicit collective action component by virtue of people subscribing to and upholding the same rules.

The spatially extensive nature of watershed resources points to the need for collective action in developing and maintaining resources and their component technologies. Examples are grazing land, wetlands, common waterways and water storage structures. However, the potential for robust collective management is likely to be contingent on the level of existing community organization and social capital. Whereas there are many social and individual benefits associated with people managing resources cooperatively, there are also costs. Participation and negotiation are time intensive and may be a threat to existing community power balances. The size of watershed communities is likely to be important, where smaller and less spatially dispersed groups tend to be more unified than larger ones. Watershed projects organized along social lines may strengthen collective action, but administrative boundaries have practical benefits. The influence of markets on collective management is uncertain. Market forces can weaken community cohesiveness and raise the opportunity cost of participation, but they can also increase the value of tradable natural resource products and therefore the incentives for managing those resources.

Administrative problems and poor policies can also hamper watershed development. Government agencies and extension sometimes lack coordination in philosophies and service provision. Land use mandates can disrupt social and ecological systems. Privatization of water and land has implications for access to resources, particularly when common resources previously accommodated multiple resource users and when outsiders or elites gain at the expense of the poor.

Assessing the impact of interventions, policies, environmental changes, and other actions is often problematic in a watershed context given the complexity of resource flows, the scale of different effects, and assigning values to resources, products and services which are not traded. Conversely, identifying the causes of different outcomes presents many of the same challenges.

The objectives associated with watershed research and/or development projects are numerous. Some of the most prominent goals include improving water use efficiency and productivity, fostering sustainable production of resources, reducing soil erosion, improving vegetative cover, and advancing food security. Despite the diverse nature of these objectives that arise from concerns about efficiency, environmental conservation and poverty, the justification for undertaking research at a watershed level is foremost biophysical. It enables better measurement of the quantity and quality of waters, sediment and other lateral flows. They comprise natural units in which one can effectively measure processes and fluxes.

Nevertheless, the presence of lateral flows does not necessarily justify a watershed approach. Smoke, biodiversity, and water exhibit lateral flow behavior. However, in the case of smoke and biodiversity, a watershed approach is not appropriate.

Oftentimes there is a tension between which takes precedence in defining a watershed: hydrological or socio-political units. In the case of the Lake Victoria watershed, one cannot divide up the lake; the lateral flows are strong and highly interconnected. However, if watershed projects conform solely to biophysical boundaries, they have the potential to skirt the local political system and deny people representation. The danger is more serious if watershed management does not embody a participatory approach. The fact that property rights and collective institutions often embody complex sets of social rules that apply to natural resources and watershed management suggests approaches that conform to these institutional frameworks will have better results. However, biophysical and socio-political approaches need not be contradictory. Socio-political units can be combined to match with a set of hydrological units.

A replication of the boards produced by the working groups is shown in Tables 1, 2 and 3.

Table 1: Group A—Issues and problems related to watersheds research and development projects and the extent to which they relate to property rights and collective action

Clusters	Issues	Relation to collective action/property rights
Assessment	• Cumulative effect of locally adopted practices • Sub-national and transnational action • Market v. non-market values of resources, products and services • How to assess impact	Weakly connected to both
Identify and resolve conflicts from users groups	• How to negotiate and resolve conflicts • Competing interest of land users • Unevenly distributed benefits and costs • How to integrate competing interest in watershed plan	Weakly connected to both
Composition and interest of stakeholders	• How do we identify different stakeholder groups • Allocation of water among groups of users • How to decide use of harvested water • Existing distribution of benefits and costs • Existing management system	Weakly connected to both
Facilitation of good collective action	• Role of social capital • Market effect on collective action (positive or negative— market forces can weaken or break down collective action, but changing market can also push the need for collective action) • Benefits plus opportunity costs of collective action	Strongly connected to collective action
Establishment of maintenance of watershed components	• Grazing land development and maintenance • Management and use of wetlands • Establishment and maintenance of common waterways • Maintenance of water storage structures	Strongly connected to both
Environmental problems	• Eutrophication of lakes (excess plant growth) • Water quality and human health	Weakly connected to both
Desired outcomes	• Improved water used efficiency and productivity • Sustainable production • Reduced soil erosion • Better vegetative cover • Conservation issues • Food security	Weakly connected to both
Land and resource rights		Strongly connected to both

The following table depicts the extent to which Group B associated issues with the importance of collective action versus property rights. Those clusters situated closer to collective action are relatively more related to collective action than those issues positioned more towards property rights. Most issues, however, contain some element of both. Below that, Table 3 reflects those issues that the group felt did not have a close affiliation to either property rights or collective action.

Table 2: Group B—Issues and problems related to watersheds, watershed research and development projects

Collective Action	
Negotiation	• Solutions based on people • Conflict resolution
Management unit	• Watershed boundaries: administrative or social • Size of watershed for planning • Level of community organization
Ecological externality	• Flooding in lowlands • Non-point source of pollution from agriculture • Burning and smoke • Burning fields - water effect • Sedimentation in irrigation system • Inefficient use of water resources • Conjunctive use of scarce water resources
Administrative problems	• Failure of integration between technical departments and welfare departments • Changes in land use: institutional mandates • Degradation of public grazing land • Shortage of drinking and irrigation water
Policy	• Privatization of water supplies and hydropower development • Converting public to private land: implication for rights
Redistribution	• Justify environmental payment to poor • Equity • Illegal encroachment
Property Rights	

Table 3: Group B—Issues largely unrelated to collective action or property rights

Justification of watershed Research	• Measurement purposes: water quantity, quality and sediments • Watersheds are the only natural units where we can measure processes and fluxes effectively • For research: ecological and socio-economic representatives
	• Changes over time • It’s the thing to do
	• Highly variable rainfall • Wind shed • Women and children • Poverty and power gradient • Upland and lowland conflicts • Location specificity

3. METHODS FOR SCALING UP FROM THE PLOT TO THE WATERSHED LEVEL: PRESENTATION BY HANS SCHREIER

GIS tools assimilate point, linear and spatial data on watersheds and enable one to scale up from the plot level to the watershed level and beyond. Stratifying data obtained from employing GIS methods also provides a means to assess the spatial integration of socioeconomic and biophysical information. In addition to biophysical attributes and processes, information on human inputs (e.g. fertilizers) and management is critical for understanding the causes of pollution, flooding and water shortages that plague many watershed regions.

There are several rules encompassing the process of scaling up. First, since one cannot scale down, only up, it often makes sense to collect data at more micro levels. In scaling up, one loses details. However, if an area is too small, one fails to see trends. The more data is collected on continuous, graded scales, the easier it is to quantify data and build a hierarchy. In the scaling up process, data becomes less similar and relationships become non-linear and more complex, necessitating different variables and methods to deal with these problems. Systems are often hierarchical and there are step functions that indicate changes in processes. When integrating biophysical and socioeconomic data, the quality of its analysis is enhanced by ensuring data is collected using the same spatial units and sampling design.

Two alternative approaches exist for selecting spatial units for collecting data: the parametric and the genetic method. The former has the advantage of being objective, quantitative and suitable for statistical analysis, although it requires a dense network of points to capture variability and fails to integrate variables to produce a more comprehensive picture. On the other hand, genetic approaches capture relationships and cover a larger spatial area, but the units become more difficult to identify at higher scales. Generally, prior knowledge of the study site is needed to use this more subjective method effectively.

Three approaches are used in modeling and scaling up, often in combination with one another. The simplest is the analogue approach, which compares the characteristics of known sites with new sites having similar conditions. Information on a limited set of site characteristics is gathered for the various spatial units producing a matrix of different combinations or site types. Random household surveys on input and management factors can then be taken to gather data from each of the different site types and an average calculated for each of the types. This enables one to view overlaps between the biophysical conditions of sites and management factors to hypothesize how their relationship can lead to different environmental outcomes.

The site factor approach identifies variables and their relationship to other variables and outcomes, and uses this information to hypothesize outcomes on other sites. One possible application is to relate the effects of different land use and inputs in contributing areas on stream water pollution, which is measured at key points in the flow. However, this method works best when relationships are linear.

Most complex and data-intensive is the systems approach, which analyzes dynamic processes, such as water, nutrient and sediment flows and maps them alongside different trend scenarios, such as land use patterns or population growth. This constitutes both a spatial and temporal scaling up to enable extrapolation to an entire watershed. A systems approach can be used to assess the impact of filters and buffers on sediment deposits in downstream areas arising from land use practices in contributing areas.

Two case studies conducted in Nepal illustrate the use of the systems technique and the integration of biophysical and social science information in applying GIS tools. In the first, land use, socioeconomic data and water flows are mapped to predict sediment rates based on their identified origin (farms, roads, paths, deforestation) and seasonal water flows and degradation levels (monsoon, pre-monsoon). As a result of this study, interventions were undertaken by the research team to work with communities in rehabilitating common land which was seen as contributing to the erosion and sedimentation problem. A portion of this common land was set aside as a protected demonstration site for growing different species of nitrogen-fixing trees.

Another case study produced a forestry map containing a vast range of overlaid biophysical and socioeconomic data corresponding to different areas of the forest, including resource user groups and property rights. Conservation efforts by the state involve closing areas that are used for the collection of firewood, litter and fodder. Data showed that women are the main collectors of these products, leading to the conclusion that if forestry conservation is to be effective, the Forestry Department will need to work with women to develop such strategies. GIS methods can also be useful in determining where women go to collect these materials, how often they go, and what their daily travel time and distances are.

PARTICIPANT COMMENTARY ON THE PRESENTATION

A number of participants expressed concern about the replicability of the rehabilitation project's demonstration site, which was seen to entail high investment costs and input requirements, particularly labor. Also, when institutional arrangements (e.g. collective action and property rights) are not in place, it is costly to establish them and this can become a disincentive for undertaking rehabilitation on common lands. Furthermore because of the disjoint between upstream and downstream causes and effects, the incentives to rehabilitate are often at odds with the distribution of costs and benefits arising from land use practices.

On the other hand, community groups have little interest in rehabilitating degraded sites because they realize few benefits from investing time and effort in stabilizing soils and reducing sediment loads many kilometers downstream. The challenge, therefore, is to figure out how the downstream water users could compensate the upstream rehabilitators for improving the resource.

WORKING GROUP SESSION II

The second working group session had participants assess appropriate research tools to address an identified cluster of problems, and then indicate at what scale the tools should be applied.

Group A

Group A elected to explore various tools for addressing the specific problems of improving arable land and rehabilitating common land within the general problem cluster of "establishment and maintenance of watershed components". Application of each tool was examined according to where it fit best along a continuum of social/administrative and hydrological scales.

The goal of improving arable lands is ultimately a means for increasing the value of farming systems and thereby raising farmer incomes. Such problems are typically addressed at the plot level (hydrological/biophysical scale) or at the individual or farm household level (social administrative scale). Yet, because each of these captures different information and some factors vary between individuals/households while others vary more according to plot, ideally research on farming systems should collect data and do analysis for both units. If a researcher is examining the potential for adoption of new technologies, for example, he or she would want to undertake an economic analysis of farming systems, analyze the structure of property rights, assess externalities and the need for collective action to address them, examine gender roles and implications of technology introduction, and conduct biophysical simulation methods (e.g. to forecast erosion patterns). By shedding light on the potential opportunities and constraints of introducing new technologies, these tools can pave the way for improved solutions.

However, the temptation to try to manipulate the existing institutional environment to suit new technologies can be misguided. Institutions typically have evolved to suit a number of difficult environmental, economic and social realities, including climatic and market risks. Attempts to change or abolish them can therefore be not only financially costly, but also costly to people's livelihood strategies. Likewise, technologies that demand the altering farming systems may impose high costs. Despite the technical advantages of circular contour bunds for curtailing erosion, for example, farmers often prefer rectangular barriers to suit the rectangular shape of their plots. Altering the geometry of plots to suit the bunds would not only be costly to farmers, but also produce numerous other impracticalities. Therefore, one needs to apply careful analysis beyond identifying constraints to technology adoption to also consider what the ramifications would be if attempts were made to alter these constraint factors and what alternatives exist for adapting technologies to suit the institutional environment.

The task of rehabilitating common land can be addressed by doing preliminary constraint analysis and gender analysis. Common land uses such as grazing and fuel collection are often segregated by gender, such that effective rehabilitation solutions derive from understanding to whom solutions are best directed and the welfare implications of technologies or extension that primarily address one sex. Such analyses are suitable at the community level and the second- order watershed level. Tools such as rapid appraisals, participatory action research and stakeholder analysis are suggested in light of the externality-prone nature of resources managed in common. These techniques are particularly valuable for highlighting the institutions and shared rules that govern the use of common-pool resources. However, qualitative methods alone may be insufficient for appreciating the full scope of problems confronting common-pool resources. Technical measures of resource conditions are captured more accurately and scientifically by tools like GIS, which allow researchers to move from simple diagnosis of the problem to predicting potential outcomes.

Additional tools that may help to address the problem of rehabilitating common land are given in Figure 2.

Figure 2: Problem—Establishment and maintenance of watershed components

SCALE: Social/ administrative units

- Individuals
- Farm household
- Community
- Multi-community
- National
- International

MEANS TO ADDRESS THE PROBLEM

Rehabilitation of common land
-Preliminary constraint analysis
-Gender analysis

Legal and institutional analysis

RESEARCH TOOLS

- Introduce higher value crops
- Economic analysis of farming system
- Property right analysis

- Gender analysis
- Assess needs for collective action
- Simulation methods

- PRA/RRA
- Technologies assessment
- Action research
- Stakeholders analysis
- Socio-economic assessment
- Assessment of compatibility in tech. And Socio-economic
- Demonstrations
- Information discussion
- Institutional analysis

Market Analysis

Environment Analysis

SCALE: Hydrological units

- Plot
- Second order watershed
- Macro-watershed: 4^{th} order
- River Basin

Group B

Group B structured its discussions around a series of questions:

- what are the problems?
- where are those problems?
- why does problem exist?
- who contributes to the source of the problem?
- how does the problem occur?

