The 1999 SANREM Annual Report is dedicated to the memory of Robert D. Hart in remembrance of his contributions as Director of the SANREM CRSP.

Robert D. Hart

1946-1999

Choosing a Sustainable Future

SANREM CRSP
1999 Annual Report

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Choosing a Sustainable Future

This document describes the progress of the SANREM CRSP[1] for the period June 1, 1999 to May 31, 2000.

With a world population expected to hit 8 billion people by 2030, the demands for food and fiber will be unprecedented in our history. And those demands are growing in the face of continuing deterioration of the ecosystems that we depend on for survival.

Humanity's challenge in the coming decades is to pursue three goals simultaneously. First, we must produce enough food to keep up with the needs of rapidly growing populations without significantly increasing the amount of land under the plow. Second, economic opportunities must be available so poverty can be reduced. Poverty is not only a tragedy for the individual but contributes to environmental and political instability. Third, our natural resource use must be sustainable because depletion of natural resources affects our ability to address the first two goals now and in the future.

The three goals are interdependent. For example, good soil management has an impact on both agricultural production and the opportunity to maintain a livelihood.

Achieving the three goals will depend on our ability to make the best decisions for the long term and accept the trade-offs in the short term. And good decision-making is what the SANREM CRSP is all about.

SANREM's Approach

Through research, training and information exchange, SANREM aims to improve decision-making so that food production and land use are balanced with environmental conservation.

The SANREM program — funded by the U.S. Agency for International Development — was started in 1992. The program is a partnership of universities, research institutions, development organizations and rural communities around the world that have joined together to develop sustainable ways of using land and other natural resources.

SANREM works to improve natural resource decision-making at all levels through one global and three regional projects.

Some aspects of sustainable agriculture and natural resource management are site-specific. Regional projects in Southeast Asia, the Andes and West Africa focus on decision-makers at local to provincial levels – e.g. farmers, mayors, land use planners and others.

The three regional projects let us test out ideas, develop models and put sustainable practices in action. Each one deals with unique problems and can help develop ways to address problems in other parts of the world because the regional research sites are representative of the terrain, climate and problems that create decision-making issues throughout developing countries.

But local decisions are not the only ones that impact on an area. Decisions made at different levels in a country or even the world can impact on the ability of a local area to put sustainable practices into action. So SANREM, during its second phase (1998-2003), is developing tools and models to aid decision-makers at regional, national and even global levels through its Global Project.

SANREM's global and regional projects aim to provide natural resource decisions-makers with:

[1] SANREM CRSP is an abbreviation for the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program. SANREM is funded by the U.S. Agency for International Development and is managed by the University of Georgia.

(a) data and information, (b) tools and methods to use data and information, and (c) enhanced capacity of individuals and institutions to make decisions.

By thinking about environment and development issues hand-in-hand, we should find ways to meet basic human needs, improve standards of living for all, and protect and manage ecosystems for a safer more prosperous future.

Ultimately, sustainable resource use is based on decisions that nourish the environment, the community and the individual.

SANREM's Program Objectives

Three focused objectives contribute to SANREM's long-term goal, which is to improve decision-making by natural resource managers:

Objective 1. Landscape/Lifescape Decision Support
The first objective is to develop methods, tools, and institutional capacity that support sustainable agriculture and natural resource management policy design, issue analysis, planning, and implementation at the landscape/lifescape scale.

Objective 2. Regional Decision Support
The second objective is to develop methods for assisting decisions made at global, regional and national levels on broad issues related to sustainable agriculture and natural resources.

Objective 3. Technology Transfer
The third objective is to develop methods that facilitate exchange of natural resource management information and knowledge within and across multiple scales.

Global Project

Tools for Environmental Decision-Making

The Global Project, in part, ties together common threads that run through all the projects to support agriculture and natural resource management decision-makers who work at national, regional and global levels. To do this, the Global Project engages in three types of activities, all of which are geared to promote sustainable natural resource management:

- Activities that ensure participation of local people in decision-making (GLO 31: Assessment of decision-makers' priorities and decision-support opportunities);
- Activities that provide access to information for decision-making (GLO 11: Communications); and,
- Activities that develop methods and tools for decision-making (GLO 21-26: Global Decision Support System)

Ensuring Participation and Providing Information for Decision-Making

In the past, efforts to implement change in developing countries have failed when the directives for change came from the top. The failures are due in part because local people were not engaged in the decision-making process.

One activity of the global project emphasizes the need for a better understanding of the difficult natural resource management decisions being faced by a variety of decision-makers at various levels in the decision-making hierarchy, especially in settings where decentralization is in progress. From the local to regional level, the Assessment of Decision-Maker Priorities (ADMP) project is trying to find out what decision-makers identify as important issues and critical decisions related to natural resource management. At the same time, the ADMP is trying to discover what decision-makers need to make wise decisions — e.g., information, decision support tools, or training. The ADMP also aims to ensure that decision support activities respond to the real demands of decision-makers in settings where devolution of or shifts in power are in progress. This effort is being carried out collaboratively between the Global and Regional Projects in Mali, Ecuador and the Philippines.

SANREM is also providing information about sustainability issues to research and general audiences — and to SANREM and non-SANREM partners — through a variety of means. Through print media, publications such as newsletters, brochures, and reports document SANREM achievements. Through a Web site, anyone with Internet access will be able to learn about SANREM activities and research results. Information exchange is also facilitated through face-to-face and electronic conferences and workshops.

In terms of information exchange between SANREM and other institutions, a key SANREM accomplishment has been collaboration with the United Nations Food and Agriculture Organization. During the past year that collaboration, in partnership with the Government of the Netherlands (NL) and the International Institute for Sustainable Development (IISD) resulted in facilitation of an interactive Web Forum for the FAO/NL Conference on the Multifunctional Character of Agriculture and Land and a face-to-face conference. Additionally, SANREM has coordinated study tours for a Senegalese community-based natural resource management project and a USAID mission-supported team of Ethiopian researchers. SANREM has visited with both the Soils CRSP and made visits to the BASIS CRSP to discuss opportunities for collaboration.

Integrating Environment and Development in Decision-Making

A suite of computer models called the Global Decision Support System (GDSS) is being developed by Texas A&M scientists to help developing countries predict how changes in technology or policy effect food availability, agriculture and natural resource use.

In part, GDSS can be thought of as a high-tech equivalent of the map. GDSS uses computer-based technology to capture, store, analyze and display information about places on the earth's surface: What's on it? Where are the natural resources? What crops are grown? Where are the roads? Where are the markets?

