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Watershed-Based Natural Resource Management: Lessons From Projects in the Andean Region

Title of Honors Thesis

by

Andrew Robert Sowell

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Honors Thesis submitted to the AAEC Department Faculty of the

Major

Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

BACHELOR OF Science

(Science) / Arts

In Honors

In Honors or Honors Baccalaureate

APPROVED

George Norton, AAEC

Name of Research Advisor, Department

Name of Co-Advisor (if applicable), Department

Darrell Bosch, AAEC

Name of Committee Member (if applicable), Department

This student has fulfilled the requirements of the AAEC

Major

Department to graduate In Honors

(In Honors) or Honors Baccalaureate

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Watershed-Based Natural Resource Management: Lessons from Projects in the Andean Region

Undergraduate Thesis by Andrew Robert Sowell

Virginia Tech, Department of Agricultural and Applied Economics
April 2009

Research Advisor: George Norton
Committee Members: Darrell Bosch and Jeffrey Alwang
Honors Advisor: Dixie Reaves

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I. Description of Problem

In the modern world, many challenges are posed by limitations in water resources and widespread soil degradation. The best means to address such challenges is through watershed management. Watersheds are generally defined as areas of land that drain into a common point (Kerr and Chung 2001) or body of water. The vital role of watersheds in everyday life is evident as they supply drinking water, recreation, and in general, sustain life as we know it. Over $450 billion dollars are now linked to tourism, manufactured goods, and food and fiber production, which all rely on healthy watersheds (EPA 2008).

Watershed deterioration is a common occurrence in many parts of the world. This deterioration often occurs as a result of improper watershed management, which can consist of poor use of watershed resources without conservation works. Such improper use can result in loss of forested areas and land degradation as a result of soil erosion (Prasad et al. 1997).

Effects of improper management of natural resources can be seen in different ways throughout the Andes. The páramo is a highland ecosystem which has shown many of the effects of improper management. One issue that frequently occurs in the páramo is excessive water use by upstream users, which leaves little to no water for downstream watershed users. (Stanley 2006)

Another problem which has occurred in many highland ecosystems in the Andes is lack of native forests, which often act as catchments for water. In Bolivia, for instance, the Polylepis forests of the highlands have been greatly reduced in area due to unsustainable farming practices, which has decreased biodiversity, increased soil erosion, and caused water scarcity in downstream areas by reducing water flows. (Hjarsen 1997)

Improper management of small-farm agriculture has also impacted soil and water quality. Ecologically, farming on steep slopes is not recommended due to high risks of erosion, but is an economic necessity throughout many Andean communities. This condition is worsened in that many areas are not cultivated using proper soil conservation techniques, which leads to high amounts of soil and nutrient runoff. This runoff can degrade the quality of the soil, reduce yields long-term, and cause high amounts of organic and inorganic material to deposit in rivers. Another improper management which often occurs in Andean watersheds involves human and animal waste, which can be a cause of disease when allowed to accumulate near water sources.

Studies have shown a link between poverty and poor environmental quality. Insecure livelihoods in agriculture limit future investment potential and can induce unsustainable land use, which furthers poverty conditions. Due to the existence of this linkage, watershed management projects are now being endorsed for reasons of poverty alleviation as well as environmental protection. (Johnson et al. 2008). In such projects, forward thinking is encouraged in that conservation efforts and watershed management will almost always be less expensive than rehabilitating the physical and social structures of the watershed (World Bank 2001).

Watershed management has been a topic approached by countless non-governmental organizations (NGOs) as well as by national governments themselves. The United States

Agency for International Development (USAID), for instance, spent a total of $353,470,000 between the years of 2001 and 2005 on the topics of watershed management and Integrated Water Resources Management (IWRM). Of this total, $83,332,000 was spent in Latin America and the Caribbean. (USAID 2006)

Watershed management is a topic of great importance to many government agencies and NGOs, however, similarity of resource management interests has not always led these groups to work in a coordinated manner. As will be discussed later, Latin American watershed management is somewhat decentralized, potentially causing research to be conducted without a thorough knowledge of other efforts throughout the region. Knowledge of existing watershed management projects is essential to ensure that new projects benefit from the lessons learned in other management experiences (Kerr and Chung 2001). Success in watershed management could be furthered through an effort to catalog and synthesize lessons learned through past projects.

II. Objectives

1. To describe the watershed management experience in the Andean region and identify common characteristics of successful watershed management projects

2. To synthesize information on the impacts of successful watershed management projects in the region

3. To describe the determinants of successful watershed management projects.

III. Methods

The paper will address objective 1 by first identifying the distinguishing features of watershed projects as a sub-discipline of Natural Resource Economics by reviewing selected works and reports. The paper will then describe how this particular type of project has fit into the overall scheme of environmental management in Latin America, particularly in the Andean region.

The second objective will be approached by analyzing specific case studies of projects completed in the region. The approach for the set of projects will be systematic, seeking to answer a set list of background questions about each project in discussing them. Although project documents used in the study do not always contain the exact same information, the paper will seek to answer the same list of questions in analyzing each project. The following general questions will be approached with each project:

1. Where was the **project site**? What was the topography of the site?
2. What were the general **objectives** of the project?
3. Over what **time frame** was the project carried out?
4. Where did **funding** come from and in what amounts?

5. What was the physical **size** of the targeted watershed(s) and how many people participated?
6. What **components** made up the project? For example, what technical components (such as computer modeling, GIS, water quality monitoring, impact monitoring, etc.) or educational components were utilized throughout the project?
7. In what ways did the project employ **participatory methodology**?
8. What **impacts** were achieved? Impacts will be separated into economic, social, and environment benefits.
9. How is **success** defined in the project and do the impacts match the initial objectives?
10. What key **lessons** can be taken away from this project when seeking to replicate results? For some projects, lessons will be specifically given by the authors, while other cases, lessons will be derived largely from the participatory methods and impacts sections.

After the section in which specific projects are discussed, a broader discussion of lessons learned will follow. This section will provide both a synthesis of projects covered and an explanation of the general determinants of success in watershed management projects. The end discussion of lessons learned in watershed management will facilitate the carrying out of objectives 2 and 3.

IV. Background of Watershed Management in the Andes

Watershed Management as a Scientific Approach

The watershed approach relies on a hydrological definition of the watershed, which is geographically focused. This approach must also include all possible stressors from air and water as well as be community-based and involve all possible stakeholders. Also necessary is a coordinating framework to allow all stakeholders to be effectively integrated into the process. Watershed planning must strategically address priority water resource goals. The methods to address such goals are to integrate multiple programs (regulatory and voluntary) with sound science and strategic watershed plans. These plans must be managed adaptively, meaning that as circumstances or available resources change, the project can react accordingly and continue to be effective. (EPA 2008)

There are many distinguishing features of watershed projects that must be considered when implementing or evaluating such projects. The following are a few examples of features which impact the progress and effectiveness of watershed projects.

- There are often externalities and interconnection among watershed users, which implies that benefits from proper management may accrue to other watershed users, generally downstream.
- There are often multiple objectives and determinants, which means that a broad range of topics can be covered in a single project. Addressing multiple problems at once allows for an integrated approach to handling problems in a region, although it may also complicate the matter of fully quantifying benefits.
- Long gestation periods cause a delay between project investment and accrual of benefits. For this reason, success in watershed management is often contingent upon availability of credit to pay the upfront costs of projects. (Kerr and Chung 2001)

Distinguishing Features of Watershed Management in the Andes

Institutional setting of watershed management in the Andean Region is largely influenced by Non-Governmental Organizations (NGO). Government influence in the past thirty years has been diminished as civil society has grown, creating a more decentralized approach. The Roman Catholic Church has also become an important source of leadership in development and decision-making in Latin America. In addition to the decentralized nature of watershed management in Latin America, conflicts, particularly in Bolivia and Colombia, have shaped the modern institutional and social landscape for watershed management (Bruneau 2005).