Dissecting problems in these terms enabled the group to better identify what tools are needed to understand problems before attempting to solve them.

For example, to understand the problem "sedimentation from a non-point source" (see Figure 3), one needs to understand the extent of sedimentation. Tools that help one answer 'what' and 'where' questions are land use maps and field-level technical measures. Land use maps let researchers know whether land is used for agriculture, forestry or other uses, while property rights maps show private, state, and common land. Combining such maps with maps that use technical measures to plot degradation levels can reveal relationships between land uses, claims to resources and degradation, although the relationship may not be one of direct cause and effect.

Community participation in land use mapping can present residents different incentives. On the one hand, farmers and others are likely to gain better insight about how their land use is affecting environmental outcomes and may provide incentives to adapt practices that generate unfavorable outcomes. However, this incentive may be overshadowed by a fear that their negative practices will be exposed and/or that attempts will be made to curtail or tax practices that are critical to their livelihoods. Environmental sensitivity analyses can provide additional information on cause and effect relationships as well as the costs and benefits of modifying land use practices.

Understanding who contributes to a problem plus why and how the problem exists is better achieved through the use of stakeholder analyses (especially to identify who the decision-makers are), and methods designed to derive information on socio-economic factors at the community and household levels. Although government agencies tend to be key decision-makers regarding natural resources (e.g. forest departments), often stakeholder analysis does not extend to those within government agencies to try to understand the incentives driving their decisions. Analyses will need to be refined to be applicable to government decision-making, but so far few such tools exist.

Figure 3: Tools to apply to the problem of sedimentation from a non-point source

Problem: Sedimentation from non-point source

Tools to understand

Who, Why and How?

Land management practice
- Analysis of decision making units: government, community, firms and households
- Community survey
- Household survey
- Socio-economic survey

Tools to understand

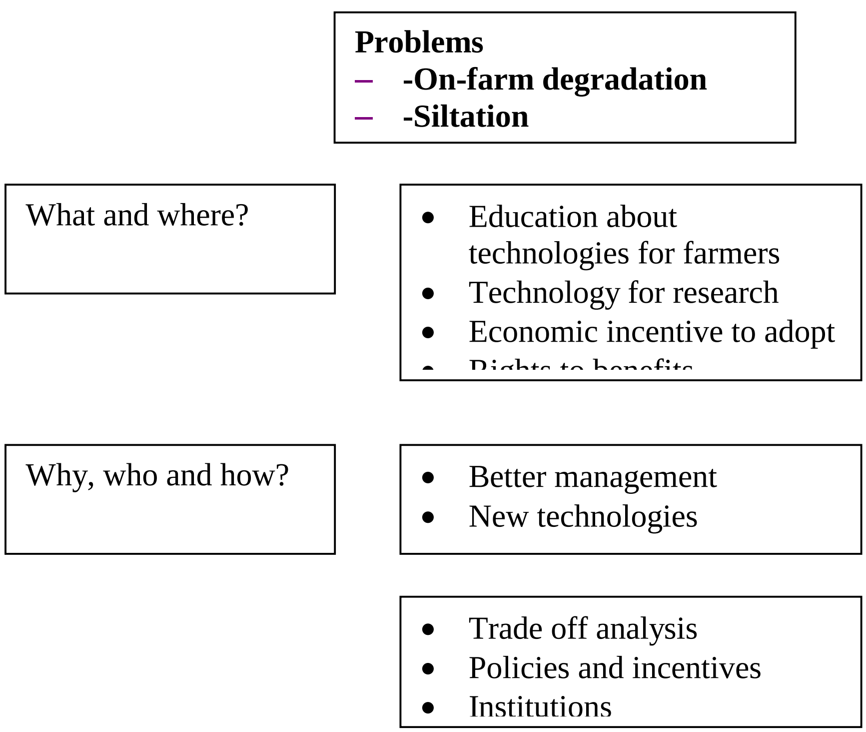
What and Where?

- Land use maps
- Field level technical measures
  - incentives to participate
  - match to technical measure
  - history educates farmers: leading to understanding of management
- Environmental Sensitivity Analysis

Solutions for non-point source sedimentation include reducing on-farm degradation and reducing or eliminating siltation (see Figure 4). Applying the questions of what, where, why, who and how to these ‘solutions’, which are in themselves ‘problems’, enables a deeper level of understanding to emerge. Addressing the problem of on-farm degradation necessitates improved management and land use technologies. For this to happen, farmers need to have information about technology options and their costs and benefits. Such information should include the expected performance of a technology in that particular environment.

In addition to biophysical considerations, an understanding of the nature and allocation of rights to natural resources is important for assessing farmers' adoption incentives. A farmer is unlikely to invest in a technology where weak rights constrain the ability to capture the benefits from investment. Trade-off analyses are useful tools for highlighting farmers' underlying incentive structures provided they consider non-financial costs and benefits (e.g. risk, social capital) as well as financial ones. ICRAF applies a framework of considering adoptability, feasibility, profitability, and acceptability to assess the potential outcomes of technology transfers. Both physical and social environments are dynamic, however. Therefore, constraints and opportunities that are present today will likely change so that technical solutions will constantly need to adapt to suit new realities. Ultimately, long-term solutions to the identified problems are rooted in complementary policies and institutions that offer farmers incentives to choose and continuously modify resource-improving technologies and practices.

Figure 4: Tools to apply to in order to solve problems of on-farm degradation and siltation



4. PARTICIPATION
PRESENTATION BY NANCY JOHNSON AND OLAF WESTERMANN

A core part of CIAT's research agenda is devoted to studying and developing participatory methods for undertaking watershed management and applying these techniques in research on watershed issues. The presentation details the structure, rationale and methodologies behind this research component. Annex 1 describes the workshop field trip to the San Dionisio watershed where CIAT is involved in numerous participatory research projects.

PARTICIPATION AND WATERSHED MANAGEMENT

There are three ways in which participation is associated with watershed management:

1. <u>Participatory watershed management</u>: Stakeholders participate in development processes and decisions. For example, stakeholders such as farmers, local government leaders, representatives from local NGOs, and/or researchers jointly discuss and decide about watershed planning and set priorities for taking up development tasks, such as trying out a technology or methodology in a new location.
2. <u>Participatory research on watershed management</u>: researchers and other stakeholders work together in the process of developing new technologies or institutions for watershed management. Although research is the focus, all stakeholders participate in the process and decisions are made jointly.
3. <u>Research on participatory watershed management</u>: Researchers collect materials from various projects applying participatory watershed management methods and carry out analyses in order to understand issues, such as collective action and how stakeholders negotiate and implement natural resource management. This research may or may not be participatory and therefore may or may not involve other stakeholders.

Typologies of Participation at Different Stages of Research, Project Planning and Implementation

User participation can be categorized into five types: contractual, consultative, collaborative, collegial and stakeholder experimentation (Lilja and Ashby 1999). The least participative is contractual, where outsiders make the decisions while local stakeholders are contracted to carry out the work. In the case of consultative participation, outsiders seek the opinions of other stakeholders, but the implementer or the researcher makes final decisions. Collaborative research involves both outsiders and local stakeholders in joint decision-making, in which the latter carry out the resulting actions. In the case of collegial research, farmers and other community members make the decisions and implement them, though research advice is given. However, the outside researcher intervenes on a collegial basis, expressing his or her opinion, but not manipulating or forcing decisions. In farmer experimentation, researchers are not involved in any systematic way. Projects may use different types of participation at different stages of the research process. There is not right type of participation. Different types are expected to have different advantages and disadvantages, and what type is best depends on the objectives of the specific project.

Rationale for Farmer Participation—Two Hypotheses

Hypothesis 1: There are efficiency gains and improved adoption outcomes when farmers have a stake in the process.

Incorporating farmer participation may increase the cost of research in the short run, but it is likely to decrease it in the long run by increasing the chance that technologies are appropriate and adoptable, reducing adoption lags and raising the adoption ceiling. Although costs to formal research organizations may go up when participatory research involves increased time spent consulting stakeholders and making joint decisions, costs may actually go down if significant research activities and responsibilities are transferred to partners.

Hypothesis 2: There are educational and social capital rewards for all the stakeholders.

Incorporating farmers into the innovation process with scientists and others will increase human and social capital. First by working closely with researchers, farmers can strengthen both their technical knowledge about agriculture and natural resource management as well as their analytical capacities with regard to how to systematically evaluate different technologies. If they work as a group, they can improve their organizational capacity. It has also been observed that as a result of participation, farmers' confidence to interact with researchers, extension agents and others increases, empowering farmers to address their own problems as well as actively seek out appropriate information or advice when necessary.

Rationales for Applying Participatory Approaches in a Watershed Context

Participation is a desirable and at times essential condition for purposeful watershed management. This is due to the characteristics of watersheds and their corresponding management practices. Because of lateral flows and the cross boundary nature of watershed resources, the effect of an application of a technology on one plot is not necessarily confined to that plot or the user of that plot. For example, lateral flows of pesticide can harm water quality down stream. In case of non-point source pollution, it is difficult to determine the source. Externalities are even more pervasive for resources shared in common. In the case of groundwater irrigation, excessive drawing of groundwater results in all users being affected by falling groundwater levels or salinity.

From the research perspective, analysis at the watershed level enables a more holistic and improved understanding of natural resource management processes because the focus is on entire watershed and not only on one plot. The extensive nature of resources and interdependency of users at the watershed level underscores the rationale for multi-stakeholder participation in watershed management and research.

Not only are there are multiple users of watershed resources, there are also multiple uses for agricultural land, forests, pastures, roads and housing. Even within particular agricultural uses, there can be variations like water-intensive crops, long and short duration crops, etc., each of which affect the environment differently. Water-intensive crops absorb more water and reduce what is available for other crops, especially in arid zones. If water rights are not clearly defined and/or multiple uses are not compatible, it causes users to compete with one another for scarce resources. Hence, they demand participation among users to enable understanding and negotiation of each other's use priorities and concerns.

If all stakeholders are not provided an opportunity to participate, more powerful stakeholders are likely to take control of watershed resources and undertake use practices with little regard for their impact on less powerful individuals. Rich farmers are likely to select crops, inputs, and land uses that maximize profits, which may produce negative externalities on the down stream residents. Examples are the use of chemical fertilizers and pesticides or drawing high volumes of water needed by cash crops. Socially optimal resource management calls for better coordination and collective action in negotiating, decision-making, management and conflict resolution among all watershed stakeholders. However, in order to ensure the poor and marginalized members of the community have a voice in these processes, there need to be effective democratic forums. Where these do not exist, efforts to organize the poor and less enfranchised groups can help in asserting their interests and put pressure on the rich to adopt resource management practices that are not harmful.

For collective action to emerge, all stakeholders need to have a shared understanding of causes, effects and interdependencies of resource management. Often, common understandings can emerge more readily if resource users participate in interactive forums and share common objectives, particularly if they perceive that their coordinated efforts will yield short-term, high value benefits for all. Such was the case among the group of Indian sheep herders referred to earlier, who saw the opportunity to earn higher incomes from minimizing conflicts with farmers. Incentives fueled the appreciation of resource interdependencies; such that herders opted to purchase grazing land and high value fodder seed, rather than place their livestock in danger by allowing them to graze on farmers' crops. This suggests that more empowering forms of participatory research that involve farmers and other stakeholders in a substantive way might be most appropriate for watershed management research. This will help manage the complexity of watershed, enhance shared understanding of problems, and foster greater acceptance of solutions.

The Participatory Watershed Management Learning Approach employed by CIAT

CIAT has adopted a Participatory Watershed Management Learning Approach consisting of joint watershed research by CIAT scientists, partners and farmers. Farmers are involved in the analysis, planning and implementation of watershed research and development activities that span from the plot level up to the watershed. In evaluating the merits of such an approach, several questions can be posed:

- *Can we understand the watershed system without the active participation of farmers in the research?* Most watershed systems and their components cannot be understood without input from farmers and other resource users residing in the watershed community. Outsider knowledge is limited to the results of documented research and experiments and its contextual reach. Watershed systems involve complex cause and effect relationships. Researcher understandings of the suitability and the impact of new technologies are greatly enhanced when farmers are involved in the assessment process. Furthermore, there are many systems that are operating in villages without being documented. Researchers can only come to know and understand these systems by doing on-site research involving farmers.
- *Do farmers also need to do research to understand the system?* Engaging farmers in a research process that is rooted in a learning approach expands their own understanding of the watershed system and strengthens their capacity and motivation to do ongoing research in response to ever emerging issues and evaluate the impact of technologies and practices they employ. This relates to the question of whether researchers can transfer their understanding of issues and generate positive impacts without farmers' participation in problem definition, priority setting and research and, if so, how?
- *Can we learn participatory processes without actually doing them?* The answer is 'yes' as well as 'no'. Research on participatory watershed management itself does not necessarily involve the participation of all stakeholders. However, one can better learn about participatory processes by engaging in them. This is

known as action research or learning-by-doing, whereby the researcher develops skills in participatory processes while also gaining an understanding of the concepts.

Who actually participates in these learning processes will differ from community to community according to what is most appropriate for them. Simply because the research is participatory does not mean that all farmers necessarily participate. It can be an entire community or it can be a few representatives. For example, in the case of setting up a field school, the entire community may participate in doing research on and learning Integrated Pest Management (IPM) techniques. But if research involves undertaking plot level experiments, only a few farmers are likely to participate initially, with the expectation that the knowledge gained from their research would be shared with the rest of the community (see Annex 1). At a certain point in the research and development process, it may become important to involve all stakeholders, especially in community natural resource management research. This lesson was learned in the case of Asobesurca, a watershed users organization supported by CIAT in the Río Cabuyal watershed in Colombia. In August 1994, a fire destroyed part of the buffer zones created by Asobesurca the same year to protect water sources important to the inhabitants. An analysis showed that certain inhabitants of the microwatersheds were not represented in Asobesurca, including those who were seeking land, people who were short of labor, and indigenous groups who had expressed strong opposition to the creation of micro watersheds protection zones. Consequently, Asobesurca invited more people to participate in analyzing the problem and researching alternatives to the practice of burning fields (Ravnborg, Guerrero, and Westermann 1999).