Using geography as a common denominator, GDSS ties data from many different sources together —cultural, economic, environmental, demographic and political information. But the power of this high-tech map lies in the ability to analyze the data and determine how different kinds of data impact on each other. The models will allow a manager — for example a policymaker or government leader — to ask questions and test different options before implementing a new practice. How will decreased rainfall affect crop production and prices? How would new soil erosion practices affect crop yields? How would building a road effect marketing grains? Which regions are best for sorghum production and which for dairies? The idea is that foreknowledge of a decision's impact should lead to better decision-making at national, regional and even global levels.

So far, GDSS is proving useful for assessing the status of agriculture and natural resources in East and West Africa. Preliminary runs with the agricultural sector model for Mali, for example, are providing projections for the status of food security in the year 2015 with current practices and various options for intervention. GDSS has been used to identify regions in Kenya that are suitable for development of small-holder dairy operations.

Philippines

Integrated Planning and Management of Land Resources

SANREM research began in the Philippines seven years ago – a region characterized by rapid economic growth where global and regional markets influence the natural resource management options. But also, it is a nation where decision-making powers previously exercised by the central government are being transferred to local communities. Because of decentralization, communities are experiencing the challenge of making natural resource decisions locally for the first time. The SANREM Southeast Asia Project in the Philippines aims to assist local and provincial government at the community and watershed scale in the creation and successful implementation of decision-support tools for natural resource management, planning and policy analysis.

The research site is located in the Manupali watershed on the island of Mindanao. Among the key problems affecting the region are deforestation, declining soil fertility and crop yields,biodiversity loss and increasing erosion.

The SANREM Southeast Asia project offers outreach and policy support to communities based on collection and analysis of environmental, social and economic data. Agroforestry techniques are being tested and introduced to reduce erosion in hillside agriculture, diversify small farms and create buffer zones to prevent encroachment of agriculture on protected areas. Citizens have been engaged in water quality monitoring in the Manupali watershed for more than seven years now and have taken action to improve water quality as a result. Significant advances have been made in construction of analytical models, revision of data and scientific findings, presentation of results in local, national and international fora and print outlets, local and regional coordination and collaboration on research and information exchange, local capability building, and replication of site-based findings and methods to similar Northern Mindanao sites. The project's success has led to in-depth collaboration with related institutions and similar projects elsewhere in the Philippines and in Southeast Asia.

Ecuador

Managing Fragile Ecosystems: Sustainable Mountain Development

SANREM's Andes Project conducts research to understand the principles underlying sustainability issues in mountain watersheds and landscapes. The focus is on bridging the gap between scientific data about environmental problems and the perceptions of local people about the problems.

Studies are conducted at two mountain sites in Ecuador – Nanegal and Cotacachi. SANREM Andes researchers at these sites are examining the impact of population change in mountain areas, ecological consequences of land use changes, and comparative ethnoecology of a fragile ecosystem. Historical changes in land use are being tracked to enable scientists to make predictions about future land use. Traditional agricultural methods are being recorded, since those methods have been sustainable over long periods of time and knowledge of them is being lost. Water resource management and education activities have also been initiated.

Other researchers are studying social capital in the region in order to ensure that the organizations in place will have the skills and strength to implement

plans the community develops. Natural resource decision-making can be understood by examining relationships among three institutional sectors: market, state, and civil society. Appropriately balanced and linked, these sectors can reinforce one another and promote sustainable development. A healthy civil society generates both bridging and bonding social capital, generating opportunities to conserve and enhance natural capital.

By combining results from these activities, SANREM aims to help define the future the community wants and then implement changes needed to achieve that desired future.

Mali

Managing Fragile Ecosystems: Combating Desertification and Drought

West Africa is a unique arid and semi-arid region of the world characterized by a fascinating blend of cultural, socioeconomic and biophysical features. The complex interactions of people, crops and animals affect natural resource management in virtually every community within this vast region. Because nomadic and sedentary agropastoral peoples compete for the same natural resources, the potential for conflict always exits.

Presently, increasing human population pressure and poverty, newly evolving social organizations, and increasing variability in weather and climate are further complicating what has historically been a delicate, though sustainable, balance among natural resource users in the region. In areas where viable community-based natural resource management approaches are evolving, accelerated environmental degradation and greater competition for natural resources are being counterbalanced. Nevertheless, the situation remains tenuous. It is essential that natural resource management institutions and strategies be adapted and diffused to concerned stakeholders throughout the region. This will assist not only in improving natural resource management within the region but also in providing information on conflict avoidance techniques.

The SANREM West Africa project is supporting natural resource management (NRM) decision-makers at multiple scales with appropriate data, tools and methods for analysis and capacity building to make informed decisions concerning conflict and NRM problems associated with the agricultural and pastoral systems of West Africa. SANREM West Africa is addressing the issues of growing food insecurity, continued degradation of the natural resource base and increasing potential for conflict induced by these interdependent factors. In order to do so, the SANREM West Africa project offers an integrated package of activities designed to further our knowledge of Sahelian Landscape/Lifescape dynamics and to apply that knowledge in assisting local and national scale decision-makers to improve their management of the natural resource base.

The key activity has been the establishment of the Natural Resource Management Advisory Committee (NRMAC) in the Commune of Madiama as a forum for local discussion, analysis, and development of ways to prevent conflict over natural resources. Training in Holistic Resource Management (HRM) and consensus building has been completed for local leaders and technical assistance providers. In addition, natural resource and conflict management practices are being tested and demonstrated. The development and support of the NRMAC will be critical of the successful implementation of new practices and plans to ensure food security and natural resource conservation in the area.

SANREM Southeast Asia
Project Overview

SANREM-Southeast Asia is managed by the University of Wisconsin-Madison and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD). Its institutional partners are the Municipality of Lantapan, the Province of Bukidnon, Tigbantay Wahig Inc., the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), the University of the Philippines at Los Baños; Central Mindanao University, the International Institute for Rural Reconstruction, Heifer Project International, Auburn University, Purdue University, Central Queensland University, and the International Center for Research in Agroforestry. The cooperation of the people of Lantapan municipality, Bukidnon, Philippines is an essential feature of the project.

Introduction

The primary objective of SANREM-Southeast Asia is to assist in the creation and successful implementation of decision-support tools for natural resource management (NRM) and planning at community and watershed scales. By decision support tools we mean research findings, models and methods that enable us to identify and answer questions that link economic and social development goals with long-term viability of the environmental and natural resource base.

Since successful implementation of NRM tools in a specific locality depends on conditions in broader economic, political, and policy contexts, an important component of our strategy is to engage in information exchange and capacity-building, both locally and among national and international research and policy institutions. We also promote collaboration among researchers and between researchers and natural resource managers at all levels, to ensure that output is rigorous, relevant and accessible.

The primary geographic scope of SANREM-SEA includes the Municipality of Lantapan, our Philippine research site, as well as similar areas in the Philippines and elsewhere in Southeast Asia. Similarities are defined by geographical contiguity, but also through common experiences that shape the direction of natural resource use and the logic of local NRM strategies. These experiences include rapid economic growth, growth of market opportunities for upland farmers, and above all, devolution of powers from central to local government.