Development efforts, since the early 1990's, have become increasingly participatory and driven by community demand. Projects such as PRORURAL in Ecuador and PRODECO in Paraguay have sought to provide investment resources to small groups and build local capacity for action (Alwang et al. 2008). There has, in general, been a large movement in the Andes to make development a participatory process by involving all stakeholders in project execution. In what is known as Community-Driven Development, stakeholders are even involved in setting objectives for projects to ensure that project goals match community needs. This helps to ensure that communities will be motivated and empowered to continue work after the project term ends.

Although the decentralized nature of Watershed Management in the Andes was previously mentioned, there are also movements towards unifying scientific data. One such effort is CONDESAN, the Consortium for the Sustainable Development of the Andean Ecoregion, located at the headquarters of CIP in Lima, Peru. CONDESAN built a network known as Infoandina, which shares resources and information among its more than 60 partners, which are NGOs, governments, and research institutions. The group's overall objectives are reducing the desperate poverty and protecting natural resources in mountainous communities of the Andes. CONDESAN bases its efforts around a multidisciplinary approach and broad participation of stakeholders (IDRC 1998).

Another prominent feature of watershed management throughout the Andes region is the extent to which it emphasizes small-scale agriculture. This means that projects cannot possibly reach all the necessary recipients through the direct proceedings of the projects, but rely instead on diffusion and spread of technologies. Success of watershed management projects is measured by more than short term adoption of new practices, it is essential that practices and technologies are implemented permanently and they can spread from farmer to farmer. The need for projects to be self-diffusing among farmers increases the extent to which project objectives need to reflect localized needs and conditions (Tschinkel 2001).

V. Projects Reviewed

The following section will contain background information on the watershed projects which have been studied specifically. These typology of objectives contained in the case studies in watershed management are organized into four broad categories of project objectives: 1) soil

management, 2) water quality/quantity management, 3) biodiversity management, and 4) development of data and extension.

While it is often the case that objectives or final impacts for one project can fit more than one of the categories mentioned, for the sake of feasibility, projects have been assigned to the category to which they best fit. The information contained in the following section is intended to answer all the background questions listed in the methods section of this paper to the extent that information can be found.

The case studies selected are only a small representation of the projects completed throughout the Andes. The projects reviewed of each type are intended to be representative of the experiences and objectives associated with each category of projects. The cases used in this study are examples of projects that have, in most cases, met their objectives and can lend some insight as to the processes associated with their success.

1) Projects with Objectives in Soil Management

The first category of watershed management projects are those that deal most directly with management of soils. A vast majority of watershed projects emphasize soil conservation either as a means towards other objectives or as an objective of its own (Kerr 2007). The common thread through many projects is the desire to improve management of farm land in order to minimize soil loss and maximize productivity.

Basic features of seven projects are included in this section: PROMUSTA, Permacultura Cayambe, PROCAM, Making a Difference to Andean Livelihoods Through an Integrated Research Approach, PROLADE, PUCD, and Helping Farmers Reclaim Eroded Land and Increase their Productivity and Income. The seven case studies that follow will illustrate the varied objectives, methods, and results that have come through soil management projects.

1.1 PROMUSTA (Colombia)

1. **Project Site:** Andes Mountains in Ecuador
2. **Project Objectives:** To make farmers more likely to adopt conservation measures and to improve resource conservation throughout the Andes
3. **Project Timeframe:** Began in 1988
4. **Implementing Agency:** CARE International, Ecuadorian Ministry of Agriculture and Livestock, state and local governments.
5. **Size of Targeted Region:** 193 Communities at time of baseline survey, 9,333 families participating, 10,847 hectares of land owned by participants.
6. **Technical or Educational Components:** Technological 'menu' offering conservation methods and alterations to the agricultural system.
7. **Participatory Methodology:** Community members were asked what they viewed to be problems. Farmer-promoters oversaw the project's activities. Assistance was customized to each farmer. Project activities ended once the community members said they were ready to continue on their own.

8. **Impacts Achieved:** In order to measure perception of gains through the project, 413 of the 9,333 participating households were surveyed. Project reporting does not specifically state that survey participants were random; nevertheless, results of the survey are intended to be representative of all participating households. Also, estimates of benefits are said to be conservative as the authors account for the possibility that non-participants may have adopted some practice. Additionally, it is mentioned that households not participating could still be benefitting from reduced externalities among households that do improve soil management.

   Economic Benefits: 90% of those surveyed adopted some conservation technology. 95% of those who adopted said it was worth their effort. Those near urban centers and those who have black soils benefitted the most. The primary soil conservation method advocated was terraces, which were used in conjunction with alterations in agricultural systems to make their adoption more profitable to households.

   Social Benefits: Increased conservation efforts can lead to benefits externalized to other watershed users, which has potential to reduce conflicts. Possible examples of externalized benefits would be decreased sediment load in rivers and improved water flows long-term stemming from a reduced need to deforest upland areas in search of new cropland.

   Environmental Benefits: 60% of those who adopted perceived a soil quality increase. Overall, a great deal of benefits could accrue over time as a result of decreased soil loss.
9. **Definition of Success:**

   The first objective of increasing likelihood of practice adoption is met if surveys of some sort can illustrate a reasonable increase in use of soil conservation practices in the targeted areas. The households surveyed at the end displayed a strong correlation between project participation and implementation of improved practices. The increased use of conservation technologies along with the favorable opinions presented of those technologies indicates some degree of success, at least among the surveyed population. The second objective of improving resource conservation throughout the Andes is more difficult to measure in that we do not know if results were carried out long-term or if similar projects were replicated in other areas. The success of the project seems to match with its initial objective although long-term impact is difficult to discern.

10. **Lessons for Replication:** Resource conservation should be done as part of a larger agricultural restructuring to make conservation profitable, rather than simply subsidizing. Selection of communities with social capital and self-selection of participants are very helpful for success.

Project Source: Winters, Crissman, Espinosa. *Inducing the Adoption of Conservation Technologies: Lessons from the Ecuadorian Andes*

1.2 Permacultura Cayambe (Ecuador)

1. **Project Site:** Cayembe, Ecuador

2. **Project Objectives:** Long-term goal is to recover the traditional stewardship ethic and technologies of indigenous cultures. The project was a pilot project towards that end, with specific goals of developing examples of sustainable agriculture and ecological regeneration (permaculture)in Cayembe, training community members in permaculture, and promoting the development of local organizations capable of implementing their own permaculture.
3. **Project Timeframe:** 1991-1996
4. **Implementing Agency and Funding Information:** CIBT, Centro de Investigacion de los Bosques Tropicales; funding sources/ amounts unknown
5. **Size of Targeted Region:** 403,000 ha
6. **Technical or Educational Components**: Permaculture facilities, educational programs, scholarships for participants.
7. **Participatory Methodology:** A regional permaculture demonstration and training center was developed using indigenous apprentices and economical methods. Schoolchildren and farmers were especially instructed in ways of ecological gardening and reforestation. 12 total educational programs were sponsored for the community members to learn about permaculture. Additionally, local leaders attained 25 scholarships to participate in local, regional, national, and international courses on permaculture, sustainable development, and related topics. Field days and a resident apprenticeship program were also integrated into the details of the project. Additionally, support was provided to empower local indigenous organizations and create local NGOs.
8. **Impacts Achieved**:

   Economic Impacts: The efforts are beginning to obtain additional sources of funding to continue efforts, such as a UN grant supporting Andean native crop biodiversity studies.