In conclusion, participatory research processes are key to enhancing the impact of building on technologies and institutions in watershed management projects. The following arguments support the logic that shared understandings between researchers and farmers are more likely to produce positive results and build mutual capacity:

- Understandings gained by researchers alone are unlikely to have much impact if farmers do not also share the same understandings.

- Researchers' comprehension of the biophysical and social interactions of watersheds and their communities is bound to be more accurate and richer when farmer knowledge and experience is incorporated.
- Action research and learning from farmers deepens researchers' understanding of participatory processes themselves and how they can be used to more effectively to assimilate technological and institutional innovations that will have a positive impact on the livelihoods of farmers.

In the process of setting objectives for research and development projects, it is important to consider how progress toward achieving those objectives will be measured. CIAT is now in the process of working to improve the impact evaluation component of their participatory research.

PARTICIPANT COMMENTARY ON THE PRESENTATION

Problems in Identifying the Stakeholders

Defining stakeholder groups prior to launching the resource process is not easy since we often do not understand the full extent of the interrelationships and the positive and negative externalities arising from resource management. Knowing how different stakeholders will be affected is important for knowing how to best engage them in the research process. Also, there are likely to be stakeholders not only within the watershed, but outside it as well. Because often one does not have prior knowledge of the relevant stakeholders, projects need to be flexible and adaptive. This is aptly demonstrated in the case of Asobesurca, which did not initially recognize landless people as relevant stakeholders but later incorporated them.

Researchers/Project Managers Typically Define 'Stakeholders' According to their Priorities

Who participates often depends on the objectives of the researcher and their definition of who the stakeholders are. For example, stakeholder groups may be related to poverty or gender or only include those most directly affected by a particular problem or technology being addressed. In some cases, selection may be based on who is most visible and easily identifiable in the community, or who is most cooperative and willing to support the objectives of the researchers. Since stakeholder definition has considerable equity implications, we need to ask ourselves who is defining the stakeholder and how might their selection affect the outcomes of watershed research and development projects?

At the same time, when watershed management involves many stakeholders with a wide array of interests, it is impossible to address all interests effectively. Typically researchers and project managers determine who participates and whose interests should be promoted. In the case of property rights, creating institutions for more secure tenure to enable improved resource management typically necessitates exclusion of other stakeholders. In undertaking participatory research, how do we address these potentially equity-reducing outcomes? What sides should researchers take when faced with a tradeoff between a solution that favors natural resource improvements and one that will result in significant short-term gains in the livelihoods of the poorest?

The Importance of Allowing Sufficient Time for Negotiation

It is important not to rush into solutions that create winners and losers, with the idea of devising quick means of compensating losers. Solutions are likely to be more effective if the negotiation process is not pressured, but given time to bring about mutually agreeable alternatives. Maximizing joint benefits is an economics concept, but it does not necessarily bring about an optimal solution. Can we really compensate losers? Often it seems we are pressured to make decisions too soon, but we need more time for negotiating outcomes to arrive at an agreeable compensation structure.

The Cost of Participation

Often it is argued that participation increases the costs of research. However, the argument lacks validity when one considers that participation significantly increases the possibility of devising appropriate and effective solutions that will be adopted. Ultimately, this is more efficient and less costly.

Scaling up Effective Methods

Research organizations are gradually seeing the benefits and learning the tools for doing on-location, as opposed to centralized, research. The next step is to expand researcher knowledge of effective institutional structures for enabling more participatory research, such as CIAT's Telecenter approach (see Annex 3) and the collective learning approach via community-level experimentation groups called CIALs (see Annex 1). In Colombia, representatives of 50 CIALs meet on an annual basis to exchange experiences. Their effectiveness and low cost has led to the Colombian National Extension System adopting the CIAL approach as their national strategy.

Super Researcher or Extension Service Providers

The CIAT framework involves researchers undertaking both a research and extension role. How effective can this 'super researcher' approach be compared to national extension workers carrying out on-site components? Local level parish councils in Uganda have contracted independent extension providers for watershed projects. Perhaps the CIALs could contract the national extension services to work with them directly.

WORKING GROUP SESSION III

During this session, the two groups diverged in their tasks, with Group A relating the typologies of participation to the watershed research at their institutions while Group B focused primarily on the participatory tools suited to address the particular issues encountered in watershed projects.

Group A

Working Group A employed the typologies of participation suggested above to examine where on this scale their different research institutions currently operated in the various stages of the research process, and where they perceived their institutions to be moving in the future in terms of undertaking participatory research with watershed communities. Group members placed the name of their institutions in the cells of two matrices that plotted participation typologies (contractual, consultative, collaborative, collegial, and stakeholder experimentation) and research stages (diagnosis, priority setting, planning, implementation and monitoring and evaluation). These are illustrated as Tables 4 and 5. In some cases, research projects differed according to the extent of participation they apply, or intend to apply. Hence, organizations are often listed more than once for the various stages. What is revealed by this table is the wide range of types applied by the various centers.

Table 4: Which typologies do participants' institutions currently apply at different stages of the watershed research process?

	Contractual	Consultative	Collaborative	Collegial	Stakeholders experiments
Diagnosis	IBSRAM ICRISAT CIAT	ICARDA ICRISAT ICLARM	PRADAN CIAT		
Priority setting		IBSRAM ICLARM	ICRISAT ICARDA PRADAN CIAT	ICARDA (Egypt)	
Planning	IBSRAM	ICRISAT ICARDA CIAT		ICARDA (Egypt) PRADAN	
Implementation	ICLARM	ICLARM CIAT	ICARDA ICRISAT IBSRAM ICLARM	CIAT ICRISAT ICLARM ICARDA (Egypt)	PRADAN ICLARM
M & E	ICARDA ICRISAT IBSRAM CIAT		ICLARM ICRISAT PRADAN		

Table 5: What participants' institutions plan to achieve in the future in terms of participation of community and stakeholders at different stages of watershed research

	Contractual	Consultative	Collaborative	Collegial	Stakeholder experiments
Diagnosis		ICRISAT ICLARM	PRADAN ICARDA IBSRAM ICRISAT	CIAT (adaptive)	
Priority setting		IBSRAM ICLARM CIAT ICARDA	ICRISAT ICARDA PRADAN CIAT	ICARDA (Egypt)	
Planning		ICARDA	ICRISAT IBSRAM CIAT	ICARDA (Egypt) PRADAN	
Implementation	ICLARM	ICLARM CIAT	ICARDA ICRISAT IBSRAM ICLARM	CIAT ICRISAT ICLARM ICARDA (Egypt)	PRADAN ICLARM ICARDA (partnership)
M & E	ICRISAT		ICLARM ICRISAT PRADAN IBSRAM ICARDA	CIAT	

In ICRISAT's case, for example, researchers and farmers together identify constraints in the field, but research analysis is done mostly in house. They are collaborative in the implementation of the research program. ICRISAT scientists sit with farmers who collaborate in the design of water harvesting tanks and make decisions regarding their implementation, such as task allocation. Implementation is typically undertaken by village self-help groups, but supervised by scientists.

ICLARM scientists sit down with the farmers and consult them in setting priorities for research. Scientists ask farmers about what project features or fish are most appropriate given the biophysical conditions of the region and their own needs and preferences. Regular monitoring and evaluation meetings are conducted with the farmers. PRADAN, an NGO engaged in watershed development, uses a collaborative approach in the diagnosis phase. Problem mapping as well as initial and corrective benefit analysis are undertaken in public meetings.

Despite this variability, the pattern of current practice appears to be for lower degrees of participation in upstream activities (e.g. diagnosis, priority setting), and more participative modes for downstream activities (especially implementation). Future plans also seem to call for more collaborative modes of research.

Whereas participation has many advantages, there are instances when it can be problematic. During the initial stages of a project, it is not always clear who the stakeholders should be nor even who is willing to participate. Having farmers or other groups undertake the selection process is likely to reflect their biases. Nevertheless, the input of various groups should be consulted since outsiders are unlikely to be experts either. Poor identification of the important stakeholders in the beginning can be costly in terms of diverting projects and wasting time. Other potential problems are that participation can ignite major conflicts and increase the cost of research. Also, when farmers do not perceive short-term benefits from participation, they may fail to get motivated.

Despite the potential drawbacks of adopting participatory approaches, most participants agreed that research needs to be more client-oriented and demand driven. This calls for greater levels of farmer and other local stakeholder participation, which makes projects more viable and improves the quality of implementation. However, more research is needed on how to identify the right participants and the right number of participants. Greater efforts to contract and consult farmers should be done in the diagnosis stage since it would bring historical knowledge and local innovation into the process. Overall, participation improves the quality of watershed research and development projects by building the capacity of farmers and other local stakeholders to do research. The financial costs of participation are therefore overshadowed by the value that is derived from the poor being empowered to carry out their own research.

Group B

Working group B sought to address two questions:

1. What is special about research on watersheds with respect to the need for participation?
2. What sort of participatory tools and approaches enable researchers to address the unique problems of watershed projects?

The group raised various issues that differentiate watershed research from other types of research. In watersheds, people are linked because of biophysical interdependencies and resource flows, even if they live far away from one another. Externalities are not just manifested in an upstream/downstream mode or even as lateral flows, but rather from multi-directional resource flows. Because of these wide-reaching flows, there is a need to focus on off-farm issues, which are better addressed by collective learning and collective action. However, externalities typically extend beyond the community level, suggesting that federations of community groups may have roles to play in helping people develop common goals. In the San Dionisio watershed in Nicaragua, a federated structure has been created for this purpose.

Participatory research is likely to be an effective strategy for addressing off-farm problems that require collective action solutions. However, much of the current participatory research continues to deal principally with on-farm issues. Simplified simulation models could be used by farmer researchers to predict the outcomes of certain technologies, enabling comparison with indigenous technologies and practices.

Diversity in people's interests and land uses in a watershed context raises the likelihood of conflict that can only be addressed through extensive stakeholder negotiations that not only involve rights to exploit a resource and engage in different land uses, but also duties not to exploit others in their use of a resource. Thus, long-term frameworks are needed to develop or strengthen collective action and property rights institutions for managing watershed resources. Participatory research can be effective in building rapport and trust not only between researchers and local stakeholders, but also among different local interest groups who, by working together, have a greater ability to form shared understandings of each others' problems and priorities. But these processes also take time. Participatory watershed management projects will therefore benefit from financing that is compatible with these extended time horizons that promise more enduring outcomes.

Researchers have a facilitating role to play, particularly in highlighting interdependencies and the subsequent need for collective action. Hence, researchers also need to be skilled in participatory methods. The question was posed as to whether it is possible to understand participation without actually engaging in the process? Some argue that it is sufficient for researchers to simply recognize the validity of participatory methods and have an appreciation for them. Yet, even if not all researchers are experts in conducting participatory research, research organizations should have in-house expertise on participatory research philosophies and methods. Within the CG system, there is a need to strengthen the capacity of Centers to engage in participatory research.

Whereas participatory methods present considerable opportunities for enhancing the quality of research so that it better meets the demands of resource users, they may not be suited to all environments or require substantial modification. It is lot more difficult to implement participatory approaches in countries where the political climate is not open to democracy. Furthermore promoting local organizations and political advocacy in such contexts can even be risky, such that participatory research may only be feasible and appropriate in contexts where democratic processes are legitimate. The existing property right laws in some countries may also constrain the ability to engage stakeholders in collective solutions; particularly if such solutions seek to change the way resources are managed or modify who has access to the benefits. Thus, it is important to scan the legal frameworks surrounding property rights and collective action so that participatory research can be better positioned.

These and other outcomes of the discussion are illustrated in Table 6.

Table 6: Participatory tools for addressing the unique problems encountered in watershed research

What is different about watershed research?	Approaches to address the problems
Participation may need to focus on off-farm solutions and problems	• Employ simplified simulation models and compare with local knowledge • Address scope/opportunity of existing legislative framework • Apply phased learning approach to gradually raise consciousness and interest in collective action • Train more researchers in participatory skills and develop in-house expertise
Resource flows may link users who are widely separated across the landscape	• Engage land users in site characterization and resource valuation • Support the development of federations of local groups at the watershed scale • Identify common goals among different stakeholders
Interdependencies require collective learning	• Identify research and participation models and replicate them if possible • Examine opportunities with school education campaigns • Enable researchers to facilitate awareness of interdependencies and the need for collective action • Link researchers with experts in facilitation and conflict management
Watersheds comprise socio-economic and bio-physical interactions at a broad scale	• Identify ‘hot spots’ in conjunction with policy makers, then focus on them with local stakeholders • Facilitate networks of local organization • Consider ethical challenges and concerns in an effort to avoid jeopardizing stakeholders
Stakeholders embody a diversity of interests and priorities regarding watersheds products and functions (not just different cost and benefit ratios)	• Consider ex-ante analysis of potential research outcomes, including who benefits and who loses • Identify and work with local leaders who can appreciate the interests of a broad set of stakeholders • Provide local people training in stakeholders analysis and negotiating options • Do not assume that problems and solutions are the same in all parts of the watershed • Use landscape simulation tools to present scenarios for multi-stakeholder evaluation

Table 6 continued	
What is different about watershed research?	**Approaches to address the problems**
Changes/interactions might leave some stakeholders worse off	• Engage potential beneficiaries and losers in alternative options • Use approaches that include all interest groups from the outset • Validate the importance of marginal groups participating in decision making
Political regulation of natural resources may conflict with local decisions and institutions	• Work with groups (e.g. NGOs) that negotiate or influence policies favoring increased decentralization • Target politicians and legislators for participation in the research process and dissemination of research results in an effort to heighten their understanding of the issues and lessen legal constraints to implementation of local decisions • Work in areas where local democratic processes are considered legitimate
Collective action for NRM may require adaptation of property rights	• Make property rights assessment part of problem diagnosis and characterization
Engendering participation requires a long time frame, which may not fit with current research management systems or donor expectations	• Identify indicators of participation to show progress over time • Seek sources of long-term funding for participatory watershed management projects • Justify long-term, open-ended research in funding proposals • Engage researchers and donors in long term perspective approaches
There is uncertainty in identifying future stakeholders	

COMMENTARY ON WORKING GROUP PRESENTATIONS

Incorporating Lowland and Upland Stakeholders

Addressing off-farm issues and incorporating lowland and upland stakeholders in the participation process are essential elements of effective watershed development. Although many watershed issues may not be of direct concern to some upland farmers, they result in critical externalities affecting different users. Hence, the participation of all stakeholders is crucial.