Project Objectives

- Develop methods, tools, and institutional capacity to support sustainable agriculture & NRM policy, planning and implementation at the landscape scale.
- Develop methods for assisting decisions made at global, regional and national levels on broader issues related to sustainable agriculture and NRM.
- Develop methods to facilitate exchange of NRM information and knowledge within and across multiple scales.

Progress Towards Five-Year Indicators

In Year 2 (1999-2000), the project made progress toward all 12 five-year indicators. The following are selected highlights; individual indicators are grouped for convenience and brevity.

1. Watershed model designed and constructed for generating information and policy analysis at community level for local and provincial government.

2. Integrated economic-environmental policy models applied at a landscape scale for local and provincial government and non-government organizations. Computer-based simulation model to answer questions regarding potential impacts of policy changes on upland land use practices and outcomes has been completed and is currently being used by researchers at the University of the Philippines and planners at the Bukidnon Provincial Planning and Development Office.

3. Strengthened capacity for local and provincial analysis of NRM challenges and opportunities, policy design and implementation strategies. Activities have included computer model application, training of NRM trainers, water resource management, agroforestry management, and policy analysis for a broad range of participants: researchers, provincial and municipal government staff, non-government organizations, people's organizations and farmers.

4. Strengthened capacity among local institutes and NGOs to continue training and provision of skilled inputs after the end of direct SANREM support. Substantial progress on capacity building with Central Mindanao University and community-based organizations in Year 3.

5. Documentation of research and applications through the usual channels for the scientific and policy-making community.

6. Case studies developed outlining the experience of local NRM in decentralizing economic and political systems for government, NGOs, and the scientific and development community.

7. Documented regional cross-fertilization through sharing of methodologies, strategies, and research findings for researchers and local and provincial governments.

8. Exportable methodological lessons based on our earlier Philippine work for researchers, local, provincial, and national government and NGOs.

Publication of research results in scientific journals; presentations at national and international conferences and workshops. We gave priority to popularizing research information and case studies, locally through co-organization of and presentations at the Bukidnon Watershed Summit; nationally through submissions to the Philippine Council on Sustainable Development and the House of Representatives' Watershed Enhancement Program and input to the development of the National Watershed Management Strategy. Phase I monograph scheduled for publication in fall 2000. At the regional level, we organized two international workshops for regional information exchange and collaboration: one on devolution and local NRM (Chiangmai, Thailand), and another on sustainable NRM issues in the Philippines and Vietnam (HCM City, Vietnam). Replication of the water monitoring activity is now occurring at several locations with training and support from the Lantapan-based Tigbantay Wahig NGO.

9. Progress identified toward establishment of NRM planning processes and strategies in 5-6 other municipalities in Northern Mindanao (based on targeted training and cross-site visits; ultimately leading to local formulation and adoption of NRM strategies by selected municipalities.

Analysis of Lantapan NRM planning process conducted, and collaboration established with organizations spanning the Mt. Kitanglad area municipalities (specifically the League of Mayors and the Protected Areas Management Board) for the purpose of replicating the Lantapan process.

10. Progress established toward mutually supportive institutional arrangements with USAID-funded local development projects.

Cooperation with GOLD and GEM continued through attendance by GOLD-GEM staff at SANREM planning meetings, SANREM-sponsored events such as the Bukidnon Watershed Summit and cross-site visits.

11. Transferable lessons distilled for the design of sustainable development strategies for use by the research, and development community.

12. Relationships established among researchers engaged in landscape-based NRM across Southeast Asia.

We have expanded our network of partners in Philippine projects, NGOs, and GOs working in NRM. We hosted numerous site visits and several training requests, and made project presentations made at key national agencies. Other accomplishments as already noted.

13. Progress indicated toward establishment of an integrated approach to NRM as a component in policy analysis and planning.

Benefits to the U.S.

Decision support tools for policy planning as well as participatory NRM planning processes being developed by SANREM–SEA would be most useful to U.S.-based researchers, conducting NRM and policy research in areas with economic/environmental conditions similar to SEA. Efforts have been made to share this knowledge within professional organizations and in university colloquia. SANREM-SEA participated in a BIFAD session on NGO-University research partnership and the inter-CRSP technology assessment activity in Ethiopia.

Year Two Impacts

Our most significant impact is in developing awareness of and action towards challenges and opportunities in promoting sustainable NRM. Ours is a project that offers options to farm households for better land management strategies and decision support tools to various types of decision makers, in particular those involved both locally and nationally in designing legislation that directly affects management of the natural resource base. Multifaceted capacity building activities, development of decision support tools, technical facilitation, and institutionalization comprise the main components of the research-policy link. At the local level, this link is expressed by the policymakers' request for technical assistance in NRM planning and policy analysis. Policymakers, who also happen to be natural resource managers, have come to realize that sustainable NRM is integral to any municipality's economic, social, and political development. What is evident in our strategy in the Manupali watershed and beyond is that SANREM-SEA does not provide uniform solutions or recommendations to policymakers. Instead, we assist in providing a learning experience for decision makers to develop their own solutions by ensuring the availability of locally adapted decision support tools and planning processes.

SEA 99-22. Weather Monitoring Using Automatic Weather Stations

The SANREM-Southeast Asia (SEA) project provides decision-making support to natural resource managers in the Philippines. The weather monitoring activity is designed to gather weather data in the Lantapan watershed in order to provide a sound meteorological description of the landscape. SANREM scientists and local governments will use this information in their modeling and tool design activities geared to promote sustainable agriculture. Weather elements are monitored through the automatic weather stations (AWS) installed in the watershed wherein changes in the weather are easily detected and disseminated. For Phase 2 Year 2, annual and monthly rainfalls were recorded. Eight wet months were recorded as compared to Year 1's three. Data of rainfall intensity, air and soil temperatures, relative humidity, and solar radiation were recorded, analyzed, and compared against Year 1 recordings.

SEA 99-23. Environmental Management Planning and Development Policy Analysis using a Watershed-Community Model in Lantapan, Bukidnon, Philippines

The goal of this activity is to engage in integrated natural resources planning and development of policy analysis for the municipality of Lantapan. It combines research directed at learning about the economic and policy setting for environmental management in Lantapan with the development and implementation of measures for sustainable development. Several accomplishments were achieved this year. They include capacity building activities, identification of policy instruments, selection of policy issues to be addressed, and communications with local government units. Drafts of the Comprehensive Land Use Plan were presented to several local level legislative bodies in Lantapan. Several papers were written and presentations made. Data collection has continued.