   Social Impacts: The indigenous organizations and projects formed are now locally-run initiatives separate of CIBT. However, they are not self-sustaining yet, so Permacultura Interandina was formed as a consulting, training, and support group for such organizations.

   Environmental Impacts: Native crop and reforestation programs are being introduced. Awareness and consciousness of environmental issues increased, as did the ability to find more sustainable practices.
9. **Definition of Success:** The impacts achieved through the project are an early step for the long-term goal of recovering traditional stewardship of the land. The specific objectives in this project of developing organizations and training community members have begun; however, long-term sustainability of efforts has not been firmly established. Impacts appear to be significant steps towards the objectives of the project, however, do not represent the completion of the goals.
10. **Lessons for Replication:** The project is still working towards its long-term objectives; as long-term results of the project become available, more lessons will be learned about the recovery of traditional stewardship.

Project Source: Mecham, Jefferson *Permacultura Cayambe*

1.3 PROCAM (Colombia)

1. **Project Site:** Upper Magdalena Watershed, Colombia
2. **Objectives:** Develop sustainable land use, strengthen watershed management and development institutions, and provide baseline data for an investment project in the Upper Magdalena Watershed
3. **Project Timeframe:** Approved 1981, completed 1987
4. **Implementing Agency and Funding Information:** Project was implemented by Colombia's INDERENA (Instituto Nacional de Recursos Naturales Renovables y del Medio Ambiente). $27 million dollar project, $9 million provided by World Bank loan.
5. **Size:** Unknown
6. **Technical or educational components:** Unknown
7. **Participatory Methodology:** Reporting did not place an emphasis on methods utilized. The project seemed to lack participatory methods.
8. **Impacts Achieved:**
   - Farmer consciousness of natural resource problems was increased.
   - Local soil conservation fund was established, but unfortunately, the project failed to produce lasting results as pre-project ways of overgrazing, steep slope cultivation, and burning continued after the project ended.

9. **Definition of Success:** The primary objective of developing sustainable land use was clearly not met as no long-term changes in land use were made as a result of project activities. As for the objective of strengthening local watershed management and development institutions, the project does not seem to have set up a firm base for future management. No project documentation shows in-depth socioeconomic or biophysical analyses of the watershed. Additionally, 95% of the loans the projects attempted to provide to watershed users were not accepted.

10. **Lessons for Replication:** In the future, projects should include better monitoring and evaluation components and deeper understanding of target area. Additionally, projects should utilize a more participatory approach and wider variety of tools. Documentation suggests that interventions be grounded in local knowledge and thorough data on socioeconomic and biophysical factors. Additionally incentives could be used to help pay for higher production costs under conservation measures.

Project Source: World Bank, *Issues in Watershed Management: A Pilot Project in Colombia*

1.4 Making a Difference to Andean Livelihoods Through an Integrated Research Approach (Peru)

1. **Project Site:** Ilave-Huenque watershed in the Peruvian Altiplano
2. **Objectives:** Develop capacity of farming systems in the watershed to withstand present and future social and economic variability and shocks, as well as increasing production and income to improve quality of life in the watershed.
3. **Project Timeframe:** Unknown

4. **Implementing Agency and Funding Information:** Project implemented by CIP and CIRNMA with the help of the peasant communities of Anccaca, Santa Maria, Jiscuani, Carata, and Apopata in Puno, Peru. Exact amounts and sources of funding is unknown.
5. **Size:** 777,000ha
6. **Technical or Educational Components:**
7. **Participatory Methodology**: Participatory Rural Appraisal was utilized to target communities, while static and dynamic diagnoses were used to characterize communities. The negotiated action plan began as a general discussion at the regular communal assembly. Adaptive research was conducted with farmers and technical staff forming voluntary experimental groups, where all participants had the same weight in discussions. Farmers themselves validated the options they tested, selecting those that made a difference in yield, cost reduction, or resource conservation. Diffusion practices varied, but were sometimes carried out at field days, where farmers show the benefits of practices such as soil and water conservation. Additionally, it diffusion could occur informally when neighboring communities observed that areas implementing conservation practices faired substantially better than non-implementing areas following climatic shocks.
8. **Impacts Achieved:**

   Economic Impacts: Increased yields of potato and quinoa, as well as increased production of dairy products, alpaca fibers, and horticultural products. New production systems resulted in an approximate 70% increase in yield, depending on the options implemented. Another positive result was the creation of a revolving fund, established by the national research institute (INIA) which facilitated improved technology, Integrated Pest Management, and Integrated Soils Management. Every year 1,200 potato farmers and 800 quinoa farmers introduce improvements to production processes. Nearly 100% of farmers have adopted at least one of the components introduced.

   Social Impacts: By the end of the project, nearly 2,000 households produced alpaca sweatshirts for international markets. The added economic value associated with the alpaca sweatshirts is expected to go towards food and education because of the prevalent role women have in production. Additionally, a few women's groups began working independently and exporting to North America, which led to more rural employment and stronger social cohesion in women's groups. The project as a whole was said to have strengthened farmer's groups, as well as women's groups.

   Environmental Impacts: Inclusion of alfalfa in fallow periods of potatoes, along with use of slow formation terraces helped to reduce erosion for those who participated. Field days implemented for farmers led to higher diffusion of conservation technologies. Some of the improvements to the natural resource base were possible because the adoption of practices was made to be profitable in the short term and visible differences in soil quality would come about in only a matter of a few years.

9. **Definition of Success:**

Success can be measured by the extent to which new practices are adopted and accepted. Additionally, the success of this project can be measured in terms of the economic impact of the adoption. This is measured by the degree to which yields increase or costs decrease. If adoption of practices leads to conservation of resources or increased social cohesion, these too, can be considered successes, although they can be difficult to quantify. The objective of raising incomes and quality of life appears to be met through the increases in yields reported and improved production of alpaca sweatshirts. Improved conservation practices highlight new production systems that could grant more stability to the livelihoods of watershed users in the event of climatic shifts.

10. **Lessons for Replication:** Success in watershed management requires a long-term research commitment. Research and development must occur simultaneously. An alternative to the lead research group should take charge of development efforts. All stakeholders must be incorporated into the project from the start. Local and regional authorities, due to high turnover rate, are difficult to incorporate into planning, but their input is essential to success. Flexibility is required since new challenges are sure to arise. Additionally, long-term success in encouraging conservation practices will only occur if incorporated in with changes in the agricultural systems that will make them more profitable. Conservation efforts need to pay attention to profitability in addition to ecology.

Project Source: Quiroz, Roberto et al. *Case Six. Project title-Making a Difference to Andean Livelihoods Through an Integrated Research Approach*

1.5 PROLADE (Honduras, Nicaragua, Colombia, Peru)

1. **Project Site:** Valleys of Cochabamba and Santa Cruz in Bolivia
2. **Objectives:** To turn back the gradual desertification and overall environmental degradation that occurs throughout study areas. The goal to achieve this objective is to allow for inexpensive farmer adoption of soil and water conservation techniques.
3. **Timeframe:** Most fieldwork completed 1996-1999
4. **Implementing Agency and Sources of Funding:** San Simon University; Cochabamba, Bolivia. Funding provided by Department of International Development of the UK.
5. **Size:** Unknown
6. **Technical or Educational Components**: Aerial photography and GIS were used to characterize typical watersheds. Also, use of various soil conservation mechanisms was a major part (ex: stone walls, boundary hedges, etc.)
7. **Participatory Methodology:**
   1) Establishment of soil and water conservation communities which have been farmer tested in other Latin American countries.
   2) Participatory technology development with farming families in influential areas. PRA used to identify soil erosion and declining productivity as main problems. Additionally, workshops, farmer discussions, and farmer evaluations were held. On farm researchers would manage trials with live barriers and cover crops, then encourage farmers to continue the process.