New Institutional Economics

New institutional economics (NIE) may be able to offer insights to enable better understanding of the incentives and strategies for participation. Although NIE is advanced in its theoretical understandings, it remains weak in terms of offering operational guidelines. Also NIE theory is derived largely from economics, whereas better understandings of participation need to be more interdisciplinary. The new political economy discipline offers useful approaches for understanding the rationale for decision-making in the allocation of resources.

5. IMPACT: PRESENTATION BY JOHN KERR

Impact assessment of watershed projects is critical in light of the increasing importance being placed on watershed development by governments, donors, NGOs and research institutions. For example, in India the budget for watershed development has increased drastically within the last ten years, while numerous donors are investing large sums in funding watershed activities. As a result, watershed projects affect the welfare of a large numbers of people. Because watershed development addresses both biophysical and socioeconomic factors, measuring the impact of projects is highly complex and challenging. However, to date there is little historical data available for impact assessment. This may derive from the difficulties encountered in undertaking impact assessments as well as the lack of rewards in the short term for collecting data designed to assess impact in the long run. Assessing impact is challenging in an environment where there are lateral flows of water, sedimentation, nutrients, and harmful chemicals. The complexity is compounded by the existence of multiple stakeholders with different and often conflicting objectives amidst a confluence of interdependencies among watershed users.

ESTABLISHING PERFORMANCE INDICATORS

For impact assessment to be undertaken effectively, projects first need to set performance indicators. This is critical for being able to know whether any change has happened and the project is successful. Performance indicators enable one to evaluate intermediate outcomes such as adoption of improved practices and evidence of collective action, and final outcomes such as improvements in natural resource management, productivity, and poverty alleviation. Understanding the relationship between intermediate and final outcomes is essential for understanding the impact of intermediate outcomes on final outcomes. For example, how does the adoption of improved practices lead to poverty alleviation or to land improvement? Performance indicators can be set at different levels, including the plot, village, and watershed level.

The Need for Baseline Data

Often projects do not establish impact indicators prior to or early on in the project cycle and hence, there is no data collected on them. Ideally, for 'before and after' studies, baseline data is required, but very often its collection is not planned in advance. Without baseline data, researchers interested in assessing 'before and after' relationships are left to rely on recall data in order to reconstruct pre-project conditions. Whereas factors that constitute one-time events are likely to be recalled clearly, those that change continuously can be difficult to recall. Because it is easier to recall the direction of change than the magnitude of change, responses to the former tend to be more reliable.

Control Villages

Another approach is to assess impact on a 'with v. without' basis that compares watersheds or villages where project interventions have taken place versus those where they have not (controls). Although control sites should ideally be comparable to study sites, this is rarely possible in a dynamic socioeconomic environment as it is in scientific laboratories. To compensate, researchers may have to veer from random sampling in favor of stratification.

Although it is important to adhere to scientific rigor in undertaking impact assessments, lack of data and the realities of dealing with a complex human and ecological environment do not always enable the ideal criteria to be met. Therefore, the results must be judged accordingly.

Quantitative vs. Qualitative Approaches

Data collection and analysis can be conducted using both qualitative and quantitative approaches. Qualitative analyses typically utilize participatory evaluation techniques, whereas quantitative approaches tend to employ statistical methods for collecting data.

Qualitative approaches are usually less structured, iterative and open-ended while quantitative approaches are more rigid, fixed and one time. Qualitative approaches build on insiders' perspectives (e.g. rural villagers) in framing the research questions while quantitative approaches are based on outsiders' perspectives, namely those of researchers. The fundamental difference in philosophy is which constitutes the best source of information. But these two methods need not be mutually exclusive. Often in fact, they are highly complementary.

Ideally, research begins with qualitative data gathering to find out what questions to ask. Once established, these questions can be incorporated into a quantitative survey. After administration of the survey, qualitative methods can again be used to triangulate quantitative information and interpret those results. Used alone, qualitative and quantitative approaches each have their problems and limitations, which are described below.

Drawbacks of Cost-Benefit Analyses

Cost-benefit analyses (quantitative approach) embody two problems.

1. Projects frequently have sound information on costs, but project benefits usually have to be assumed. Often it is assumed that these benefits will continue over time although this many times is not the case. Hence, impact assessments will reflect a gap between the assumed benefits and the actual outcomes. Furthermore, evaluations are unlikely to capture all project outcomes, particularly those that are derived indirectly since it can be difficult to trace processes and their effects.
2. When undertaking impact assessment, the data collected is typically aggregated in an effort to gain an overall picture of the situation. However, by ignoring the

distribution of outcomes among the sample and not examining specific cases, critical information can be lost. A project that relies on collective action to meet its objectives risks failing if even a small minority of the sample has negative cost/benefit ratios since success may be contingent on community-wide cooperation.

Ways to Offset these Problems

The problem of aggregating sample data can be addressed by incorporating distribution analyses and taking note of special cases. 'Hot spots' can be identified *a priori* and distinguished from those areas where problems are less severe. By intentionally gathering data on 'hot spots' and handling them separately, one can ensure their features are incorporated into the impact analysis. Where sites are sparsely distributed, stratifying according to project outcome may cause one to overlook important lessons. For example, a project site may not show impact in terms of adoption of harvesting tanks, but instead may have a viable process of water use planning. In such a situation, qualitative approaches and choice-based sampling can be useful in identifying such villages and capturing important alternative impacts. However, one cannot always design sampling processes in advance. Moreover, non-random project site selection requires statistical adjustment. Finally, relying wholly on an economic model to assess impact can overlook less quantifiable problems, such as complex property relationships. Rather, a balance between qualitative and quantitative approaches is needed to incorporate both the biophysical and socioeconomic aspects of the watershed into impact evaluation.

Drawbacks of Qualitative Research

Qualitative research also suffers from sampling bias because it often relies on a small, purposive sample. Hypothesizing that factors derived from one particular case apply similarly to other sites can result in misleading conclusions. Interviewing government officials about projects can also produce misleading information. Thus, a critical component of good qualitative research is verification of information from multiple sources with different interests, a process known as triangulation. Biases can also come in the form of researcher or disciplinary bias, donor bias, and roadside bias (when project sites are selected according to their accessibility and ease of gathering data).

The challenge in developing a good mix of qualitative and quantitative methods for impact assessment is to design a methodology such that the problems inherent in one approach are offset by the merits of the other.

Other Problems Encountered with Impact Assessment

Attribution, or the process by which one identifies the underlying causes of a particular problem, is highly challenging issue facing impact assessment of watershed projects. Factors that produce a direct impact on outcomes are outnumbered by those that relate indirectly, particularly when one considers the host of resource interactions that characterize watersheds. Moreover, assessing real life environments does not produce the luxury of being able to test the counterfactual or establish rigorous control experiments. If impact is found, is it because of the watershed project, or because the process that led to the impact was already in place and would have happened anyway?

Multiple objectives in watershed projects such as water quality improvements, erosion reduction, and poverty alleviation can result in these objectives being at cross-purposes, such as those which seek socioeconomic improvement and those that have biophysical targets. There are multiple dimensions of performance related to these multiple objectives. There are also multiple determinants of these performances. For example, improvements on arable land can be the result of various factors such as erosion checks, restoration of moisture and nutrients. These determinants vary for different actions undertaken. Motivation of stakeholders is likely to vary as the costs and benefits of different actions vary. Further complexity is generated by the existence of several units of analysis such as plot, family and watershed.

If data is collected through another team or agency, it can reflect their biases or standards. It is also possible that important data is not collected or lost. Letting others collect data can impose a major loss of understanding of the issues and problems. The key advantage of being involved in data collection is that it enables one to assimilate valuable qualitative data as well.

Key Lessons Learned

The impact study undertaken by Kerr, et al (1998) in India produced various insights for guiding future work. These include:

- The importance of identifying statistical problems in advance and incorporating them into the project design,
- The importance of conducting rapid rural appraisal (RRA) studies with different types of impact indicators,
- The need to spend sufficient time in the field and directly ask local people what they perceive to constitute impact—in order to deepen one's understanding of critical issues and better identify the reasons behind changes.

Impact Assessment as Part of a Larger Process

Impact assessment is one step in a larger process of research and development. It is not only looking backward at the results of research, but also using what has been learned to inform the development process. However, one needs to be clear about the underlying assumptions built into impact assessments for particular projects in order to apply their lessons to new scenarios.

PARTICIPANT COMMENTARY ON THE PRESENTATION

Baseline Data

Often the researcher lacks the necessary baseline data (or the capacity to collect it), and good control villages do not exist. For example, in India, one cannot get aerial photos. So, one needs to incorporate considerable qualitative research. Collection of baseline data needs to be more systematically incorporated into project designs, while at the same time more efforts need to be undertaken to share information on baseline data already collected among researchers and to coordinate collection for current and future research projects, with a view as to what information will be most useful later. A lot of baseline data that has been collected is never used because its existence is unknown or it lacks coordination in measurement. Rather, it is important for research institutions and national agencies to establish certain types of baseline data that are most likely to be useful later.

Project Justification

Impact assessments are often undertaken as means to justify investment in a project and ensure project implementers are held accountable for project results. However, projects are often measured against very general and highly aggregated goals that do not take into account other measures of achievement or less quantifiable, yet meaningful, results.

Attribution Problems

Ideally, an impact assessment raises the level of understanding about what characteristics contribute to project success and what factors impede it. However, assigning attribution is very often complicated. For example, it may be very difficult to separate out the causes of a rise in well water level in terms of whether it is due to a particular land treatment or because of comparatively higher precipitation levels in a given year.

In addition to this, there is the problem of establishing a proper control framework. One cannot restrict farmers from changing and thereby no longer fitting into the control framework. Such dynamics confound the ability of the researcher to undertake a rigorous comparison. It also presents challenges for capturing incremental change and identifying the causes. Because there is so much variation in the system, identifying real 'controls' may be impossible. Rather, characterization based on biophysical and socioeconomic attributes may enable more realistic comparison.

Although the spread of project benefits beyond the project area may result in a lack of control sites and make attribution more difficult, technology spread can also be a favorable indicator of impact. If a technology has been adopted in the neighboring villages, it is likely to mean that farmers found it useful. Where technology spread has also led to adaptation of technologies from the original, the capacity to assign causality is further weakened.

Scaling Up

Scaling up impact assessment beyond a limited number of individual watersheds is likely to require the involvement of more local people in data collection and analysis.

Increased participation of farmers and other local stakeholders can be achieved providing them with impact assessment training. In the context of CIAT, local trainers who are already involved in implementation of watershed activities are trained to play the additional role of collecting and analyzing data.

Sampling Bias

Sampling bias can occur if project areas are selected by governments, NGOs, or other implementing agencies based on their likelihood of succeeding. Government staff often selects those villages that are close to government headquarters and have better infrastructure. Such villages are also likely to be the target of more than one government program, which may further limit the capacity of impact assessments to determine which project interventions contribute to successful versus failed outcomes.

Integrating Quantitative and Qualitative Data

An analysis of how to integrate quantitative and qualitative data, which suggests standards and research approaches, would be very useful. CAPRi could prepare or commission a paper on best practices for integrating qualitative and quantitative data, which is grounded in property rights, collective action, and watershed issues.

WORKING GROUP SESSION IV

Both working groups A and B discussed problems and issues related to assessing the impact of watershed management and potential solutions or suggestions to address them. Summarized below are the various issues discussed. The problems have been grouped in two categories—one having to do with the incorporation of impact assessment into the research process, and the other with statistical and analytical problems. Problems are noted in italics and the corresponding suggestions discussed below each.

Integrating Impact Assessment into the Research Process

How do we incorporate impact assessment into the research process and apply it as a strategic tool for research planning? Impact assessment should be a component of the overall project plan from the start. Project designs should include objectives linked to measurable goals and impact indicators, perhaps through use of a logical framework approach. Monitoring mechanisms should also be established in advance of project implementation. A continuous monitoring system is a strategic tool for research planning since outcomes from monitoring can reveal problems in the research questions and design, as well as provide opportunities to modify the agenda or methodology. This approach is reminiscent of the learning systems concept advocated by David Korten (1980) and proponents of adaptive management (e.g. Uphoff 1991), whereby insights gained from impact assessments are incorporated into a dynamic project design process.

Conflicting Research, Project, and/or People Goals The multiple goals of different stakeholders in a watershed often produce conflicting situations. Thus, there is a need for more strategic planning among researchers, project implementers and local stakeholders to ensure that research, project and people goals are compatible. By involving communities and local stakeholder groups in the planning, implementation and analysis of the results of impact assessment, local input is reflected in assessment output and reports. This further provides a foundation for complex negotiations among the various stakeholders. A development process built on lessons learned can only emerge when impact assessments jointly address both project and local stakeholder needs. Integrating non-agricultural research can also ensure a more holistic approach to solving watershed problems.

Differing Expectations Between Researchers, Donors and Local People There is a need to have more stakeholder analysis and forums that explore the constraints and possibilities of different impact evaluation approaches and devise mutually acceptable expectations. Often the expectations of donors are high and overshadow project goals. Provision of donor education on impact evaluation problems, realistic timeframes, and data limitations may be required. As well, researchers and project implementers need to communicate and include more appropriate timeframes in their planning and proposals.

When should one do impact assessment, particularly given that there tend to be long time lags between institutional development and environmental impacts? A priori examination of how project inputs are likely to be incorporated into the watershed system will enable a better appreciation of the best time to assess impact. Analysis of historical trends can be useful in this regard and permit researchers to identify potential intermediate impacts for measurement. Preferred methods may include participatory impact analysis involving local stakeholders and longitudinal research.