SEA 99-24. Integrated Watershed Modeling for Decision Support and Policy Planning

This goal of the Integrated Watershed Modeling activity is to integrate a set of biophysical and economic findings from research in the Lantapan watershed, the Philippines in order to create a computer-based decision-support tool for natural resource management and planning. Accomplishments from the past year include the following. A computer-based environment-economy model for policy research and planning is being developed which is specifically focused on watershed planning. During the second year of Phase II, this activity's research focused on using the model to study potential policy changes at the national, provincial, and local levels, and their impacts on land use patterns and economic as well as environmental outcomes. Strategies and data required to transfer the model to other settings in Southeast Asia are also being investigated. Year 2 activities culminated in a training workshop for potential users in Los Baños and release of a computer-based model and written documentation to work plan partners in the Philippines. Results of the research to date include: heightened knowledge regarding linkages between economic policies, land use changes in upland agriculture, and economic and environmental impacts at the watershed scale; identification of potential barriers and constraints to policy-induced changes in land use practices in upland agriculture; and the development of a computer-based simulation model that can be used by host country scientists and government leaders. The model can be used to answer questions regarding potential impacts of policy changes on land use practices and outcomes in upland agriculture. The scaling up of lessons learned in Lantapan to other sites in Southeast Asia was also accelerated.

SEA 99-25. Water Resources Management and Education

The goal of the Water Resources Management and Education activity is to promote the development and spread of community-based water quality and quantity monitoring in Lantapan, Bukidnon, the Philippines and in Southeast Asia as a significant component of natural resource management and planning. In the past year, activities primarily addressed a continuation of seven years of water quality monitoring by the Tigbantay Wahig, Inc. citizen group of Lantapan, Bukidnon. A total of 537 physico-chemical and bacteriological samples were collected as proposed. All data have been summarized. The majority of data have been graphed and presented to the Lantapan community, the local government unit and the scientific community. Impacts of this activity included: 1) increased organization and capacity of the Tigbantay Wahig, Inc.; 2) greater participation of the Tigbantay Wahig in the local government's NRM planning; 3) extension of the SANREM Landscape/Lifescape approach within other Local Government Units (LGUs), Heifer Project International (HPI) and other non-governmental organizations (NGOs); and 4) increased capacity and assistance to Central Mindanao University as well as other universities in the Philippines. Work plan presentations were made at the SANREM Conference in Chaing Mai, Thailand, the Bukidnon Watershed Summit and the Watershed Enhancement Program at the Philippine House of Representatives in Quezon City. There is a high potential for spread of the

community-based water-monitoring model within the Philippines and to other countries.

SEA 99-26. Bioeconomic Modeling of Changes to Traditional Vegetable Production Practices in the Manupali Watershed and Extensions to Other Southeast Asian Watersheds

The goal of this activity is to measure and model the impact of change in vegetable production strategies on income generation and resource use in Southeast Asia. In particular, this activity seeks to determine whether full and/or partial conversion of vegetable farms to Agroforestry will lead to sustainable use of soil and water resources and satisfy the income demand of upland farming families. Accomplishments during the past year include the following. Field experiments and data analyses continued in 1999/2000, with outputs in the form of various publications, additions to the site database, and information relevant to bio-economic modeling for the watershed.

SEA 99-32. Adapting and Transferring Lessons Learned from the Manupali Watershed to Other Critical Watersheds in Southeast Asia

The goal of this activity is to provide a mechanism for adapting and transferring natural resource management techniques learned from SANREM work in the Manupali watershed of the Philippines to other critical watersheds in Southeast Asia (i.e. the Lao PDR, Vietnam and Thailand). Several accomplishments were made during Year 2. They include the following. Principal investigators identified Vietnam as the site for testing and adapting SANREM-Southeast Asia decision support tools and processes. After a series of consultations and a workshop, the team agreed on a participatory action research framework (PAR) that aims to explore the consequences of coffee expansion in the Vietnamese uplands. Workshop participants redefined the research questions and methodology. Using some of the tools from the SANREM portfolio, the work plan will center on three main hypotheses. One, that increasing commercialization and changing access to and control over resources influence the land use decisions of farming households, community and higher policy making bodies. Two, change in environmental quality influence farmers' and policy makers' land management decisions. Three, change in resource tenure induced by commercialization influence land management decisions. Major activities include a case analysis of existing agricultural systems using a PLLA/PRA approach (Participatory Landscape Lifescape Appraisal/Participatory Rural Appraisal), conduct of validation workshops with stakeholders, and a policy meeting-workshop to present and discuss implications of the findings.

SEA 34. Replicating Models of Institutional Innovation for Devolved, Participatory Watershed Management

The goal of the Replicating Models project is to provide tools for decision-makers and stakeholders to better integrate environmental knowledge with technical and institutional innovations to enhance the management of natural resources at the local government level. There is an increased use of participatory, devolved and demand-driven approaches to watershed management in response to the growing realization that people and their institutions play vital roles in managing resources effectively. The need for research to evaluate the performance of this approach and analyze cases where these approaches have been tested, identify important constraints, and isolate criteria and indicators of impact is being undertaken by the SANREM-Southeast Asia project. A successful example of this approach has been the SANREM-initiated municipal-led natural resource management planning as undertaken in Lantapan, the Philippines. This model will be tested for replication at other locations.

A replication process for this model has been initiated within the seven municipalities surrounding the Mt. Kitanglad Range National Park (MKRNP) in Bukidnon, the Philippines. Priority focus has been given to analyzing the planning processes as adopted by the Local Government Unit (LGU) of Lantapan in developing the NRM plan. Surveys and a self-assessment workshop were conducted. A working team at the local level was organized as a pool of resource persons and advocates to act during the replication activities in the other sites. This was related to the objective of implementing an LGU-to-LGU model of sharing information and experiences. New linkages were set up with the Integrated Protected Area Management of Mt. Kitanglad through the Protected Area Management Board (PAMB). This new local NRM model has been replicated where a new Preventive Systems Approach to protected areas has evolved. Key factors affecting local NRM and their policy implications at the local and national level have also been identified and analyzed.

SEA 99-42. Capability Building for Natural Resource Management at the Local Level

The goal of the Capacity Building activity is to develop the human resources capability in natural resources management and planning for local institutions, community leaders, educators, local planners and professionals involved in the use and management of the Manupali Watershed, in the Philippines. Based on the results of the training needs analysis (TNA) conducted in Year 1, "Training of Trainers for Natural Resources Management" and a "Training-

Workshop on Natural Resources Management and Sustainable Land Use Planning" were conducted in October 1999. Action plans for future activities were formulated during this period. Central Mindanao University (CMU) was tasked with the monitoring of the progress of the Local Government Units (LGUs) of Valencia and Lantapan in Bukidnon. Another capacity building activity on environmental modeling was conducted to complement this activity's thrust. This was made possible with the collaboration of the team working on the modeling work plan and the Southeast Asia Center for Graduate Studies (SEARCA/NRMP).