8. **Impacts Achieved:**

   Economic Impacts: Approximately 200 families are believed to have benefitted from the adoption of live barriers, principally Phalaris grass. Time was taken to assess farmers' views of what advantages and disadvantages they see with conservation technologies and efforts were made to show the visible advantages they identified. Such advantages included yield increase, increased resistance to storm damage, lower labor requirement, etc. Disadvantages included reduced cropping area and limited first year effectiveness.

   Social Impacts: The process of participatory technology development, resulting from farmer-set priorities toward soil and water conservation, has led to high levels of adoption of live barriers. High levels of participation in the whole process have allowed farmers to see the benefits of the conservation mechanisms and see their relevance towards their own priorities.

   Environmental Impacts: High levels of participation, in that the development answered local needs and the farmers were part of the trial process, was said to result in almost automatic adoption of conservation methods. This can result in reduced erosion and overall improvements to the natural capital of the region. Also, it was found that Tarwi was the legume performing the best for soil conservation under the widest range of circumstances.

9. **Definition of Success:** The long-term objective of turning back desertification is underway through the efforts of the project, however, such a goal is difficult to immediately identify as successful or not. The goal to make progress on that objective is to facilitate inexpensive adoption of soil and water conservation techniques by farmers. That goal is met with success by the 200 families adopting live barriers and receiving a variety of benefits from them. The high level of adoption reported through the project is a form of success relevant to the original project objectives.

10. **Lessons for Replication:** Participatory technological development allowed the entire process to be successful, encouraging accelerated adoption. It is said that much on-going work is participatory in nature, however field level on-farm trials must be scaled up to incorporate all users groups in a range of agroecological niches within a representative number of watersheds. Individual and group research must be connected with practical community level development. The functionality of the community process relies on good identification and development of methodologies for improved community management of watersheds, identification and promotion of productivity increasing practices, working with locally-identified institutions for the range of agro-ecological zones of each watershed. Methodologies for scaling up field-level research are critical.

Project Source: Sims, Brian G., Jim Ellis-Jones, and Stephen J Twomlow, *The Development of Low Cost Soil and Water Conservation for Smallholder Farmers in the Mid-Andean Valleys of Bolivia.*

1.6 Participatory Upland Conservation and Development (PUCD, Bolivia)

1. **Project Site:** Pirai Watershed (Upper and Middle) in Santa Cruz, Bolivia
2. **Objectives:**
    a. To strengthen the capacity of local grassroots organizations to take advantage of the social-development opportunities offered by Bolivia's new policies on people's participation and local governance.
    b. To provide technical assistance to farmers to adopt more sustainable and efficient practices in natural resources management.
3. **Timeframe:** Original timeframe was 1992-2000, but continued until 2002.
4. **Implementing Agency and Sources of Funding:** FAO, SEARPI (Pirai River Watershed authority), along with other local communities, local governments, other internationally funded projects and a number of national and local NGOs. Only had small allocation ($250,000/year), but received funding from other sources as the project continued.
5. **Size:** The upper watershed alone covers 97,000ha, while containing 8,500 people
6. **Technical or Educational Components:** Rotational credit schemes, technical assistance for public works, improved techniques for land management.
7. **Participatory Methodology:** Training and administrative assistance to form grassroots organizations through the People's Participation Law. Assistance to local governments on people's participation and participatory management of natural resources. Small scale community-based public works through technical and financial assistance. Small-scale agricultural infrastructure built through provision of rotating credit. Participatory research and extension to provide a 'menu' of options for improved techniques for land management and animal husbandry. Identification, validation, and diffusion of techniques to sustainably use forest resources. Environmental education in schools and through different media, including efforts to target local administrators and tourist operators.
8. **Impacts Achieved:**

    Economic Impacts: A significant proportion of farmers adopted simple and cost-effective measures that allow for more sustainable use of land, soil, water, and forest resources. Simple and low-cost incentives and savings/credit schemes for facilitating the diffusion of new technologies and practices were successfully tested and implemented. On- and off-farm alternative sources of income have been identified and are increasingly being utilized.

    Social Impacts: Grassroots organizations in the Upper Pirai Watershed have been formally acknowledged as "Organizaciones Territoriales de Base." Their capacity to deal with immediate needs has been strengthened and they have been empowered as partners in the local planning and governance process. This is foreseen by the People's Participation and Municipalities Law.

    Environmental Impacts: Among different sectors of the local economy, awareness of environmental issues has been raised. Samaipata, the administrative body responsible for

the Upper Pirai Watershed is now incorporating into its development plan activities to control environmental risk and increase participatory management of natural resources.

9. **Definition of Success:** Following along the objectives of the project, success would entail 1) grassroots organizations being more empowered to take advantage of social-development opportunities, or 2) an increase in the percentage of farmers using practices deemed more sustainable or resource efficient. In this project, the first objective is met in that grassroots organizations in the watershed have become formally recognized and are more empowered in planning and governance. The second objective has been achieved through use of credit schemes and incentives that encourage farmers to adopt more sustainable practices in land use.

10. **Lessons for Replication:** Opportunities for dialogue between different watershed groups will promote active involvement of population in managing the environment. It is important to keep in mind that biodiversity conservation is connected to water and soil resources management. Through encouraging resource management among the population, the project sought to create synergies between management of resources, biodiversity, livelihood security, and adaptation to climate change. It should be noted that in 2003, the area received the status of a national protected area, which allowed development of sustainable economic activity and closed the area for large-scale intervention.

Project Source: Manuel Tejada, *Case study: Integrated water management and up-scaling of successful dialogues in the Cotahuasi sub-basin.*

1.7 Helping Farmers Reclaim Eroded Land and Increase their Productivity and Income (Bolivia)

1. **Project Site:** Bolivian Altiplano (Patacamaya and Viacha regions have completed projects. Final results could not be found for Pucarani and Sica Sica regions.)
2. **Objectives:** To help reclaim the eroded pastures of the Bolivian Altiplano while also seeking to improve the productivity of farmers in that region. This project seeks to address the connected issues of eroded land and rural poverty.
3. **Timeframe:** Patacamaya: 1997-2000; Viacha: 2002-2003; Pucarani and Sica Sica: 2004-2007 (estimated, only first year completed during reporting)
4. **Implementing Agency and Sources of Funding:** Project implemented by Strategies for International Development (SID)- Bolivia
5. **Size:** Country-wide: 45% of population, 22% of land area is Altiplano; Patacamaya- 1,630 farmers in 50 communities; Viacha- 1,550 farm families in 40 communities; Pucarani- 1,500 farm families in 25 communities; 1,300 farm families in 30 communities.
6. **Technical or Educational Components:**
7. **Participatory Methodology:**
    a. Direct work with farmers demonstrating innovative methods for land reclamation and income improvement.

b. Help farmers associations and NGOs employ more effective methods in their work sites.
c. Organize workshops where NGOs find solutions to common problems, share lessons learned, and seek agreement on best practices.
d. Competitions among communities were utilized as a means of mobilizing widespread participation.
e. The project was planned and evaluated with beneficiaries and also employed successful farmers.
f. Women were employed and involved in all project areas equal with men. Projects began with market assessments and sought to create opportunities for farmers to expand markets.
g. Farmers were assisted in identifying buyers and making business plans.