Data, Statistical, Analytical and Measurement Challenges Associated with Impact Assessment

Most of the existing watershed projects lack baseline data needed to do longitudinal analysis, whereas inadequate control sites present problems for undertaking cross-sectional analyses. Where possible, efforts to do both before/after (longitudinal) and with/without (cross-sectional) analysis should be undertaken. More efforts need to be employed to establish baseline data and identify suitable control sites. In the absence of baseline data, one can potentially make use of recall data. Although this data tends to be less accurate, it nevertheless enables one to establish overall trends with a reasonable degree of confidence. Government published records such as district censuses are also useful sources.

How do we identify non-project influences on outcomes and separate out their relative effects compared to those of project variables? System linkages can be difficult to trace when essentially everything is interconnected. Perfect solutions do not exist for identifying and parceling out the relative influence of different factors. With quantitative survey techniques, factor identification depends on the hypotheses of the researcher. Traditional empirical methods (namely regression analysis), when applied in non-experimental situations, fail to take account of one's lack of knowledge of the counterfactual (i.e. what outcomes would have occurred had a particular factor been absent). They can only be approximated through the use of imperfect control sites. Nevertheless, quantitative methods exist that take into account lack of knowledge of the counterfactual by employing interval estimates rather than point estimates to better reflect what is not known. Analysis of historical trends may also allow one to compare outcomes with and without project interventions. Furthermore, qualitative research conducted before and after quantitative research can help to ensure the right variables are captured and test the validity of quantitative results. Other methods suggested by the group to improve explanatory factor identification and analyses are referred to in Table 7.

Difficulties in Capturing Off-Site Impacts In watershed projects, there are often off site impacts such as the recharging of wells due to the construction of water harvesting tanks and silting of ponds resulting from upstream land practices. However, given their non-linear and indirect nature, there are difficulties in capturing these off-site impacts. This problem can be addressed by undertaking qualitative assessments and ex-ante studies that enable a systems analysis of upstream and downstream resource uses and of the external impacts of human interventions, both direct and indirect. Ex-ante analysis (e.g. using theoretical equations and simulation models) can be a valuable component of project design.

How do we define adoption of natural resource management technologies and practices? Impact studies need to be clear about the definition of adoption they apply, given that technologies embody different uses, are often adopted in tandem with other technologies, are subject to temporary or partial adoption, are adapted over time, and are subject to a wide range of uses. It is important to undertake monitoring and evaluation to account for different stages of adoption and analyze the underlying components of internalization. A commodity or production orientation is often inappropriate for studying adoption of natural resource management technologies and practices. Better results may derive from assessing functional and service related benefits by applying non-market valuation techniques (Freeman 1993).

How do we measure conflicts and conflict resolution? How do we determine if the project has had an influence in creating or resolving conflicts? Unlike measuring physical parameters like land area and quality of water, measuring conflict resolution is complex and is best addressed via a mix of qualitative and quantitative approaches. Narrative descriptions of conflict resolution often reveal the sources and benefits of collective action for conflict resolution and in general can be used to shed light on the causes and effects of conflict resolution as part of impact assessment. Although imperfect in their ability to capture the complexity of conflict, attempts have been made to quantify conflict resolution incidences, as well as the issues and persons involved.

The Challenges of Quantifying Behavioral Changes Biophysical indicators are frequently used to capture changes in human behaviors. For example, the gradual abandoning of free grazing practices are indicative of people's behavioral change. Analyzing what lies behind such modifications can often be enhanced through qualitative research that examines the role of norms, institutions, and organizations to the extent that they both reinforce behaviors and foster change.

How do we determine costs versus benefits and weigh them against one another when multiple resource sectors, uses, and stakeholders are involved? A more holistic appreciation of costs and benefits (material and non-material) can be achieved by extending the scope of baseline data gathering and monitoring and evaluation studies to include multiple sectors and involve multiple stakeholders. Although such an approach heightens the complexity of such an analysis, it raises the likelihood of acceptability to a broad range of interests. To appreciate the complexity of a problem, researchers will also need to avoid aggregating costs and benefits in favor of acknowledging differences across groups and areas. Only then will they be able to compare the real value of different technologies and practices.

How do we address the scale of interventions (e.g. plot, farm, watershed levels) and their environmental impacts? Watershed research needs to consider both hydrological and social boundaries in order to comprehend people and resource interactions, draw conclusions about environmental outcomes, and devise appropriate solutions to problems. Both scales contain various units of spatial analysis. By applying spatial modeling and tools (e.g. reflective spectrometry) that disaggregate landscape and social characteristics and can be scaled up, one can assess aggregate impacts at the watershed/community level.

Both working groups identified many more problems and potential solutions that are not captured in this summary. These are noted in Table 7 below.

Table 7: Problems encountered in evaluating the impact of watershed development projects, and potential means of addressing them

Problem/issues	Suggestions/solutions
• Poor link between the research agenda and project goals • Setting realistic "goals"	• Strategic planning • Relate project target to a development agenda with a long term perspective • Link project objectives to goals—log frame
• Unreasonable expectations • Participatory research implies the involvement of many stakeholders with different expectations	• Stakeholder analysis • More time and money to develop project documentation involving those with expectations (e.g. donors) • Donor education on impact evaluation problems • Develop joint solutions
• Aggregate quantification of impact • Behavioral changes are difficult to quantify	• Encourage researchers to combine qualitative and quantitative research • Integrate more qualitative research
• Selecting an appropriate time frame for assessing impact of watershed projects	• Describe timing of potential impacts realistically
• Difficulty in assessing the impact of public relations	• Survey sources of information and attitudes • Build public relations into the research process, including communication with policy makers
• How to define adoption of the wide range of natural resource management (NRM) technologies and practices	• Be clear about the definition of adoption (use, hybrid, extent of use, etc. • Recognize stages of adoption of NRM practices • Analyze underlying components of internalization • Apply participatory monitoring and evaluation • For NRM research, focus on functional and service related benefits using a) valuation techniques and b) benefit transfer methodology • Define adopted technologies/practices as those which are applied with minimum or no external assistance
• Involving the community in analyzing impact results	• Prioritize (potential) problems in 'hotspots' • Adopt a multistage method for identifying key communities, then apply a participatory approach • Let communities identify possible impacts during the planning stage • Employ participatory monitoring and evaluation • Institutionalize local input into impact assessments and preliminary reports to all stakeholders for comments • Involve informal collective NRM groups in the assessment process, noting what can be learned from their structure and how they work • Enable communities to form groups and actively participate in impact analysis • Pick a sample of households for longitudinal analysis

6. LINKS TO THE CGIAR WATERSHED PROJECTS

Based on the information solicited by CAPRi prior to the workshop, 10 CGIAR Centers are engaged in 18 watershed management research projects in 21 countries.[3] The vast majority of projects (83%) explicitly address institutional issues, although the extent of their focus varies. The workshop was successful in deepening the awareness and understanding of the relevance of institutional issues in the CG's research on watersheds, especially the importance of collective action and property rights. In addition to exploring various methodological tools for addressing institutional issues, the program provided an opportunity for researchers to become familiar with the work of other Centers and research institutions. This was accomplished by assembling descriptions of watershed research projects (see Annex 3), while also setting aside time in the program for participants to present this research and propose potential collaborations. Follow-up from the workshop has included posting emails of watershed-related information to participants, integrating project descriptions into the main CAPRi project inventory, synthesizing and disseminating impact evaluation results and collaboration interests to participants, editing of workshop papers and other commissioned papers on watersheds for publication in the journal Water Policy, and preparation of this summary paper.

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[3] Countries include: Asia: Thailand, Cambodia, Laos, India, Thailand, Vietnam, Sri Lanka, Philippines; Sub-Saharan Africa: Ethiopia, Mali, Niger, Côte d'Ivoire, Ghana, Nigeria, Kenya; North Africa: Egypt, Yemen, Syria; Latin America: Honduras, Nicaragua, Colombia.

7. SUMMARY AND CONCLUSIONS

Watershed management is a complex integration of biophysical externalities that stem from the lateral flows of water, sediment and nutrients as well as institutional arrangements that embody interactions among multiple users such as farmers, fishers and landless rural and urban dwellers. Because of the critical nature of the resources and problems related to watersheds—which involve forests, soils, crops, water, and aquatic resources—there is growing attention to watersheds, both in the CGIAR, its research partners, and other government, NGO, and donor organizations. Yet there is often fragmentation among the different studies and projects that prevents cumulate learning. The workshop held in Nicaragua in March 13-16 represents one contribution to building greater shared understanding, particularly among watershed research projects. The network among workshop participants is also likely to yield further sharing of information and approaches in the future.

The workshop focused on four critical issues encompassing watershed management: institutions of collective action and property rights, scale, participation and impact assessment.

Institutions of collective action and property rights provide effective tools to address the problems that arise due to scale, lateral flows and negative externalities in watershed project. This was effectively demonstrated by ICRAF's work in Southeast Asia and East Africa. Because property rights were not properly defined and enforced in the upland area of Mae Chaem catchment in Thailand and the Sumber Jaya catchment area of Indonesia, conflicts arose among ethnic groups living in these areas. Low investment and over grazing were also common in these watersheds. At the same time, examples of collective action in these countries, such as Landcare groups in the Philippines and the adoption of focal area approaches in Kenya, were effective in addressing such problems as tree and land degradation.

Participants at the workshop identified an overwhelming number of watershed management issues such as resolving conflicts, establishment and maintenance of watershed components, ecological externalities, redistribution of benefits and policy implications that are connected to collective action and property rights. Property rights themselves rely on collective action in that their effective application requires the support of collectives, whether formal or informal. For example, in the Lake Victoria watershed, the continued supply of good quality water to towns in and cities in Kenya, Tanzania and Uganda relies on the existence of a well-defined set of property rights that are sufficiently enforced. This demands a high level of cooperation not only among the national governments of these countries, but also at the sub-village level to ensure widespread adoption of conservation farming practices that protect the water supply.

In devising effective research methodologies to apply to watersheds, issues of scale are of central importance. Due to the presence of lateral flows of water, sediment, or even wind, interventions at the plot level often manifest themselves at higher levels of scale, whether these are neighboring plots or distant locations in the watershed. But watersheds are not simply hydrophysical phenomena, but rather encompass social and administrative boundaries that often do not lie neatly within the biophysical confines of the watershed.

Furthermore, biophysical hierarchies of scale (e.g. plots, catchments, watersheds, river basins) differ substantially from sociological or administrative hierarchies like households, community organizations, villages, ethnic groups, local government jurisdictions, nations, etc. Researchers need to identify and develop methodologies that accommodate this complex array of scales if they are to better understand the interactions between natural resources and their managers.

Geographical information systems (GIS) can provide useful techniques for scaling up data from a micro to a more macro level (e.g. from the plot level to the watershed or national level). Because of its ability to examine relationships that are non-linear, GIS techniques can be well suited to a watershed context. Two techniques, parametric and generic, are used for collecting and presenting data, which can be scaled up to different levels using one of three approaches: analogue, site factor and systems. Spatial analysis of watershed data can provide a wealth of information in a simple and easy to understand format, thereby identifying a confluence of factors and yielding information on potential cause and effect interactions and existing or probable 'hot spots'. However, it is a complement rather than a substitute for more in-depth techniques to study watershed communities and natural resource management.

Applying participatory methodologies for studying watersheds can generate considerable benefits in understanding the relationships between natural resources and their managers as well as for developing effective solutions to resource management problems. Although the argument is often made that research involving farmer participation is much more costly in financial terms, the advantages gained in terms of improved information and adoption outcomes that emerge when farmers have a stake in research and project implementation can ultimately result in more cost effective outcomes. There is ample evidence to show that farmers are more likely to adopt technologies and improve resource management practices when they are actively involved in identifying the problems and designing the solutions. In addition, farmers often contribute critical local knowledge and technical solutions that would otherwise be bypassed by traditional research methods and technology development. By training farmers and other local stakeholders to take an active role in the research process, participatory methods also enhance the prospects for greater self-reliance in identifying and solving local problems. Projects launched by CIAT and ICRAF have evolved to the extent that these research institutions function primarily as information brokers between farmer researchers and policymakers or as developers of tools to enhance farmers' research capacity. In San Dionisio, CIAT is developing various tools that can facilitate decision-making by the watershed stakeholders committee, thereby strengthening the capacity of local people to experiment with and select crop varieties that best meet their needs.

Within the CGIAR, there is an increasing recognition of the value of participatory research. However, knowledge of and experience with participatory methodologies is still rather limited. Participation is usually complex in a watershed context due to the intricate overlap of multiple uses and users, such that means must be found to accommodate a wide array of stakeholders and create forums for effective negotiation. Centers like CIAT and ICRAF are well positioned in their research agenda to develop valuable tools that will enhance the capacity of other research institutions to expand their application of participatory methods.

Even if researchers studying watersheds pay heed to issues of property rights and collective action, attend to complex issues of scale and involve local stakeholders in the research process, judging the quality and outcomes of the research process relies on the integration of impact assessment. Nevertheless, this has often been a neglected or underrated component of project design. Yet, impact assessment is fundamental for engendering a dynamic process for improving research design and technology development. Without it, many mistakes risk being repeated while important information and lessons learned necessary for generating effective research innovations will be lost.

Quantitative tools like regression analysis are often commonly to assess impact. While they provide useful insights, it is important to understand their limitations. One of the major problems encountered in empirical assessments of impact is attribution. In an interactive and complex environment like a watershed, determining cause and effect relationships presents numerous challenges. Not only is it impossible to isolate interventions from other causal factors, but also interventions themselves generate a myriad of impacts, while the scope of direct effects is often superceded by an abundance of possible indirect effects that can be difficult to identify or quantify. Greater efforts to combine qualitative and quantitative impact assessment methods are likely to lessen the problem, particularly if qualitative methods are used as a means to inform the hypotheses motivating empirical research and validate its results. Another key problem researchers encounter is a dearth of baseline data, which is needed undertake a rigorous ‘before and after’ analysis. Typically, impact analysis is not part of project planning so that no plan is made to collect data before the project has started. Programming impact assessment into project planning is the most obvious means of addressing this constraint. Rich analysis of impact is possible when projects have regular monitoring with periodic data collection and analysis. Ideally, results from monitoring and assessments are linked to project development so that there is a continuous learning process surrounding the program or research.