SEA 99-44. Technical and Institutional Innovations to Evolve Agroforestry Systems for Sustainable Agriculture and the Management of Protected Ecosystems in the Framework of a Watershed Model

This project aims to broaden and deepen researchers' knowledge base on effective and cost-efficient technical innovations and farmer-driven Landcare approaches for fostering, expanding, and sustaining smallholder participation in and adoption of conservation farming in upland watersheds. An additional objective of this activity is to build and nurture an enabling environment for the establishment, development and management of smallholder tree-based production systems as viable enterprises, and as a vehicle for the reforestation of deforested upper watersheds. The Landcare Approach is central to SANREM's Southeast Asia research and extension approaches and methodologies for the expansion and enhancement of adoption of agroforestry technologies. Initial results from SANREM's ongoing research informs current strategies for sustaining smallholder participation in and the adoption of conservation farming practices. Current on-farm experiments report promising results towards broadening species diversity across the landscape. Significant impacts include: (1) widespread adoption of agroforestry tree species; (2) strengthening grassroots capacity to promote smallholder tree-based production systems through farmer-to-farmer training and information dissemination; and (3) heightened environmental awareness through multi-stakeholder consultations and information exchange.

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Environmental Management Planning and Development Policy Analysis Using a Watershed-Community Model in Lantapan, Philippines

Introduction

The goal of this activity is to engage in integrated natural resources planning and development policy analysis for the municipality of Lantapan. Research directed at learning about the economic and policy setting of environmental management in Lantapan is combined with the development and implementation of measures for sustainable development.

Biophysical and economic findings from previous research in the Upper Manupali watershed will be integrated in order to create decision-support tools for natural resource management and planning at both a community and a watershed scale. While other SANREM-Southeast Asia research activities aim to provide data and analytical tools such as models, this activity is the primary vehicle for implementation of policy analysis and environmental planning exercises for the benefit of the community. This work supports the Lantapan Natural Resource Management and Development Plan, a plan developed in accordance with the mandate of the Philippine Local Government Code of 1991 during SANREM Phase I (1992-1997).

As mandated by the National Government, a comprehensive Land Use Plan was conceived to support the implementation of the Natural Resources Management and Development Plan (NRMDP) of the Municipality of Lantapan. This is envisioned as a tool in actualizing and concretizing the objectives of SANREM-SEA Phase II (1998-2003).

Objectives

- Improved capacity for local-level policy analysis in the context of natural resources management and economic development.
- Analysis of current policy issues and instruments relating to natural resources management, as inputs to community-level debate.
- Documentation of results and evaluation of progress, for the purpose of institutionalizing processes and methodologies and generating usable insights for other municipal units.

Methods or Approach

A specific goal of this project is to support integrated economic development and environmental management policy formation in Lantapan both at the barangay and municipal level. This is intended to occur mainly, although not exclusively, through the development and application of the Lantapan NRM Development Plan as a long-term planning tool for the municipality.

The another goal of this activity is to demonstrate the value of this approach to other municipalities and localities. This is in keeping with the emphasis in SANREM Phase II (1998-2003) of extending lessons learned in the upper Manupali watershed to upland watersheds elsewhere in the Philippines and Southeast Asia.

The research activity that feeds into this planning process makes use of a wide variety of data and methods, including the watershed model that incorporates and integrates information gathered in previous and ongoing SANREM-sponsored research. At the same time, other methods are used for the development and implementation of the NRMDP itself, including the preparation of land use and other thematic maps and the study of national-level requirements for the preparation of

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municipal land use plans. The policy support activity thus takes an integrative approach to environmental assessment and planning, both in terms of the tools that it uses, and in its integration of research with development policy at the municipal level. This also requires significant local level investments in analytical capacity.

Results and Discussion

In preparation for the use of the model as a tool for policy analysis we engaged in capacity building among members of the LGU NRMDP team; identification of relevant policy instruments at the disposal of the LGU or provincial government; selection of policy issues to be addressed; and communications with other local government units for the twin purposes of acquiring information on NRM processes and of sharing the results of our own work.

Research in support of policy measures for the NRMDP produced several scholarly papers as well as presentations to local and international audiences in Year 2. Data-gathering continued in the areas of land use and price monitoring, and a new research activity examining the introduction of large-scale agribusiness ventures to the watershed was begun.

Drafts of the municipal Comprehensive Land Use Plan were presented to the Municipal Technical Working Group, Technical Advisory Group, Sangguniang Bayan and the 14 barangay council representatives. Mapping and sectoral studies based on thematic maps was undertaken and used for community-level consultations. A number of environment-related ordinances were developed and passed, governing garbage disposal, livestock concentrations and movements across the watershed, the transport of potato seed, and adoption of contour farming on sloping lands. Another ordinance, banning aerial pesticide spraying, was introduced but has not yet been passed. The question of water rights pricing, which is becoming pressing with the arrival of commercial banana-growing ventures, became the focus of attention at a legislative level.

Impacts

Major local impacts of this activity include the formulation and passing of environmental ordinances and the use of the integrated NRMDP as a framework for policy analysis, planning, and community-level discussions. This relatively formal integration of local development planning and environmental concerns is a huge step forward from the ad hoc approaches to policy-making and implementation that preceded the NRMDP.

In the municipal legislature, water policy, land use policy and policies on several other environmental issues including aerial spraying are now subject to community-wide input, discussion, and lobbying.

At the national and international level, the publication and dissemination of research results is attracting interest in SANREM's work from the scientific community. This resulted in an invitation to present a paper on SANREM work at the Allied Social Science Association meetings in Boston, January 2000.

Publications and Presentations

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Integrated Watershed Modeling for Decision Support and Policy Planning

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Introduction

Watershed protection is an important economic and environmental policy concern throughout Southeast Asia (APO, 1995; Doolette and Magrath, 1990). This research work plan is predicated on the belief that an integrated economy-environment model can be a useful supplemental tool for policy planning directed at watershed planning. The model used for this activity is described in Shively (2000) and was demonstrated in seminars during February 1999 conducted at PCARRD, DA-BAR, GOLD, and the municipality of Lantapan. In February 2000 the model was disseminated to work plan partners in Los Baños. The model is intended to facilitate the integration of natural resources research in several disciplines in a consistent manner. By necessity the model relies on a simplified view of a watershed economy and is designed as a heuristic tool. To maintain tractability the model focuses on a narrowly defined set of linkages that connect economic signals (such as commodity and input prices) to cropping decisions made by representative farmers, and the economic and environmental outcomes (such as erosion, sedimentation, nutrient and pesticide loadings) implied by these land use patterns.