8. **Impacts Achieved:**

Economic Impacts: 80-90% of the families in the 50 communities of Patacamaya participated in the project. Average increase in income per participating family was 64% in that region. Through vaccination and parasite treatment along with other methods, production of dairy cows increased from 5.3 lt/day to more than 10, while beef cattle production went from one to two cows per year. Nearly 1ha of land per family was recovered and income was increased by 23.3% during the period of assistance. This is believed to have been achieved due to technical assistance provided to 35 NGOs throughout the Altiplano from 2000 to 2004. NGOs were working with 1,184 communities with 30,246 farm families.

Social Impacts: Women strongly approved of the project because it focused on their problems while giving them an opportunity to use their ideas and experiences. They were given a major role in the project.

Environmental Impacts: Patacamaya: 1,593 ha reclaimed with water retention ditches, 70ha through terrace construction, 14,307ha through reserves, and 27,341ha through strict rotations. In the community of Viacha, 300ha of pasture were recovered by various means. Additionally, 30ha of salty soil were recovered by digging water retention ditches and sowing Atriplex. Furthermore, 370ha alfalfa and 80ha of weeping grass were sown.

9. **Definition of Success:** Success in a project of this sort would be measured by some amount of eroded land recovered or by an increase in productivity of farms. Results clearly show increases in milk yields along with increases in family income, which shows that the objectives were met with some degree of success. As for the objective of reducing eroded land, both Patacamaya and Viacha have shown significant amounts of soil being conserved through varying means. The success of the project strongly correlates to the original objectives of the plan.

10. **Lessons for Replication:** In a World Bank contest, this project was deemed one of the most successful in Latin America. Much success can be attributed to the technical assistance provided to NGOs to carry out work and also to the high degree of

participation involved throughout the entire process. Success comes from direct work with farmers to demonstrate methods and assistance to NGOs regarding the best methods to employ.

Project Source: SID-Bolivia, *Helping Farmers Reclaim Eroded Land and Increase their Productivity and Income*

1.8 Discussion of Soil Management

Throughout the above case studies, soil management is utilized as a means towards natural resource management. In many cases, the soil management question is: how do we most effectively increase adoption of soil conservation practices. One notable benefit of soil conservation is reduced silt in water harvesting ponds, which can lengthen their lifespan, thus providing benefits for water management as well. Generally speaking, efforts to improve soil condition are designed to raise the productivity of a watershed's natural resources (Kerr 2007).

The question of how to most effectively encourage adoption of improved practices is met with a plethora of solutions throughout the cases provided. One notable example came from PROMUSTA, which offered a solution centering around pairing conservation practices with profit-increasing agricultural restructuring (Winters et al. 2004). Another component of success mentioned in many projects is the degree of participation. Soil management projects can only be successful to the extent that they address the needs of the targeted communities and induce communities to continue conservation after the project is ended. Varying methodologies are found throughout the case studies given, but a common thread is the extent to which farmers' needs are emphasized in soil management scenarios.

2) Projects with Objectives in Managing Water Quality or Quantity

Management of water quantity or quality often comes as an added benefit of many soil management projects, but comes in many projects as an objective of its own. In 2.1 below, you can find information on the IDRC project MANRECUR. The project arose as a response to a circumstance very familiar to many Andean communities: conflicts caused by water shortages (Stanley 2006). The fragile environment described in this case study is prone to many water shortages, which can create problems for the economy, the natural resources, and the social fabric of the community.

Improved management of water resources has potential to create many benefits for users including reduced conflict, increased yields, and improved environmental quality. The following two projects come with primary objectives that revolve around improving allocation of water in a watershed. MANRECUR, along with MARENASS, represent a category of Andean Watershed Projects that seek to improve conditions in watersheds through improvements in the quality or quantity of water available.

2.1 MANRECUR (Ecuador)

1. **Project Site:** El Angel River Watershed, Carchi, Ecuador
2. **Objectives:** To assist the natural resource management of the watershed through studying water use. Additionally, there is a goal to manage conflicts arising from water use by establishing better monitoring systems.
3. **Timeframe:** Began in 1996, completion time unknown
4. **Implementing Agency and Sources of Funding:** International Development Research Centre (Canada).
5. **Size:** 100,000ha, 25,000 people, 45,000ha of Paramo
6. **Technical or Educational Components:** Simple water flow meter, GIS
7. **Participatory Methodology:** Locals were involved in conversations with project staff to give IDRC a better idea of problems experienced. Additionally, all monitoring of stream flows was participatory to build a better understanding of water flows among users.
8. **Impacts:**

   Social Impacts: Gave realistic view of water use, aided water adjudicator in understanding stream flows, which led to a denial of further withdrawals due to insufficient flows. Eased conflicts on water, brought groups together to find solutions; upstream and downstream users worked together to restore a reservoir.

   Environmental Impacts: Improved management of hydrological resources and better view of relationship between human activities and local environment. The project also helped to show the effects of upstream pollution on downstream water quality.

9. **Definition of Success:** Success in a project carrying the above objectives would entail some degree of improvement in monitoring of water flows, which could result in reduced conflict among water users. The project was met with such results as it helped establish a realistic view of water use in the watershed and eased conflicts on water. The improved management of environmental and social circumstances in the watershed indicate a degree of success pertinent to the original objectives.

10. **Lessons for Replication:** Hard evidence is valuable when locals are empowered to collect water flow and quality data. Building on local knowledge and gearing development to specific needs makes for relevant research.

Project Sources:

Stanley, Bob, *Sharing Resources and Responsibilities in an Andean Watershed*; lead researcher-Susan Poats
Waldick, Lisa, *Water Management in Ecuador's Andes Mountains*

2.2 MARENASS (Peru)

1. **Project Site:** Southern highlands of Peru, departments of Apurimac, Ayacucho, and Cusco

2. **Objectives:** Find solutions to the region's issues of resource depletion, low yields, and poverty. Specific efforts were focused on improving capacity for irrigation.
3. **Timeframe:** 1998-2004
4. **Implementing Agency and Funding Sources:** International Fund for Agricultural Development (IFAD). $15,142,800- total financing; 79% by IFAD, 19% by the Government of Peru, and the remainder by the direct beneficiaries.
5. **Size:** 88,000 Families spread over 600 Communities. Effort concentrated on Asmayacu, community of 67 families on 2,339 ha of land, 439 ha is irrigable, 100 ha is irrigated.
6. **Technical or Educational Components:** Graphical maps to highlight watershed characteristics and project actions.
7. **Participatory Methodology:** Community members were surveyed to determine problems they believed to exist. Clear transfer of funds to communities as well as a competition-based methodology that had farmers competing for a prize for submitting winning irrigation system. Lastly, local leaders were trained to be irrigation specialists.
8. **Impacts:**

Economic Impacts: 90% adoption of winning irrigation technique, leading to 60% irrigation efficiency compared to 30%. Labor costs were reduced, while productive capacity and irrigated area increased. Three crops a year could be grown, reducing production costs and increasing yields. Household assets improved for 60%, while 30% were able to move from subsistence to commercial production.

Social Impacts: Decrease in conflicts and increase in food security.

Environmental Impacts: Decreased erosion, improved natural production assets.

9. **Definition of Success:** According to the original objectives, success in this project would entail a solution to alleviate resource overuse, poverty, or low yields. These goals, which support one another synergistically, are met with a degree of success in final impacts of the project. Through the participatory use of irrigation improvements, the project had some success with alleviating poverty and helping natural production assets.

10. **Lessons for Replication:** Decision-making must be handed over to farmers under clear conditions, previously agreed upon. Farmers must be considered responsible. Good traditional knowledge of participants makes proposing acceptable change easier. Peru's new water privatization law could make replication difficult since it does not recognize community's rights and organizational forms.