The overall conclusion emerging from the workshop is that the quality of research on watersheds is considerably improved when research methodologies:

- examine the role of institutions like property rights and collective action that govern how watershed resources are managed,
- take into account the various scales of watershed dynamics and integrate both biophysical and social/administrative scales,
- employ participatory techniques as a means to capitalize on local knowledge, build local capacity, and deepen the meaningfulness of research to those it seeks to benefit,
- evaluate the impact of project interventions, government policies, and other factors on the livelihoods of people inhabiting watershed communities and on the sustainability of their natural resources to meet the needs of future generations.

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ANNEX 1: WORKSHOP FIELD TRIP TO SAN DIONISIO WATERSHED, NICARAGUA

PARTICIPATORY WATERSHED MANAGEMENT PROJECT OF CIAT IN SAN DIONISIO

CIAT's Community Management of Watershed Resources Project defines community watersheds as complex, hierarchical, dynamic and adaptive systems in which a multitude of natural processes and human activities take place. Although biophysical boundaries are used to measure input and output, decision-making about natural resource management is undertaken by communities along social lines *vis-à-vis* organizations and collective action that intersect with biophysical boundaries. The project applies an action research approach to facilitate generation of new knowledge and to help people make decisions on as stakeholder selection, technology options and overall vision.

San Dionisio has been established as a benchmark for comparing the performance of other watersheds. It was selected for the project because its communities are among the poorest and its resources the most degraded when compared to the other watersheds in this area.

The Community Management of Watershed Resources Project in San Dionisio embodies two major objectives:

3. Strengthening the decision support systems of watershed communities

In order to make sound decisions, communities need to have access to accurate and sufficient information about their environment and the possible implications of their choices. Decision support systems designed with the help of CIAT enable stakeholders to generate the right type, amount and quality of information they need to make well-informed decisions about natural resource management and develop scientific principles that can be applied elsewhere to contribute to the alleviation of hunger and poverty and the preservation of natural resources.

These systems make use of data generated from surveys and GIS.

Stakeholders utilize decision support systems to identify the benefits, costs and tradeoffs of different options and address key questions such as:

- What is the vision of the future for this watershed?
- How should we organize to enable better resource management?
- What technological options do we have to make the changes we want?
- How do we monitor and evaluate?
- Where are we going to work?
- Who are the key people who can address the problems in a particular priority area?

STIMULATING A MUTUAL LEARNING PROCESS FOR CIAT VIA PARTICIPATORY RESEARCH

The principle behind CIAT's learning process approach is to organize research that will foster joint learning by CIAT researchers with local farmers and other partners, embrace errors and develop new knowledge and institutional capacity through action that combines local participation with technical and scientific aspects.

The CIAT learning process approach is designed to benefit CIAT researchers, local communities and other partners. It follows five *cyclical* steps:

- Stakeholder meeting at watershed level addressing key questions and processes
- Identification of new work areas and new tools to be included in the research and development process according to specific needs
- Development of own application of methodological tools
- Systematization of experience into methodological guides
- Training and help in the use of the decision support tools (back to step 1)

Stakeholder watershed resource management can be seen as comprising five different stages of decision-making, which capitalize on the learning process approach. CIAT helps provide tools to enable communities to make better and more informed decisions.

CIAT's Learning Process Approach

Processes	Tools
Diagnosis	Resource mapping Stakeholder analysis Local knowledge and experimentation
Synthesis	Priority setting Feedback
Planning	Prioritizing problems Prioritizing opportunities Prioritizing options for action
Implementation	Experimenting with options and evaluating them Organizing a decision making forum for stakeholders Capacity building Documenting and disseminating information
Monitoring, Evaluation and Impact assessment	Identifying key indicators Data collection and sampling GIS mapping

These processes are not taken in linear order, but rather vary in their application and are subject to repetition. For example, a group may take a step and then take the third step and then again come back to first step. This is a heuristic model whereby the tools developed for one process may also be useful for applying to other processes.

Technology Experiments in the San Dionisio Watershed

Another component of CIAT's work in San Dionisio centers on appropriate crops and practices for the hillsides, a project known as Supermarkets for Options in the Hillsides (SOL). SOL aims to develop technological options that are economically viable and environmentally sustainable. A participatory approach is used that includes shared responsibility at all decision-making levels. Strategic principles allow for extrapolation and scaling up. Men and women of the communities actively participate in different activities (e.g., alternative grass species, seed production for grass and legumes, soil conservation, natural regeneration of native species, and identification of market products). While still in the initiating stages, SOL sites are expected to help develop technological options that small-scale farmers will readily adopt.

Since the visit to San Dionisio was made during the dry season, there was little activity in the SOL project. Attention was drawn to locally constructed check dams and agro-forestry experiments that were just getting underway which included foreign species such as Tephprosia Vogelii, Flemingia Macrophylla, and Sesbania. These new varieties are used for fuel, fodder and nitrogen fixing. One experiment involves planting trees species near water sources to assess how well they are protected. Another farm had been selected to demonstrate the use of contour vegetative strips (e.g. pineapple and natural grasses) and vegetative strips with a trench below, as erosion control measures on existing maize fields, and workers were observed digging the trenches.

Institutional Approaches: CIAT's Work with CIALs

Local agricultural research committees (CIALs in Spanish acronym) are groups of two to four community members who undertake experimental research on behalf of their community. In all, there are 250 CIALs in Latin America. CIAT collaborates with CIALs in undertaking research, while a separate CIAL Foundation provides a technical and financial support (Ashby et al, 2000). The research agenda of CIALs is based on community demand. In the Wibuse micro-watershed of San Dionisio, farmers and villagers opted for soybean experiments, which resulted in experimentation with three varieties. The variety that produced the highest yield was then selected for cultivation by the broader community. Workshop participants were able to meet with members of two of the groups that operate in San Dionisio micro-watershed.

Similar CIALs in Bolivia have undertaken experimentation on potato varieties given the favorable market opportunities it afforded. Through a community-centered process, blackberry was introduced in Columbia where its high value has promoted its spread to other areas. Colombia has proceeded to incorporate CIALs into their national policy for agriculture.

Women's CIAL in the Wibuse Micro-Watershed

Within San Dionisio, CIAT works in close collaboration with a women's CIAL in the village of Wibuse. Experimentation is done by four women chosen by the community and is centered on identifying crop varieties that are suitable for the clay soil of the village. The villagers participate in community meetings to select the crop varieties, mainly soybeans and some horticulture crops. Based on their decision, CIAT provides 3-4 different varieties of seed. The CIAL women then cultivate these seeds on their own land. After the harvests, they assess costs and benefits and make recommendations on varieties for the area. During the workshop field trip, the women from this CIAL discussed their work and requested input from the participants on possible new varieties for future experiments. They were also interested in exploring the possibilities of non-agricultural activities as means to supplement their incomes.

Association of Community Organizations: Campos Verdes (Green Fields)

In addition to the CIALs, CIAT is involved in action research on the creation of a network of community organizations that address a wide range of community interests on NRM issues. The objectives of the network Campos Verdes are to improve the management of natural resources, strengthen community organization, support projects that address the problem of food security and seek funding for community projects. Campos Verdes represents 16 community organizations from 17 different communities. The general assembly of 40 representative farmers is elected by the communities, while the executive committee of six farmers is elected by the assembly. The members of the assembly are responsible for information and motivation of the community as well as management and evaluation of projects initiated by the association.

Scaling Up

Efforts to scale up the various models and projects being applied in the San Dionisio demonstration site involve a variety of measures, including training both the users and trainers of the tools. To date, nine methodological guides have been developed and disseminated in Nicaragua, Honduras, Colombia, Peru, Venezuela, the Dominican Rebublic, Vietnam and Uganda They describe how different aspects of CIAT’s work on watershed management can be implemented in other regions (see Annex 3).

One such tool focuses on stakeholder analysis and can be applied as a means to strengthen the participation and capacity of people’s organizations. The methodology comprises five steps ranging from selection of research areas and discussion of interdependencies to stakeholder identification and formation of a basis for negotiation. An important part of the methodology is the interview process and continued comparison of analytical results to obtain maximum contrast and maximum variation in the perception of natural resource management problems and interdependencies. The interviews are semi-structured around themes concerned with the use, problems, interrelationships and conflict over natural resource management and they are rather short (half an hour to an hour). They include questions about the use of the natural resource serves as an introduction and can be accompanied by a walk around the farm to discuss and initiate thoughts about what is meant by natural resources at farm and landscape level. Information is also sought on existing natural resource problems and conflicts, the degree to which these are articulated and acknowledged, interrelationships in the use of the natural resources, and how externality problems might possibly be solved through collective action.

In the end of each interview, the interviewee is asked to nominate another farmer with a different and preferably contrasting opinion or perception. The nomination helps continue the interview sequence and the presentation of previous interview constructions allows CIAT researchers to compare opinions and obtain maximum contrast. The process of interviewing and asking for the names of interview candidates continues until the there is repetition in the perceptions and people nominated.

GIS systems are used in the process as a means to aggregate and analyze landscape level data, both of a biophysical and social nature. Reference points are selected for collecting data, which are aggregated to the landscape level. For example, poverty data and well being ranking are established for each reference point and then scaled up to landscape proportions through GIS.

ANNEX 2: PARTICIPANT LIST FOR THE CAPRI TECHNICAL WORKSHOP ON WATERSHED MANAGEMENT INSTITUTIONS, MARCH 13-16, 2000, MANAGUA, NICARAGUA

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ANNEX 3: SUMMARY OF RESEARCH INSTITUTION PROJECTS PRESENTED AT THE WORKSHOP

Project title: **Integrated Land Management Research in Khanasser Valley, Syria**

Implementing institution: ICARDA

Project leader: Dr. Christoph Studer

Collaborating partners: Ministry of Agriculture (Steppe Directorate, Olive Bureau, Department of Extension), Atomic Energy Commission, Directorate of Environment

Countries, regions: Dry areas of Syria

Project period: January 1998 – December 2003

Description:

The Khanasser Valley has been selected by ICARDA as an integrated research site to address a range of problems that are characteristic of marginal drylands. The valley is a typical dryland area in the transitional rainfed agriculture/rangeland zone of Syria. The valley is located approximately 70 km southeast of the city of Aleppo. The relatively high densities of human and livestock populations put enormous pressure on the land resources of the area and soil degradation is serious.

Data on the physical processes of land degradation in the area and on its economic and social causes and consequences are insufficient. A thorough review of experimental and field data, particularly of robust and cheap methods of measurement to improve the understanding of the physical processes involved, is required. An important aspect is the relationship between land degradation and yields. Modeling of these relationships, based upon affordable and replicable methods of measurement, provides the essential link between natural scientists and economists. Without it, the cost of degradation and the benefits of interventions cannot be assessed.

Participatory appraisals carried out in the valley have clearly shown that the farmers recognize the problem: the decline in yield levels of both crops and animals leading to a reduction of their income, thus contributing to poverty. The farmers attribute this phenomenon to a variety of circumstances and land management practices.

The farmers are well aware that most of the factors contributing to the reduction of the land's productivity lie in the way that they manage their resources, but claim that they have no other option but to continue in this way. However, a first assessment of the land resources in the valley has revealed that the land has untapped potential for development, if the land use systems and land management practices can be adapted and fine-tuned to the conditions in the area. As part of ICARDA's ongoing NRM research program, two years of survey and field research work have already been carried out in the valley.

Resource surveys and assessments have been carried out in the valley to characterize the water, soil, vegetation and human resources. The main aims of the studies are to identify problems and develop ideas and concepts for improved natural resource management. In three typical villages of the valley, detailed resource surveys, village territory mapping, and production system analyses are being carried out. A groundwater monitoring system has been put in place to monitor groundwater depletion and water quality deterioration. Several vegetation observation plots have been established to evaluate the effects of grazing on the degradation of the natural vegetation and the depletion of plant biodiversity. It could be shown that the natural restoration potential of vegetation in the valley is high and that within very short periods, the productivity of the vegetation can be regained with suitable vegetation management. In three communities, farmer participatory field experiments have been established to assess the potential of severely degraded hillsides for fruit tree cultivation, especially olive trees. First observations are promising. A reconnaissance level assessment of wind erosion on cultivated fields and severely denuded rangeland using simple measuring equipment has been initiated. All data are geo-referenced and a comprehensive spatial database is being compiled.

***Project title:* Legal and Institutional Framework, and Economic Valuation of Resources and Environment in the Mekong River Region: a Wetlands Approach**

Implementing institution: ICLARM

Project leader(s): Magnus Torell and Mahfuzuddin Ahmed

Collaborating partner organizations: Asian Institute of Technology (AIT) - Aqua Outreach Program, Thailand; Mekong River Commission (MRC) – Wetlands Program, Cambodia; Ministry of Agriculture, Forestry and Fisheries (MAFF), Cambodia; Regional Development Center (RDC) and Department of Livestock and Fisheries (DoLF), Lao PDR; Department of Fisheries (DoF) and Coastal Resources Institute of the Prince of Songkhla University (CORIN), Thailand; College of Agriculture and Forestry (CAF), Vietnam

Countries, regions: Lower Mekong River Basin particularly Thailand, Cambodia, Laos and Vietnam (possibilities to include Myanmar and Yunnan, China)

Project period: April 2000 to April 2003

Description:

The research to be undertaken in the Lower Mekong River Region will look at the economic valuation of wetland resources and a review and analysis of existing policy, legal and institutional frameworks for their use, conservation and management. The goal is to improve and strengthen the management of the region's wetlands through application of economic valuation yardsticks as measures for development indicators and through the participation of key national institutions in the research and planning exercises in each of the riparian countries of the Lower Mekong River.