Objectives

- Evaluate and measure the potential economic and environmental impacts of changes in economic policy variables and corresponding changes in land use in a prototype watershed economy.
- Assess potential transferability of the computer modeling strategy to other sites in the Philippines and elsewhere in Southeast Asia.

Methods or Approach

This work focuses on using research results generated by SANREM researchers during Phase 1 to develop and implement a computer-based economy-environment model to be used for policy research and planning. Initial steps to develop the model were undertaken in Phase 2 year 1. During year 2 substantial efforts were placed on improving the structure of the model and incorporating empirical research findings from other work plans. The model is constructed using Stella and Excel and is designed to run on a Windows PC platform. Current research focuses on using the model to study potential policy changes at the national, provincial, and local levels, and their impacts on land use patterns and economic and environmental outcomes. Strategies and data required to transfer the model to other settings in SE Asia are also being investigated.

Results and Discussion

For objective 1: Improved knowledge regarding linkages between economic policies, land use changes in upland agriculture, and economic and environmental impacts at the watershed scale. Significant aspects of the modeling in year 2 include the addition of nitrogen and pesticide loadings in the model, the incorporation of a pest population model that affects vegetable production, refinement of household and zone weights based on GIS and survey data. In addition, the model was successfully linked to the widely used biophysical model SCUAF to model a range of biophysical phenomena. A separate detailed model of carbon sequestration was developed in Stella for testing and possible incorporation in subsequent versions of the watershed model.

A computer-based simulation model that can be used by host country scientists and government leaders to answer questions regarding potential impacts of policy changes on land use practices and

outcomes in upland agriculture. Year 2 activities culminated in a training workshop for potential users, held at the School for Environmental Studies and Management (SESAM) at UPLB and accompanying the release of a computer-based model and written documentation to work plan partners in the Philippines. A total of nine people participated in the workshop, which provided "hands on" introductory training in dynamic modeling. Participants included representatives from PCARRD, the Bukidnon PPDO, SEARCA and four academic departments at UPLB. The model and a "user's guide" were disseminated to work plan partners and the research community in Los Baños. The model was installed on four computers in the SESAM computer center, one computer in the College of Public Affairs, one computer at SEARCA, and on one computer used by the Bukidnon PPDO.

For objective 2: Accelerated scaling up of lessons learned in Lantapan to other sites in SE Asia. Concept papers have been disseminated, and the prototype model was presented to community leaders in Lantapan in 1999, and to key government contacts at the provincial and national levels during February 1999. It was also presented at the ICRAF workshop in Chiang Mai, Thailand (May-June 1999). Two Vietnamese students from UPLB Agricultural Economics have been identified as potential work plan partners in the event calibration of the model to a watershed in Vietnam becomes likely.

Impacts

The modeling work is having an impact on local and provincial governments in the Philippines by improving understanding of the role of economic policies in encouraging sustainable use of upland agricultural resources. The model is being used in the office of the Provincial Planning and Development Officer of Bukidnon province. Two PPDO staff members were trained in the use of the model in March 2000. In this way the capacity of the PPDO for policy analysis, planning and decision support is being strengthened at local and provincial levels.

Preliminary steps have been taken to identify a range of possible policy changes for use in policy simulations. In support of the provincial effort, the model is currently being used by two graduate students at UPLB as part of their thesis work. One student is modifying the model to account for smallholder and plantation banana production. The other student is modifying the model to account for policy impacts on carbon storage in agroforestry systems. In both cases, it is expected that efforts will result in research output that will assist local as well as national policymakers.

Publications and Presentations

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Water Resources Management and Education

Introduction

A watershed's vitality is clearly reflected in the water quality of its rivers and streams. Human impact on a watershed can be detected as changes in water quality, e.g. nutrient content, oxygen levels, sediment concentration or bacterial counts. For example, high levels of sediment are present when soil erosion control is poor, high numbers of coliform bacteria show up when sewage is not properly contained, and excessive nutrient levels that kill desirable wildlife occurs with certain agricultural activities in a watershed.

Monitoring water quality can alert land managers to threats to watershed health and help them develop and implement appropriate practices. Experience has demonstrated that when citizens are included in water quality monitoring activities, overall stewardship of the watershed improves. In fact, marked improvements in water quality have been documented for a number of river basins when public pressure for action is strong.

Water Resource Management and Education activities were first implemented at the SANREM-Philippines site in Lantapan, Bukidnon in 1993. They were designed, in part, to train and equip local community members of the Manupali River watershed so they can monitor various physical, chemical and biological parameters of surface and drinking water quality across the landscape.

Citizens were trained in water quality monitoring methods at a workshop in July 1994. This was followed by scores of workshops, meetings, and the establishment of a citizen monitoring group called Tigbantay Wahig, which means "Water Watchers." Tigbantay Wahig, which has conducted systematic water quality monitoring throughout the municipality for more than seven years now, is the primary data collector for this activity. Oversight for water quality monitoring is provided by a Heiffer Project International (HPI) Field Office. Quality assurance is provided by HPI-Philippines and Auburn University.

Objectives

The goal of this activity is to promote the development and spread of community-based water quality and quantity monitoring in Lantapan, Bukidnon, Philippines and in Southeast Asia as a significant component of natural resource management and planning. Specific objectives for 1999-2000 were:

- To support the growth and capability of the Tigbantay Wahig as a viable and sustainable people's organization in Lantapan, and extend community-based water quality monitoring to other parts of Mindanao (including Sarangani Province)
- To collect water quality and quantity data for addition to a six-year database. This information will be useful for local water management and as a model for other communities;
- To organize the water database for use in watershed models to be developed by the SANREM Southeast Asia Program; and
- To conduct a feasibility study for the extension of the Lantapan model of community-based water monitoring through an NGO network in Southeast Asia.

Methods or Approach

The participatory research approaches employed in this activity were modeled after the Alabama Water Watch, a citizen volunteer, water quality monitoring program in the United States. Filipino partners who were educators and community developers helped customize the workshops to the local situation in the Philippines. Training workshops in water quality monitoring and data interpretation are an important part of this activity.

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Four research methods are used in the field to determine stream health and detect soil erosion from land that drains into the streams. Concurrent Total Suspended Solids and stream discharge measurements result in practical and valuable estimates of soil export. Water chemistry and bacteriological surveys are indicators of water quality.

1. *Total Suspended Solids* (TSS) are measured by passing a known volume (usually one liter) of stream water through a plastic filtering system using a hand pump. The filters are weighed before and after sampling according to standard methods in order to determine the amount of TSS. The TSS data are one indicator of soil erosion and sedimentation. Three hundred sixty-six (366) Total Suspended Solids (TSS) samples were collected from four rivers.

2. *Water Chemistry*: Seven parameters (dissolved oxygen, turbidity, pH, hardness, alkalinity, air temperature, water temperature) are measured with a customized LaMotte Company test kit. Forty-eight (48) samples were collected from four rivers.