Project Source: Cleveringa, Rudolph, Teofilo Zamalloa, Audrey Nepveu de Villemarceau, *Restoring Land Use Through Local Water Governance and Technology in High Andes Communities*

2.3 Discussion of Water Management

While it has been mentioned that improved water resources come as a result of sustainable soil use practices, water management has become a very important research objective of its own. Both above case studies are evidence that improved management of a scarce resource such as water has potential to reduce conflicts. A separate case in Cotacachi, Ecuador provided an example where management of water resources resulted in more unity among user groups due to the common effort established (Ruiz-Cordova et al. 2006).

One particular challenge to water management is the degree to which cooperation is necessary, while at the same time, user groups may receive different benefits. One example is that improved water harvesting in one watershed can result in limited flows downstream (Kerr 2007). From this, we can see that improved management of water resources may not always make everyone better off and could have potential to exacerbate some conflicts over water. With this potential in mind, it is especially useful to note that the previous examples brought different user groups together, while also using some form of hydrological monitoring to ensure that users groups were empowered to make good decisions regarding water use.

3) Projects with Objectives in Management of Biodiversity

Biodiversity is a major issue in watershed management in the Andes. The protection of wildlife remains an important issue to the field of watershed management and is represented with one project in this study. The following represents an effort to develop an understanding of conservation priorities throughout the Andes.

3.1 Improving Conservation Planning in Peru and Bolivia through the Application of New Tools and Data (Peru, Bolivia)

1. **Project Site:** Upper Amazon Watershed of Peru and Bolivia
2. **Objectives:** To apply new tools to fill data gaps and provide new analyses of conservation priorities on the Andes' eastern slope and the adjacent lowlands in Peru and Bolivia.
3. **Timeframe:** Most work done in 2005, 2006
4. **Implementing Agency and Funding Sources:** NatureServe; funding amounts unknown
5. **Size:** Unknown
6. **Technical or Educational Components:** Ecological systems mapping, model distributions of endemic species, remote sensing, ground truthing
7. **Participatory Methodology**: NatureServe staff worked with the Regional Planning Office, Alto Mayo Special Project Office, Municipal Governments, and various other project partners from the local region.
8. **Impacts:**

   Social Impacts: Tools were developed to incorporate biodiversity information into local planning. Additionally, training was provided in species distribution modeling, ecological

systems classification and mapping, conservation planning methodology, and database management systems.

Environmental Impacts: As a result of this project, an ecological systems map was obtained, as well as modeled distribution maps for about 600 endemic species. Also, researchers found modeled areas with probability of high endemism levels. Additionally, priority areas for regional conservation were documented.

9. **Definition of Success:** The project does not seek to immediately change the situation in the project site; rather, it seeks out information for future use. The measure of success, then, would be the extent to which sites for conservation action can be found, and the extent to which data is complete and accurate for future uses. Additionally, success could be measured through verifying the use of new tools in conservation site identification and in increasing public awareness and concern for conservation. The goals appear to be largely met as many conservation areas were identified. Additionally, a significant amount of training was provided to locals and incorporated into decision-making. Results, including the tools to incorporate conservation into decision-making, are relevant to the original objectives of the project.

10. **Lessons for Replication:** Working with local partners and passing along technical information will assist the overall decision-making process with respect to conservation planning.

Project Source: Grossman, Dennis et al., *Improving Conservation Planning in Peru and Bolivia Through the Application of New Tools and Data.*

3.2 Discussion of Biodiversity Management

In the case of the above case study, the primary objective of the study revolved around improving conservation planning and monitoring biodiversity. Attention to biodiversity exists in other projects as one of many components, however, as is the case with the SANREM CRSP project. In the case of SANREM, biodiversity monitoring is utilized to greater understand the linkages between watershed actions and environmental outcomes. Additionally, the project uses participatory monitoring to further local awareness of biodiversity (SANREM CRSP 2008).

4) Projects with Objectives in Developing Information Systems

The following category of projects is somewhat different in nature in that the projects do not seek to provide an immediate impact in communities. These projects instead seek to improve on the availability of data related to resource use, which in many cases will further future management of resources. In this section, the category 'impacts' has been replaced with 'outputs' because the project goals revolve around production of improved data capabilities rather than making an immediate impact.

4.1 Procesos y Productos (Peru)

1. **Project Site:** Three Peruvian watersheds: San Pablo and La Asuncion in the northern basin and Manazo in the southern Altiplano
2. **Objectives:**
    a. To determine if secondary data sets can be integrated into GIS using local NGOs
    b. To see if GIS data sets be created jointly by NGOs and watershed inhabitants
    c. To create other products that could facilitate a participatory development process
3. **Timeframe:** May 2000-May 2002
4. **Implementing Agency and Funding Sources:** Implemented by CONDESAN (Consortium for the Sustainable Development of the Andean Ecoregion). Funded by the Ford Foundation, approximately $300,000
5. **Size:** San Pablo-4240ha, 730 households; Asuncion- 8515ha, 1300 households; Manazo-26,915ha, 1700 households
6. **Technical or Educational Components:**
7. **Participatory Methodology:** Local NGOs were taught to use participatory rural appraisal in order to find development priorities as decided by the local community. The overall movement towards participatory GIS was not specifically requested by communities, but it does empower other community-driven movements for the future. Rather than seeking immediate development and changes, the project empowered communities to make their own development. Stakeholders participate in the process of GIS creation in order to incorporate their perspectives into the landscape.

8. **Outputs:** Maps were created to aid in identifying conservation sites among other uses. Furthermore the project results have stated that the creation of GIS products by local NGOs using secondary data is a realistic goal. The report states that spatial analysis tools be used in conjunction with participatory rural appraisal or other proven social research methods to ensure that project time will be seen as relevant and not as time wasted.

9. **Definition of Success:** The success of this project revolves around the ability to find answers to the three main objectives listed above. If more can be learned regarding the ability of NGOs to integrate secondary data into GIS with help from communities, then a degree of success will be found. Any information that would show the means by which GIS or other technologies can be integrated into watershed management plans would also determine the success of the project. Success in this project was achieved through the creation of maps to identify conservation sites and the discovery that GIS products can be created with secondary data from local NGOs. The other measure of success is the series of lessons learned from the process of participatory GIS, lessons that will help guide future management endeavors.

10. **Lessons for Replication:**

    The integration of secondary data sets should be more systematized in the future so that NGOs would avoid making parallel integration efforts and could instead focus on doing more

social research. Long-term management of natural resources will be easier because more technical data will be accessible.

Furthermore, it is stated that thematic maps must be supplemented with direct observation and local knowledge of the landscape. The report states that political and social constraints can be harder to overcome than technical constraints for such a project. Furthermore, it states that organizations such as those participating in this project are in a strategic position to integrate social research and GIS technology, but the impediments faced in the study must first be overcome before GIS can be a truly effective tool for settings with limited resources (physical, informational, or institutional).

Project Source: Ficenec, Craig, *Explorations of Participatory GIS in Three Andean Watersheds*

4.2 Integrating Remote Sensing, GIS, and Modeling for Land-Use Monitoring in the Arid/ Semi-Arid Andes (Peru, Bolivia)

1. **Project Site:** Altiplano region of Bolivia and Peru
2. **Objectives:** Long-term goal is to reduce the unpredictability of agriculture in the Altiplano through improved predictive models. One specific objective is to develop methods to link remote sensing, GIS, and dynamic models to increase accuracy of predicting agricultural production and testing the results against census data. Another specific objective of the project is to test new methods by comparing confidence bands of simulated agricultural products in new models against existing models, census data, and remotely sensed data.
3. **Timeframe:** October 1996-March 2000, after a 6-month extension
4. **Implementing Agency and Funding Sources:** Primarily funded by Ecoregional Fund, total funding of $491,000. Implemented by CONDESAN (CIP), Ecoregional Fund, and other partners
5. **Size:**
6. **Technical or Educational Components:** Remote sensing, GIS, and livestock and farming prediction models.
7. **Participatory Methodology:** Researchers conducted studies on farms to get a better understanding of decision-making. It is mentioned that there is a demand for planning agricultural research in the Altiplano. Overall, this project is data-centered, not high emphasis on participation
8. **Outputs:** Results include a model to simulate livestock production and remote sensing to provide biomass data to livestock models. Additionally, a model was developed for simulation of pasture growth. All information of such models was then integrated together to form one large model, capable of estimating crop or livestock productivity at different scales.