***Project title:* Assessment of the Contribution of Aquatic Resources in the Mekong River Basin to Food and Nutritional Security of the Fishing and Farming Population**

Implementing institution: ICLARM

Name of project leader: Mahfuzuddin Ahmed

Collaborating partner organizations: Can Tho University (CTU), Can Tho, Vietnam; International Institute for Rural Reconstruction (IIRR), Cavite, Philippines; Institute for Development Anthropology (IDA), New York, USA; Oxfam America – Southeast Asia Regional Office (SEARO), Phnom Penh, Cambodia

Countries, regions: Mekong Delta of Vietnam

Project period: April 1998 – December 1999

Description:

The project provided baseline information on the current state of fisheries resources and their role in household food security in the southern part of the Mekong Delta in Vietnam specifically in two hamlets, one each in Can Tho and An Giang provinces. An assessment of the aquatic resources and their biological diversity including their characteristics and values in ecological, social and economic terms were studied. The household benefits and consumption pattern of fish and other aquatic products were also estimated. Development and enhancement of research skills among partners were developed through on-the-job training. Collaborative efforts among research partners and other national and regional agencies were also established.

The data for the assessment was collected from two locations: Loi Du-b and Binh An Thanh Loi. The study reveals that the main occupation of the majority landless in Binh. An Thanh Loi is fishing and demonstrates that rights to catch fish in different public wetlands are crucial to local livelihoods. Critical problems in these two study areas are overfishing, overuse of agrochemicals, and excessive employment of destructive fishing practices. These issues can be addressed through education, regulation through collective action, and improving institutions and policies.

Future plans include expansion into other riparian countries to determine the values and relevance of aquatic resources in the Mekong Basin, and to create community and institutional capacities for improving the management through community inputs and interventions. For this project, it will seek collaboration with existing and on-going projects, program and institutions working in the relevant area in the Basin.

***Project title:* Developing Community-scale Watersheds to Improve Rural Livelihoods**

Implementing Agency: ICRISAT

Project leader: S P Wani

Collaborating partners: India: ICAR, JNKVV, NGOs (Bharatiya Agro-Industries Foundation, MV Foundation). Thailand: Department of Agriculture, Khon Kaen University and Department of Land Development. Vietnam: Vietnam Agricultural Sciences Institute, Hanoi; Ministry of Agriculture and Rural Development. Ethiopia: EARO, the Ministry of Agriculture and ILRI. USA: Michigan State University, and selected ARIs. Mali: IER. Burkina Faso: INERA. Niger: INRAN. CGIAR: IWMI, WARDA, ICRAF.

Countries, regions: India, Thailand, Ethiopia, Vietnam, Mali, Niger

Project period: 1995 - 2002

Description:

Goal: Increase agricultural productivity and alleviate poverty through better management of the natural resource base in landscape/community-scale watersheds.

Purpose: Rainfall in the SAT generally occurs in torrential downpours and most is lost as runoff, often carrying away significant quantities of soil. Runoff could be controlled to minimize soil erosion and to optimize infiltration and soil moisture levels, and the excess could be channeled and harvested for later use. Better harvesting and management of rainwater and land management at the watershed scale involving community participation is required. However, constraints to adoption at the community level need to be better understood and resolved. This Center Project seeks to identify technologies, community decision-making institutions, and policies that lead to improved rainwater and land management in SAT agriculture, by using participatory research approaches. It will do focused broad-vision research to complement ongoing development activities and to provide input into future development efforts. The Center Project will be carried out through three operational projects, one in Southeast Asia, one in Eastern Africa (EA), and one in West Africa (WASAT). Cross-project sharing of information and experience will be encouraged. Technologies will be developed and extended in partnership with NARS, NGOs, and farmers through conducting on-farm research at selected benchmark sites (BMSs) in the target ecologies.

Outputs:

1. Crop, tree/livestock technology options adapted to take advantage of improved water availability to increase agricultural productivity.
2. Water harvesting and management technologies for sandy/sandy loam soils.
3. Institutional/organizational innovations and policy options required for effective community action and individual participation in watershed development and management.
4. Technology/policy interventions to ensuring positive impacts of production intensification on environment.
5. Modeling, GIS, and remote sensing tools to assess biophysical and socio-economic potential for watershed development and aid in the choice of research and development sites.
6. Improved models and other tools for watershed layout, and technologies for harvesting and managing rainwater on a watershed scale.
7. Trained human resources for watershed research, development and management in the target countries.
8. Lessons from on-station watershed research synthesized and shared with partners.
9. Watershed development models extended and adopted by development agencies.

Project title: **Hillsides Research in the CGIAR: Towards an Impact Assessment** (Exploratory phase)

Implementing Institution: Standing Panel on Impact Assessment (SPIA), CGIAR

Project leaders: Sara J. Scherr (University of Maryland) with Hans Gregersen, Michael Nelson, Guido Gryssels of SPIA

Collaborating Partners: CGIAR Centers (informal, until/if formal proposal made by TAC and approved)

Regions of focus: All CGIAR hillside research sites are being identified in the exploratory phase. If the project goes ahead, selected projects and study sites will be chosen for impact assessment.

Project period: Exploratory phase is the first half of 2000.

Description:

Research: During the 1990s, the CGIAR moved to embrace natural resource management and ecoregional approaches to research, with several centers focusing on hillside land management. The objective of this project is to document the range of objectives, activities, and study areas of CGIAR hillside research in the past decade and suggest an approach that can be used to evaluate the impact of that body of research.

The research describes the extent and trends in hillside agriculture, and reviews the key challenges to sustainable agricultural development in tropical hillside regions in relation to food supply and rural livelihoods and broader environmental quality. It then identifies the major research foci of the CGIAR to date and considers the challenges of impact assessment for these types of projects. A CGIAR-wide phased approach to impact assessment will be proposed but based on centers' own priorities and integrated into their on-going research process.

Institutional Issues: Eight types of hillside research have been identified at the centers: 1) improving germ-plasma, 2) developing technologies for the Sustainable Agriculture and Natural Resources Management (SANREM) Collaborative Research Support Program, 3) spatially integrated databases, 4) understanding hillside ecologies, 5) land use dynamics, 6) evaluating local organization in NRM, 7) evaluating policies for NRM, and 8) pilot research and development projects. Of these, two focus heavily on local organizations for collective action in NRM. Seven centers are doing research on a variety of farmer-led research and action organizations and local governments managing natural resource, and developing decision support tools for them. Six centers also have action research programs that work directly with farmer organizations. Evaluating the impacts of these two types of research will require different methods than those used in conventional CGIAR impact assessments. The study will consider indicators and approaches for impact assessment.

***Project title:* Policy Impacts on Rural Poverty and Environment: Integrating Models of Environmental Process with Economic Models. Case Study of the Río Calico Watershed of Nicaragua**

Implementing Institution: Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

Project leader: Claudia Binder, EAWAG

Collaborating partners: University of Maryland (Sara J. Scherr), University of Bern (Hans Hurni), CIAT (Nancy Johnson), the Agricultural School of Estelí, and the National Agronomy University of Nicaragua

Regions of focus: San Cálico Sub-Watershed, San Dionisio, Nicaragua

Project period: November 1999-December 2001

Description:

Research: The objective of this study is to develop an integrated environmental-economic model of the Rio Calico sub-watershed in Nicaragua, that can be used to simulate the effects of various policies on farmer income and watershed conditions, particularly for soil and water. The major components of the study will be an analysis using GIS of land use changes in the sub-watershed, by soil type and other geographic conditions; a survey of 200 households, stratified by natural resource conditions, to document the use and determinants of land management practices and to develop for key products, production functions that include environmental and conservation variables; an environmental model of material flows in the watershed; and an economic/agricultural trade model. The GIS is being used to develop the survey sample; the survey to provide coefficients of derived demand for key inputs in the economic and environmental models. Simulation effects will be evaluated for changes in trade, agricultural input and output prices, environmental policies, and provision of technical assistance. A more detailed model will be developed for one micro-watershed, to examine land management practices more closely (especially coffee, pastures and forests), and a participatory Sustainable Development Appraisal will be undertaken with a sample of communities.

Institutional Issues Being Addressed: The initial household survey includes plot-level data on land tenure and a small number of questions about household involvement in various types of associations, by gender. The relationship between property rights and household activity in associations and the extent and type of conservation practices will be examined. The micro-watershed case study will include analysis of private and collective action in NRM.

***Project title*: Management of Soil Erosion Consortium (MSEC).** MSEC is one of the four consortia established through the soil, water, and nutrient management (SWNM) program of the Consultative Group on International Agricultural Research (CGIAR)

Executing institution: International Board for Soil Research and Management (IBSRAM)

Project leader: Amado Maglinao

Collaborating partner organizations: There are now eight partner countries in MSEC and at least 10 IARCs and ARIs and some NGOs. Discussions are being held with other interested parties.

<u>NARS:</u> Central Research Institute for Dryland Agriculture (CRIDA, India), Center for Soil and Agroclimate Research (CSAR, Indonesia), Soil Survey and Land Classification Center (SSLCC, Lao PDR), Nepal Agricultural Research Council (NARC), Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Ministry of Forestry and Environment (MFE, Sri Lanka), Department of Land Development and Royal Forest Department (DLD and RFD, Thailand), National Institute for Soils and Fertilizers (NISF, Vietnam)

<u>IARCs/ARIs:</u> ICRISAT (India), ICRAF (Indonesia), IRRI (Philippines), IFPRI (USA), IRD (formerly ORSTOM, France), CIRAD (France), SEARCA (Philippines), ACIAR (Australia), University of Bayreuth (Germany), ICIMOD (Nepal)

<u>NGOs/others:</u> Mag-uuamad Foundation (Philippines), BAIF (India), Haq Muang Nan Network (Thailand), SANREM-CRSP (Philippines)

Countries and region of focus: MSEC operates in Asia and includes activities in the following countries: India, Indonesia, Laos, Nepal, Philippines, Sri Lanka, Thailand, and Vietnam.

Project period: MSEC is intended to operate for 10 to 15 years. The first three years (starting in September 1998) of the consortium activities are supported by an Asian Development Bank technical assistance grant.

Description:

MSEC uses an integrated, interdisciplinary, participatory, and community-based approach to research that involves all land users and stakeholders on a catchment scale. It focuses on on- and off-site impacts of soil erosion, emphasizes community involvement, and provides scientific data for a rational decision-making. MSEC focuses on three major areas: catchment research, information sharing and dissemination, and capacity building and institution development.

Objectives:

- Develop sustainable and acceptable community-based land management options within a catchment framework
- Quantify and evaluate the biophysical, environmental and socioeconomic on- and off-site impacts of soil erosion
- Generate reliable information and scientifically-based guidelines for the improvement of catchment management policies
- Enhance capacity of NARS in research on integrated catchment management and soil erosion control

Expected outputs:

- Improved soil erosion control technologies that are socially, institutionally and financially acceptable to the communities in the catchment areas
- Appropriate policies that will improve the management of catchments by the local government and communities, and that will induce the farmers to adopt improved land management technologies
- Methodology for obtaining farmers' participation in the management of catchments
- Enhanced capacity of the NARES in catchment research and subsequent dissemination of its results to farmers
- Better understanding of the on- and off-site impacts of soil erosion

Activities:

- Assessment of resources including indigenous technical knowledge (ITK) and needs with key stakeholders
- Evaluation of policy and institutions, and assessment of impact

- Participatory activity identification and implementation
- Calibration of water and nutrient balances (concentration, vertical and horizontal fluxes), and erosion rate
- Analysis of changes in the soil and water conditions (quantity and quality), both on and offsite, after the introduction of recommended management practices
- Identification and implementation with stakeholders of appropriate techniques and tools for information exchange and sharing, evaluation of environmental, economic and social trade-offs and/or policy implications
- Reliance on both indigenous and scientific knowledge
- Linking increased production to natural resource conservation in the development of land use systems

Project title: **Valuation of Watershed Projects in India** (one of three modules in a larger study entitled, Sustainable Rainfed Agricultural Development in India)

Implementing institution: IFPRI and the Indian Council of Agricultural Research (ICAR)

Project leader: Peter Hazell, John Kerr

Collaborating partners: National Centre for Agricultural Economics and Policy (NCAP), ICAR

Countries or regions: Andhra Pradesh and Maharashtra, two states in semi-arid India

Project period: 1996-98 (but analysis and write up continue)

Description:

This study sought to evaluate the impact of the large investments made in watershed development since about the mid-1980s. It covered a variety of project types, including those implemented by government agencies, non-government organizations (NGOs), and in collaboration between the two. The study tried to be comprehensive in nature; it included the following activities:

- selecting a sample of 86 villages covered by the various projects but also including control villages with no project
- documenting the approaches taken by each implementing agency. (Technical approaches include water harvesting, in situ soil and moisture conservation, grass and tree planting, and improved agricultural technology. Institutional approaches include social organization to promote collective action and conflict resolution, particularly related to efforts to reduce grazing pressure on common pastures in upper watersheds.)
- developing indicators of performance in improving agricultural productivity, natural resource conservation and poverty alleviation
- examining both project and non project determinants of outcomes. Project determinants include project inputs and approaches, while non project determinants include biophysical conditions, infrastructure and access to markets,

and preexisting social institutions that indicate a propensity for collective action and conflict resolution among inhabitants of a watershed.

- undertaking both quantitative and qualitative analysis of the determinants of favorable outcomes.

The project found that on the whole, projects implemented by NGOs or in collaboration between government and NGOs devoted far more attention to social organization, and this appears to have paid off in terms of better performance in many respects. A small minority of particularly successful projects makes particular efforts to ensure that every interest group has a stake in the success of watershed development. Most important in this regard are landless herders, who stand to lose more than gain unless special institutional arrangements give them an immediate, tangible interest in protecting pastures.

Project title: **Evaluation of Current Approaches to Watershed Development** (part of the watershed evaluation module in the Sustainable Rainfed Agricultural Development study)

Implementing institution: IFPRI and the Indian Council of Agricultural Research (ICAR)

Project leader: Peter Hazell, Shashi Kolavalli and John Kerr

Collaborating partners: National Centre for Agricultural Economics and Policy (NCAP), ICAR

Countries or regions: Karnataka, Orissa and Rajasthan, three states in India

Project period: 1997-98 (but analysis and write up continue)

Description:

This study examined the approaches of new projects for which it was too soon to assess impact. It covered all of the most current project types, including those implemented by government agencies, non governmental organizations (NGOs), and collaboration between the two, as well as bilaterally funded projects.