3. *Stream Velocity and Discharge Measurements*: Measurements of stream width and depth at the main bridges in Lantapan were used to draft cross-sectional maps of the four streams under study and to calculate the cross-sectional area of each stream. Average current velocity was determined by taking multiple measurements of the time required for an object to float a known distance in different parts of the stream. Together, the cross-sectional area of the stream (square meters) and its current velocity (meters per second) are used to estimate stream discharge (cubic meters per second). Forty-eight (48) samples were collected from four area rivers.

4. *Bacteriological Survey of the Lantapan community:* Water samples were collected from surface water (18 samples), drinking water (18 samples) and households (39 samples). Each one-milliliter sample of water was collected using a sterile, plastic pipette and squirted into a 10 mL bottle of sterile, liquid medium. The medium containing the water sample was poured onto a sterile plastic dish designed to induce the liquid to solidify. Incubation of sample plates at ambient tropical temperature is usually sufficient to grow the bacterial colonies for enumeration in about 36 hours, although a heat source is recommended to maintain temperatures of 35-37C. Following the incubation period, bacterial colonies of *E. coli* and other coliforms are enumerated.

Results and Discussion

Training: Dr. Bill Deutsch conducted training workshops and sessions on data interpretation in the Philippines. (May 1999; March 2000)

A workshop entitled *Cornerstone Value-Based Planning and Management Training* was conducted in Lantapan, Bukidnon by Mr. Jim Orprecio and Ms. Janeth Bago Labis. Five officers of the Tigbantay Wahig group participated in the training. (August 11-12, 1999)

A workshop entitled *Aquaculture Management Training and Exposure* was conducted by Prof. Danilo Vicente, Dean of the Aquaculture Department of Mindanao State University, and Mr. Eugene Vicente (Aquaculture Technician). Twenty-six Tigbantay Wahig members attended the training. (August 23-24, 1999)

Significant Findings: The water quality and quantity information gathered in 1999 to 2000 is an important component of documenting trends in the four major sub-watersheds of the Manupali River in Lantapan. The data record now includes a continuous quantification of water conditions before, during and after the El Niño drought and subsequent La Niña wet period. This may be the most complete information on the El Niño-induced weather pattern collected by a community group in Asia or the world. It fundamentally documents that sub-watersheds with substantial forest cover have much more stable and higher quality stream flow than do the deforested sub-watersheds. This is generally true in normal climate cycles and is especially true with unusual patterns like El Niño. The largely deforested Kulasihan River sub-watershed had no flow for six months during the drought and has subsequently flooded during July 1997-99 with devastating results (lost crops, land, structures and human lives). Continued monitoring of these streams is now establishing the environmental impacts of settlement and land use patterns in the municipality, particular in the more pristine, upper watersheds.

Impacts

Demand for Information by Various Users

Information from the seven-year, community-based water-monitoring project has been used by a variety of governmental and educational institutions. Requests are becoming more diverse and frequent. Water quality data was presented to the municipal government and three barangay assemblies at their request. The data were used to develop the Lantapan, Bukidnon Comprehensive Land Use Plan (CLUP). The municipal government also used the water monitors' data in a Region 10 "Clean and Green" contest, and the Tugasan River of Lantapan was judged to be the second cleanest inland water body of the region. The Tigbantay Wahig group was invited to present their water information at the "Watershed Enhancement Program" held at the Philippine House of Representatives. The data was also used by the Department of Aquaculture and Technology of Misamis Oriental State College of Agriculture and Technology (MOSCAT) and by the Forestry Development Center of the University of the Philippines Los

Baños for a project entitled *"Development of Water Budget Models on Selected Watersheds in the Philippines*." Undergraduate and graduate ecology classes at Central Mindanao University (CMU) use this water quality data as reference in resource management topics. Test kits and techniques developed through this activity were used in the completion of three graduate student theses at CMU.

Demand for Decision Support Tool

The success of the Lantapan-based, water monitoring project has led to the implementation of similar projects in other provinces of the Philippines and in other countries. A series of study tours in Lantapan were conducted for representatives from the International Institute for Rural Reconstruction (IIRR) and about 30 government officials (Municipal Mayor, Provincial Health Officer, Provincial Planning Development Officer, Engineers and Barangay Captains) of Sarangani Province, Mindanao. This resulted in the development of a training and monitoring plan for the municipality of Maitum. Citizen volunteers in Maitum have been trained and formed a new monitoring group called "Maitum Munong El" (the T'boli term for Maitum Water Watch). Through the HPI-Philippines program, the water-monitoring model has been requested by governmental officials in the provinces of Bohol and Kalinga. Community-based, water monitoring is being extended throughout the Heifer Project International network. This included a training workshop in Lantapan for HPI Directors and representatives from 12 countries (Philippines, Thailand, Indonesia, Nepal, India, China, Vietnam, Cambodia, Mexico, Zambia, Poland and US/Canada). The approach was used in training workshops with the Christian Children's' Fund in Brazil and plans were made for similar training in China. Numerous requests for technical assistance have been received from other organizations in several countries, partly based on the selection of this work plan for publication in the UN-FAO "Success Stories in Sustainable Development."

Organizational Strengthening

The Tigbantay Wahig, Inc. (TW) water-monitoring group of Lantapan continued to mature as a viable people's organization. It has participated increasingly in local government and in training other groups. TW has played key roles in all study tours and training workshops in Lantapan. They have also participated in presentations throughout Mindanao and in the Philippine House of Representatives in Manila. They have maintained an effective organizational structure, that includes annual election of officers and advisory boards. The TW developed a proposal and was funded by HPI and the Tankersley Foundation for a three-year "Aquaculture and Goat Rearing Project." The purpose of this activity is to expand TW chapters in the municipality, provide training and promote policy advocacy.

Publications and Presentations

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Orprecio, Jim, Janeth Bago Lagis, and Madronio Magsakay. 1999. Citizen Water Monitoring in Lantapan, Bukidnon. Poster presentation at the Bukidnon Watershed Summit, Valencia, Bukidnon. September 1-3, 1999.

Other

March 29-31, 2000, Jhonie Sumampong and Mr. Jim L. Orprecio attended the Watershed Enhancement Program at the House of Representative in Quezon City. They presented the approach and results of our SANREM work plan.

Documentary Film on "Environment", March 24-25, 2000: hosted Dick Young at Alanib, Lantapan for the production of an HPI documentary film on the "Environment." Mr. Serafin Billones, Mrs. Teria Vivas and Mr. Joe Duba sampled water quality to form part of the film.

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Bio-Economic Modeling of Changes to Traditional Vegetable Production Practices in the Manupali Watershed With Extensions to Other Southeast Asian Watersheds

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Introduction

Land degradation across the highlands of Southeast Asia is accelerating largely due to the expansion of high value annual cropping. Much of the expansion is due to policy directions that, in turn, influence cropping decisions of upland farmers. The magnitude of soil losses from such systems represents one of the major environmental problems across the region.