   Additionally, technology was presented at multiple scientific meetings and is soon to be utilized by PDLA, a development project in Bolivia, which is being run by the Ministry of Agriculture combined with ASPROLPA, a dairy farmers association. The project has raised awareness of environmental shocks.

9. **Definition of Success:** Tangible success would be found through systems that could better predict agricultural yields and assess the risks inherent to agriculture in such a harsh environment. This project's success could lead to better access to information for future agricultural projects in the Páramo. The ability of this project to produce a model for simulating crop or livestock productivity at different scales combined with the raised awareness of environmental shocks represent two ways in which the project found success. Success in the short-term objective of improving predictive capability of models helps with the longer-term goal of reducing uncertainty of agriculture in the region.

10. **Lessons for Replication:** Managing a multidisciplinary, multicultural team in many locations is difficult and relies on good communication. Electronic sharing of data provides for a cost-effective means to advance communication. Early involvement from decision-makers is good to define outputs, but otherwise it is easier to get support once the project provides useful information to decisions. Depending on the experience level of the decision-makers, discussing the science in detail may complicate the initiative. It should be noted that there is a lag period for adopting new methods and tools, thus efforts should go to speeding that process. Unavailability of high-resolution remote sensing data complicated the matter of trying to use the predictive technologies.

Project Source: Roberto Quiroz, *Integrating Remote Sensing, GIS, and Modeling for Land Use Monitoring in the Arid/ Semi-Arid Andes*

4.3 Dissemination and Application of Decision Support Tools (DST) for Natural Resource Management (Nicaragua, Honduras, Colombia, Peru)

1. **Project Site:** San Dionisio, Matagalpa, Nicaragua; Yorito, Yoro, Honduras; and Cabuyal, Cauca, Colombia, and some references made to Pucallpa, Perú from early research.
2. **Objectives:**
    a. To improve production systems
    b. To make landscapes more sustainable
    c. To strengthen organizations
    d. Support decision makers
3. **Timeframe:** Most training workshops done between 1999 and 2002
4. **Implementing Agency and Funding:** CIAT (International Center for Tropical Agriculture); funding provided by IDRC (Canada) and Swiss Development Cooperation (SDC).
5. **Size:** Watersheds vary in size between 150 and 200 km^2
6. **Technical or Educational Components:** Decision Support Tools (DST), training guides
7. **Participatory Methodology:** Participatory analysis of status of natural resources; DSTs were developed to help train watershed users in decision support processes; Local and national research partnerships were created and partners were deployed as facilitator teams. In Nicaragua and Honduras, the training guides were validated through workshops in which participation at local, regional, and national levels was ensured.

Printed guides were used between 1999 and 2002 and participants planned ways to implement DSTs in their own work environments. Some received institutional support.

8. **Outputs:**

   Economic: National watershed management programs implemented in poor countries with bilateral aid sources are now DST's into their agricultural development strategies to accompany investments and other poverty alleviation measures.

   Social: Participating Central American institutions created a total of 17 action plans by mid 2001 which aided them in applying DSTs to their particular needs. DSTs are being introduced into the institutional programs of many different NGOs and governments. Institutional decision-making has been strengthened and the DST process is rapidly extending.

   Environmental: The use of DSTs is improving the capacity of local communities to make sound decisions about NRM. Several cases have been reported. In western Colombia, ten communities of the municipality of Bolivar, department of Valle del Cauca, received training in the use of the DSTs. As a result, they produced an integrated environmental plan, which was presented to the Municipality for finance. So far, resources have been found for a trash disposal and recycling project, which are now underway.

9. **Definition of Success:** This project will define success as the ability to use DSTs to make a variety of improvements to social, environmental and economic conditions. DSTs, through their ability to support decision making, improve natural resource management, and be a part of development projects, have been a success in this project. The success of the DSTs in helping environmental planning and management is relevant to the original objectives of the project.

10. **Lessons for Replication:** Action plans conducted by DST-trainees were initial proof of adoption. Further follow-up is needed on such plans. It was originally thought that DST was a risky undertaking in applied research for poor, rural farmers. However, it was discovered that development practitioners, local officials and NGOs, as well as farmers favored this approach. Stakeholders helped researchers to identify the focus of their NRM efforts, using their knowledge to build upon scientific evidence. This has helped to focus research and to catalyze a process which blends scientific data with local knowledge. Full impact of these projects will only be understood with more follow up.

Project Source: Zapata, R. and J. Ashby, *Case Two. Project Title - Dissemination and Application of Decision Support Tools (DST) for Natural Resource Management*

4.4 Discussion of Projects Based in Information Systems

The previous projects employ the use of various decision-making tools in order to further future watershed management actions. A key point to remember about such an effort is that overall impacts should not be judged by immediate ability to change social, environmental, or economic conditions. The better indicator of success in projects of this type is the extent to which the outputs produced can be continually utilized to improve knowledge about landscapes and the degree to which local participants are involved in employment of technologies. Another important consideration is that the information systems developed meet the needs of communities seeking to improve their own management of resources.

VI. Lessons Learned

A variety of lessons can be taken away from the thirteen projects discussed in this paper. For the sake of expediency, not every major point of every project will be reiterated in this section. This section will synthesize the major points of consideration in watershed management, while referencing important points from the case studies.

Selection of Target Areas

Development funds are limited, while the number of potential beneficiaries abound. For this reason, funds and development efforts must be focused upon places where physical and social capital is such that impacts can be the greatest. An important component to a good watershed project is selection of a target area that will have a high probability of success in addition to the need for aid. It should be noted that those deemed poor candidates for project efforts are not being treated unfairly as they experience no great loss in being overlooked for a project that would prove ineffective (Kerr 2007).

Although thorough discussion is not present in the above case studies regarding selection of communities, watershed projects should make some effort to ensure that residents of target areas have a willingness to work together to manage resources. Selection of communities with social capital along with self-selection of participants will increase the likelihood of success in watershed management (Winters et al. 2004).

Role of Participation

Watershed management is a field of study that depends heavily on local participation for success. The above case studies indicate the degree to which higher levels of participation accompany higher levels of success. One example is the simple comparison between the PROCAM project and many other projects in the study. PROCAM had limited success due in part to a lack of emphasis on participatory methodology. While this is a simplified assessment for this particular example, the value of stakeholder involvement is difficult to overstate in any development-oriented project. There are a variety of levels at which stakeholders can be engaged into a

watershed project. For this discussion, the broad areas are defined as: 1) Goal-Setting, 2) Planning, 3) Implementation, and 4) Follow-up.

Goal-Setting:

One noticeable feature in many projects is the manner in which objectives are formed. Many of the projects analyzed in this study employ some technique to survey community members of their perceptions of natural resource issues. Projects utilizing such techniques include PROLADE, MARENASS, MANRECUR, PROMUSTA, Procesos y Productos, and Making a Difference to Andean Livelihoods through an Integrated Research Approach. These projects, in some cases, use a form of participatory appraisal to assess local views of problems existing in the watershed.