As part of the study, the lead author (Kolavalli) visited each of 20 projects purposively selected in the three states. He used RRA approaches to obtain information on various technical and institutional approaches under each project.

Based on previous experience in India, the study hypothesizes that meaningful stakeholder participation is essential to project success. It identifies three critical elements of participation in the Indian context, including 1) social organization to promote collective action, 2) stakeholder involvement in making decisions related to planning and implementation, and 3) some level of stakeholder cost-sharing. Using tabular analysis of a number of qualitative and quantitative indicators developed in the study, it compares the extent and nature of participation across project categories and also compares levels of collective action achieved in the different studies. It finds that projects with high NGO involvement make greater effort to promote participation, which in turn leads to more collective action. It then examines obstacles to incorporating meaningful participation in government projects, and it outlines a strategy to overcome these barriers so that participation can become a central feature of all Indian watershed projects.

The study highlighted a few more points related to project approaches. Most of the projects that were successful were at the sub village level. It is far easier to promote collective action at small spatial scales, and to sustain its efforts at the micro level. Gender issues need special attention while planning for the watershed. If attention is not paid to involving women, the selection of the activities can be biased and add to their already heavy workload.

***Project title:* Improved Land Management in the Lake Victoria Basin**

Implementing institution: ICRAF

Project leader: Brent Swallow

Collaborating partners: Kenya Ministry of Agriculture and Rural Development (during 1999-2000), University of Nairobi, University of Florida, University of Stockholm, Paul Smiths University

Region: Lake Victoria Basin in East Africa

Project period: Start-up period in Kenya: 1999-2003. Expected expansion to Tanzania and Uganda in 2001.

Description:

ICRAF has recently initiated watershed research in the Lake Victoria Basin in East Africa. Lake Victoria is the largest fresh water lake in the developing world and an important resource for the 25 million people who live in the lake basin. The lake has deteriorated rapidly during the last 50 years, due to the introduction of the Nile perch and the increase levels of nutrients and other pollutants. ICRAF's research on Lake Victoria is concerned with four questions: (1) where are the most severe land management problems in the lake basin—called land management 'hot spots'; (2) what are the underlying and proximate forces driving environmental change in those hot spots; (3) what interventions may be put in place to slow or reverse the development of hot spots; and (4) what are the consequences of those problems and potential solutions for the welfare of rural farmers, the local environment and the overall lake basin environment.

The methods developed and used by ICRAF scientists may be of use for other researchers concerned with watershed scale issues. Diffuse reflectance spectrometry and satellite imagery are combined with extensive ground-truthing and advanced statistical techniques in order to characterize land degradation and soil fertility across large areas. Sediment from river mouths is extracted and analyzed in order to quantify historical trends in sedimentation and lake ecology. Results to date show that lands vulnerable to different types of erosion have characteristic spectral properties. Analysis of the spectral characteristics of sediment samples also indicates good potential to back-trace the sources of sediment from rivers to the surrounding landscapes. Overall, these results show where the most severe land management problems are, where they are likely to development in the future, and the factors that drive the development of those problems. This information is being disseminated to extension providers and policy makers in order to prioritize preventive and remedial interventions. Next steps in the research will focus more attention on the links between land use and 'hot spot' development, the potential for different technical solutions to solve problems, and the need for changes in property rights and more effective collective action.

***Project title:* Integrated Natural Resource Management on the Poverty-Protection Interface in an Asian Watershed**

Implementing institution: ICRAF

Project leader: Dennis Garrity

Collaborating partners: Sustainable Agriculture and Natural Resources Management (SANREM) Collaborative Research Support Program, Central Mindanao University, Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD), Green Mindanao, Municipal Government of Lantapan, Bukidnon, Landcare Association of Lantapan, University of Wisconsin.

Country: Philippines

Project period: 1993 to 2003

Description:

There are serious methodological and policy hurdles to be overcome in making integrated natural resource management effective in alleviating rural poverty while protecting environmental services in tropical watersheds. This project developed an approach to integrate biodiversity conservation and agroforestry development through the active involvement of communities. The work focuses on the Mt. Kitanglad Range Nature Park in the upper reaches of the Manupali watershed in central Mindanao, Philippines. Mt. Kitanglad is one of the most important biodiversity reserves in the Philippines, and is one of the three global sites of the Sustainable Agriculture and Natural Resources Management (SANREM) Program. The Biodiversity Consortium at the Philippine site was composed of collaborating organizations including a university, NGOs, government agencies, and the International Centre for Research in Agroforestry (ICRAF).

We developed technical innovations suited to the biophysical and socio-economic conditions of the buffer zone, including practices for tree farming and conservation farming, with annual crops that have been widely adopted. We also fostered institutional innovations to improve resource management. The elements were put in place for an effective social contract to protect the natural biodiversity of the Park. The knowledge base guided the development and implementation of a natural resource management plan for the

Municipality of Lantapan. We assisted the development of a dynamic grassroots movement of farmer-led Landcare groups in the villages near the park boundary that has had significant impact on natural resource conservation in both the natural and managed ecosystems. The experience has been recognized as a national model for natural resource management planning and watershed management in the Philippines. Using an integrated natural resource management research framework, we are currently evolving a Negotiation Support System to resolve the interactions between the three management domains: The Park: the ancestral domain claim, and the municipalities.

***Project title*: Decision Support Systems for Natural Resource Management at the watershed level in Central America**

Implementing institution: CIAT

Project leader: Bronson Knapp

Countries: Honduras, Nicaragua, and Colombia

Project period: 1996-2001

Description:

CIAT's mandate has been to do agricultural research for development in Latin America, East Africa and South East Asia. One of CIAT's main activities has been to develop decision support tools (DST) that can strengthen the decision-making capacity of local institutions in the context of community watershed management. The main objective of CIAT's DST is to provide information on the possible outcomes of different decisions for multiple stakeholders. CIAT has developed five types of DSTs: biophysical models, optimization models, cellular automata, decision trees, and a local atlas.

Among these models the optimization models are able to produce different realistic scenarios under different hypothesis such as population increases, environmental payments, better access to capital, increased productivity, and new technologies. The total farm income of the watershed and the environmental consequences of each scenario are compared, and results are presented to the community in the form of maps of the watershed. This model has used Geographical Information System (GIS) extensively. Thus the presentation is in space to help the stakeholders relate physically.

CIAT has also studied the process of transferring of the technology to local organizations through the concept of Telecenter. A Telecenter is a place where the community and local organizations can learn and share information. Technicians are trained in the use of decision support tools. Technicians provide DST services to various watershed stakeholders.

Project title: **Community Management of Watershed Resources in Hillside Agroecosystems Program**

Implementing institution: CIAT

Project leader: Jose Ignacio Sanz

Countries, regions: Andean and Central American hillsides

Project period: No fixed period

Description:

The hillsides agroecosystem of tropical America covers about 1 million square kilometers in the Andean region and Central America and sustains an estimated 10 million small farmers, most living in marginalized communities with low and stagnant incomes, limited employment, diminishing water supplies, lack of political power and institutional support, and rampant emigration to urban slums. About half of this agroecosystem shows signs of serious environmental degradation—the result of deforestation, overgrazing, and harmful agricultural practices.

Many previous efforts to address the economic and environmental challenges of hillside communities have been disappointing, because they consisted of isolated, narrowly focused initiatives operating at the level of individual farms. Building sustainable livelihoods in hillside communities requires much more—namely, collective action across entire watersheds, guided by a common vision and supported by multi-institutional alliances. Watersheds are the natural common ground for analyzing local problems and orchestrating the search for lasting solutions.

The program consists of numerous watershed-based projects, one of which specifically addresses collective action issues and is described below. The program integrates a variety of tools directed at improving the standards of living and food security of low-income farm families and rural communities in the Andean and Central American hillsides. These include:

- Information (often in the form of digital atlases) on land use trends in hillsides

- Participatory methods for tasks such as measuring poverty locally, monitoring natural resources, analyzing social groups that have a stake in the management of these resources, evaluating improved germplasm and agricultural practices, and identifying market opportunities for small-scale producers
- Computer-based decision-support tools and models for use in participatory analysis and planning
- Strategies for organizing collective action in hillside communities (see project descriptions)

Other beneficiaries are the people outside hillside communities, who depend on their water and agricultural produce. The program also helps increase the effectiveness of local, national, and international research and development organizations.

The tools, methods, and knowledge developed by this project offer rural communities the means to chart a course toward sustainable development and to pursue that course with the assistance of local, national, and international organizations. The work that goes into this process consists of six main tasks:

- Form partnerships among interested groups and organizations.
- Build a common knowledge base about local resources.
- Create a common vision of the development path the community wishes to pursue.
- Secure the commitment of individuals and organizations to action plans.
- Monitor progress toward shared goals.
- Measure the impact of collective action with respect to changes in local standards of living and the environment.

***Project title:* Collective Action in Watershed Management: A Participatory Action Research Project in the Andean Hillsides (collaboration IWMI)—A Project under the Community Management of Watershed Resources in Hillside Agroecosystems Program**

Implementing institution: CIAT

Project leader: Olaf Westermann

Collaborating partners: IWMI, ''Juntas de Accion Communal'' (the lowest level unit of non-indigenous local government in Colombia), ''Cabildo'' (the indigenous organization), the local water board, school teachers, women's groups, the local agricultural research committee, the church, etc.. Non-governmental and governmental organizations involved in the project include: IPASLA (Interinstitutional Consortium for Sustainable Agriculture in Hillsides), comprising local development and technical assistance oriented NGOs such as CETEC, Sol y Tierra, Fidar, Corportunia, etc., as well as government organizations, such as the regional environmental board (CRC) and the district extension service (UMATA)

Countries, regions: Colombia, Honduras, Nicaragua

Project period: Open-ended beginning in January 1996

Description:

Watershed management involves the integrated management of a multitude of common and privately owned resources such as cropland, pastures, forests and water. In the Andean hillsides, farms are generally small, and the population is characterized by great cultural, religious, and economic diversity. Watersheds in this region are managed at the level of numerous individual and independent holdings rather than in a concerted fashion with a view to entire landscapes. As a result, in their day-to-day management of natural resources, farmers lose sight of important watershed properties, such as soil and water flows, landscape structure and the existence of habitats for particular species.

As part of its interdisciplinary research, CIAT's hillsides project is working in two, small multi-ethnic watersheds in the Andean hillsides of southern Colombia, where little collective action has previously taken place. The objective of this work is to find ways to foster collective or concerted action among watershed users and other stakeholder groups in their day-to-day management of natural resources and thereby enable them to deal with problems that cannot be solved effectively by individuals acting alone. So far, this work has dealt with problems related to water management and conservation, erosion control, and pest control (white grubs and leaf cutting ants). The project has been focused on the development of a methodology to identify stakeholder groups in order to accomplish collective management of natural resources in micro watersheds.

The research aims to identify key elements in fostering and facilitating collective action for watershed management and is producing a set of handbooks on key issues, such as stimulating interest in collective watershed management and stakeholder identification aimed at NGOs and other agencies working in natural resource management.

CIAT has done extensive work on watersheds and produced a variety of literature on methods for analyzing watersheds. For specific descriptions of past or ongoing projects, contact Nancy Johnson (n.johnson@cgiar.org) or Olaf Westermann (o.westermann@cgiar.org).

TOOLS DEVELOPED BY CIAT AND ITS COLLABORATORS

The nine CIAT Guides

1. Local Soil Quality Indicators.
   Turcios WR, Trejo MT, Barrios E, Barreto HJ. 1999. Participatory method for identifying and classifying local soil quality indicators at watershed level. Guide 1 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 146 p
2. Land Use Tendencies by Photo Analysis.
   López E, Trejo MT. 1998. Photographic analysis of land use tendencies in hillsides. Guide 2 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 80 p
3. Participatory Mapping.
   Vernooy R, Espinoza N, Lamy F. 1999. Participative mapping, analysis, and monitoring of natural resources in a watershed. Guide 3 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 152 p.
4. Stakeholder Analysis.
   Ravnborg HM, Guerrero M del P, Westermann O. 1998. Methodology for stakeholder analysis for collective management of natural resource management in watersheds. Guide 4 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 125 p.
5. Identifying Levels of Well-Being.
   Baltodano ME, Méndez MA. 1998. Identifying levels of well-being to construct local profiles of rural poverty. Guide 5 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 182 p.

6. Making an Atlas.

Barreto H, Jiménez P, Lamy F. 1998. Atlas of Yorito and Sulaco, Yoro (Honduras). Guide 6 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 79 p.

7. Identifying Market Opportunities.

Ostertag CF. 1999. Identifying and evaluating market opportunities for small-scale rural producers. Guide 7 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 182 p.

8. Using Simulation Models.

Estrada RD, Chaparro O, Rivera B. 1998. Use of simulation models for ex-ante evaluation. Guide 8 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 194 p.

9. Developing Organizing Processes.
   Beltrán JA, Tijerino D, Vernooy R. 1999 Developing organizing processes at local level for collective management of natural resources. Guide 9 (in Spanish) of the series "Methodological instruments for decision taking in natural resource management". CIAT, Cali, Colombia. 147 p.

Tools related to the information technology sector

These include human/social/economic/productive mapping, and the use of remote sensing, aerial photos, and other GIS tools. Water/hydrological modeling is also useful, but should be calibrated; CIAT has models for the Central American and Andean regions. We do modeling of water and work out how much water is produced, when it is produced, the times of cleanest water, times of shortage et cetera.

1. The Accessibility Wizard: computer-based tools that produce, for example, accessibility maps that allow one to make maps of time to markets etc.
2. Soil-water budget model (SWBM): simulates future scenarios as fitness tests for water components, i.e. the ability of the landscape to regulate water. This enables application of stress scenarios to the watershed to see what reaction ensues.
3. "Methodology for decision taking for multiple interest groups": incorporates data from the information technology tools. It is a goal-oriented as opposed to problem-oriented methodology.
4. The IT/DSS: a computer version of the above methodology that gives more time to do the analysis needed for planning.