If beneficiaries provide input from the start, projects are more likely to generate results that are relevant to the community and increase the probability that impacts will be sustained after the project is finished. It should be noted that other projects in the study may have also found a participatory means to assess watershed characteristics, although such efforts were not reported to a similar degree.

Planning:

Once a target community is chosen and objectives are set, it is essential that the project is planned with some degree of local participation. If beneficiaries are left out of the decision-making process, there will be a higher possibility of disconnect between project efforts and community needs. Several projects in the report describe a participatory planning process, particularly the SID-Bolivia project, which was planned and evaluated with beneficiaries and even employed successful farmers (SID Bolivia 2005). Other projects in this case study made special efforts to train local NGOs and involve local farmers in the validation of new conservation methods.

Local participation in the design process of projects is a huge step towards ensuring that projects are carried out successfully. Participatory objective-setting in projects should be followed by participatory planning to ensure that the needs of the community are successfully translated into the assembly of a project that works in a specific environment. No two project sites are exactly the same, which means that involvement of locals in planning can help to customize project design to community needs.

Implementation:

After initial planning occurs, further success in watershed management is contingent upon involvement of locals in project implementation. One notable form of participatory implementation comes from the MARENASS project, which utilized a competition for irrigation efficiency. Through the competition, project coordinators found an irrigation method that was proven to work in the setting and brought the greatest efficiency of currently used techniques (Cleveringa et al. 2004).

A common thread in many programs is training workshops which are designed to pass specific management lessons on to beneficiaries. Permacultura Cayambe, for instance, included training of locals in permaculture as a component of the project (Mecham). MARENASS provides another example of such methodology as local leaders were trained to be experts in applying the winning irrigation technique (Cleveringa et al. 2004). Yet another worthwhile example is from the CIP project 'Making a Difference to Andean Livelihoods...' where farmers themselves would validate conservation methods and were sometimes responsible for diffusion of technologies at field days (Quiroz et al. 2002). In Bolivia, SID even employed farmers who successfully adopted conservation measures in order to further future growth of effects (SID 2005)

Another means by which beneficiaries are commonly integrated into project implementation is through assistance to local NGOs or farmers' associations. This assistance helps to take advantage of existing social capital in the region and shows a unity of efforts with others undertaking similar work. One notable example is Procesos y Productos, where project coordinators trained local NGOs to use Participatory Rural Appraisal and GIS (Ficenec 2003). Another example is from the PUCD project, where assistance was given to local governments and to attempts at formation of grassroots organizations (FAO 2008). Through such efforts, local groups are strengthened while outside interventions become connected to local conditions. The examples noted here represent only a very small portion of projects that support NGOs.

Follow-Up:

Long-term impacts of projects can be difficult to identify because analyses of projects are typically done soon after completion. This conventional approach gives a good view of project efforts and immediate results, but fails to capture the ability of project effects to stand the test of time. Following up five or ten years after a project's completion would allow project coordinators to see if changes in land and water use have been implemented permanently and if new practices have successfully spread from farmer to farmer.

No project reports utilized in this study specifically stated that follow-up visits were used to assess long-term effects. The project PROMUSTA, however, did implement a notable method of closing out a project. Project coordinators, in that case, ended the project once community members decided they were ready to continue on their own (Winters et al. 2004). This is a valuable strategy to mention because it allows the project timeline to proceed according to community needs rather than administrative needs (assuming that funds can be continued as requested). It is conceivable that continuing a project on the community's timeline allows a community the ideal balance of self sufficiency and assistance, thus increasing the chance that effects will be sustained over the long-term.

Role of Technical and Educational Components

Throughout the above examples, project coordinators utilize a variety of technical or educational interventions to affect the ways in which land and water are managed. It is essential that the components used for a given project match the needs of the beneficiaries. The PROMUSTA project also employed an effective strategy to ensure that technical interventions were in line

with localized needs. Their strategy was to customize assistance to each farmer through use of a menu of conservation practices and changes to the agricultural systems (Winters et al. 2004).

Project coordinators could benefit from ensuring that interventions are practical and match individual farmers' needs; however, it could also be difficult to specifically tailor to each specific set of needs in a watershed. Another possibility worth mentioning is that by customizing assistance, farmers could end up selecting interventions that do not significantly improve management of resources. While these possibilities are noted, customized assistance appears to carry with it the most promising chance of maintaining improvements to resource management.

The Interdisciplinary Nature of Watershed Management

One important consideration to the entire field of watershed management is the degree to which the study is interdisciplinary. For the sake of simplicity, the case studies of this report have been divided into categories. It is also important to realize that the importance of the categories is limited by the extent to which different objectives are mutually dependent. One example of such dependence is the discussion above regarding improvements to water quality due to soil management. While it is not possible to address every resource issue in a watershed, it is important to note that focusing on a limited scope of problems will produce limited results. A strong watershed management program takes an interdisciplinary approach, yielding insights from many different disciplines throughout the research process (Bruneau 2005).

The SANREM CRSP project, for instance, contains experts in many different fields among its principal investigators and represents a wide variety of project partners. Its primary objectives include improvements to production systems, increasing availability of off-farm opportunities, and building local capacity. Additionally, the project has an emphasis on protecting the biodiversity of the target province of Bolivar (SANREM CRSP 2008). The important point to take away is that many projects have objectives that match several of the above typologies, thus project goals reflect the reality that natural resource management is dependent on several management questions.

VII. Conclusions

Watershed management as a whole continues to be an important venue for the management of natural resources and the alleviation of poverty (Johnson et al. 2008). An important question that remains for the field of watershed management is 'how can water and land use decisions be affected so as to improve social, environmental, and economic conditions for users?' As time goes by, experiences in watershed management give more answers to this question, but there is always more to learn.

Another lesson learned increasingly over time is the value of stakeholder participation in interventions. The paper has discussed several means by which watershed management projects involve locals in their objective-setting, planning, implementation, and follow-up. Experience has shown that efforts to improve watershed conditions are met with higher levels of success when project managers ensure that the objectives match local needs and that stakeholders have a

voice in implementation. Also important to watershed management is selection of communities that are willing to participate in natural resource management.

Watershed management projects are abundant throughout Latin America and the rest of the developed world. In Latin America, such efforts are often decentralized and require cooperation between multiple organizations. The decentralization of efforts in the region makes it especially important to research past attempts at watershed management to ensure that lessons learned in other projects can be applied to new endeavors (Kerr and Chung 2001). This study is intended to provide a background upon which future watershed management projects can learn from past experiences. Due to its importance as a form of development aid and as an environmental intervention, watershed management requires coordination of resources and knowledge as new stories are continually added to the existing field of study.

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IX. Acknowledgments

This study was started through a summer research position with project SANREM CRSP (Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program). The SANREM CRSP project is sponsored by the United States Agency for International Development (USAID). I am grateful to Dr. Jeffrey Alwang for encouraging this research topic and for guiding the process. Dr. George Norton was also helpful in this process for advising the assembly of this Thesis.

The initial pivotal factor towards this topic was my participation in a six week summer 2007 internship to Ecuador. I am thankful to Dr. Norton and Dr. Alwang, as well as Dr. Darrell Bosch, for the opportunities the internship provided. Furthermore, I am indebted to the SANREM CRSP project for the assistance provided in the first internship, throughout this study, and in an upcoming summer 2009 internship to Ecuador. It is my hope that this Thesis will prove useful to the continuation of the SANREM project.

I would also like to thank all others who have positively influenced my time at Virginia Tech, particularly the professors in Agricultural and Applied Economics.