Efforts are underway to understand the implications of altered policy and farmer-sanctioned innovations in production practices on the sustainability of upland farming systems in Southeast Asia. Within this project we provide biophysical and economic data from on-farm and researcher-managed experiments that test resource-neutral soil conservation practices and agroforestry practices aimed for their effectiveness in yielding off-site soil sediment but without sacrifice in farm income.

Field experiments and data analyses continued in 1999/2000, with outputs in the form of various publications, additions to the site database, and information relevant to bio-economic modeling for the watershed.

Objectives

- Provide evidence for or against the thesis that full and/or partial conversion of vegetable farms to agroforestry will lead to sustainable use of soil and water resources, and satisfy the income demand by upland farming families.
- Provide model parameters for inclusion of such evidence into a watershed model.
- Monitor the changes in the practices of vegetable production and the adoption of participatory-led research substantiated innovations (to be addressed in 2000 to 2001).
- Provide a robust model for prediction of impacts due to changes in upland vegetable production practices on farm scale income generation and resource management (to be addressed in 2000 to 2001).

Methods and Approaches

The four research sites in the Manupali were set up in 1994 to 1995: one for in-depth quantification of soil erosion on land sloping at 40 percent with a range of soil conservation technologies imposed, and the other three with various vegetable/tree intercropping strategies. In 1998, the erosion site was converted from entirely vegetable production to vegetable/tree intercropping and fallow (with sunflower introduction) to quantify specific effects on soil loss, with only a few plots remaining in continuous vegetable production.

Data collected during 1999/2000 include crop and tree growth and yield parameters, and soil and water erosion rates. During the current year, the Principal Investigator met with cooperators for data analysis and interpretation, and linked with the Purdue University Principal Investigator (Dr. G. Shively). A planned survey to quantify impact at the farm level of research to date had to be postponed due to peace and order constraints in the watershed.

Results and Discussion

Two major outputs were achieved in 1999/2000. The first is a set of data (Tables 1 to 3) relating the effects of agroforestry, fallow, and continued vegetable production with or without liming. The second is

a manuscript in which much of the information collected to date has been summarized in readiness for inclusion in the modeling work of G. Shively (Purdue University).

With respect to the field data, it is evident that after establishing the sunflower or trees only (with vertical grass strips between rows of trees), erosion was essentially stopped (Table 1), compared plots with vegetables or vegetables and trees. The inclusion of trees with vegetables did not reduce erosion, for the space in up-down strips between rows of trees were not protected from erosion, neither specifically via the vegetable crops nor by the tree pruning that were laid in vertical lines between rows.

Crop yields (Table 2) in plots without lime were notably poorer than those with lime (the soil pH had declined since the 1994 initiation of the experiment) and by the 11th season yields were very low overall.

Tree growth (height) started with an unfavorable bias against the up-down vegetable/tree and on the contour plantings, but this was less evident as trees grew, suggesting that it was due to factors outside of the normal randomization process. The field experiment continues, and a harvest of the trees planted in 1995, which was planned for May/June, has been postponed until later in 2000 due to peace and order problems.

A 14-working day visit by the Principal Investigator to analyze and discuss results collected to date has led to a draft document, and biophysical inputs into the Purdue University bioeconomic policy directions model.

In summary, the research is on target, with objectives 1 and 2 being well addressed, and objectives 3 and 4 within striking distance for the coming year.

Impacts

None have been specifically measured this year (the survey had to be postponed), but general interest in trees production in the watershed is evident. Due to the increasing worldwide demand for timber, new policies promoting tree plantations can be expected, especially in the Philippines where there is a movement toward self sufficiency. Tree production on sloping uplands reduces soil loss and improves rainfall infiltration. Also, tree farming is not as risky an income source as vegetable production; therefore, more farmers can be expected to become involved in agroforestry.

Publications and Presentations

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Table 1. Total eroded soil (T/HA) per season according to treatment.

Treatment	(n)	Season		
		8	9	11
Sunflower	8	2.8 (1.20)	0	0.3 (0.78)
Trees only	6	2.4 (1.35)	0	0.2 (0.51)
Vegetable / lime	6	3.3 (0.77)	3.3 (0.60)	12.4 (5.33)
Vegetable / no lime	2	3.6 (0.58)	5.5 (1.87)	13.4 (9.70)
Trees / vegetable / lime	2	4.7 (0.03)	5.9 (0.55)	15.0 (1.54)

Table 2. Crop yields (T/HA) according to treatment. Crops different to each season with exception of beans as one of strip plot treatments.

Treatment		Season			
Original	Newly Imposed	8 Corn, fresh	9 Cabbage	10 Dry beans	11 Cabbage
Up-down	Veg / no lime	3.4	7.5	0.34	0
Up-down	Veg / lime	9.4	18.1	0.76	0.98
Contour	Veg / no lime	6.5	12.7	0.38	0
Contour	Veg / lime	9.8	26.5	0.74	0.87
Up-down	Tree / veg	5.3	0.9	0.16	0
Up-down	Tree / veg	10.4	8.2	0.21	0
Strip	Veg / no lime	3.4	3.0	0.20	0.11
Strip	Veg / lime	8.0	6.3	0.77	3.62
Strip	Bean / no lime	2.4	2.5	0.20	0
Strip	Bean / lime	5.0	4.0	0.77	0.29

Table 3. Tree growth (height - m) according to treatment.

Treatment		Season			
Original	Newly imposed	8	9	10	11
Strip	Trees only	1.06	2.62	3.68	4.61
Hedgerow	Trees only	1.01	2.23	3.67	4.52
Contour	Trees only	0.99	2.10	3.75	4.58
Up-down	Trees / veg.	0.88	1.85	3.59	4.36

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Adapting and Transferring Lessons Learned from Manupali to Other Critical Watersheds in Southeast Asia

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Introduction

With the goal of identifying and testing decision support tools and approaches from a portfolio developed from SANREM-Philippines in other critical watersheds in Southeast Asia with similar conditions, the team has gone through a series of activities to identify priority research area of Vietnam. Selection of Vietnam for expanded collaborative research initiatives is strategic. Vietnam is undergoing rapid transformation of both its economic as well as its biophysical landscape. Economic reforms which include de-collectivization of agriculture (decentralization of resource management), elimination of an array of administrative prices, liberalization of trade, to name a few, resulted to a rise of 7 percent of Gross Domestic Product (GDP). On the other hand, with a population of 78 million, and an annual population growth rate of 2 percent, environmental pressures on land resources are expected to become a serious problem in the near future.

During an exploratory trip conducted to identify potential areas of collaboration in August 1999, it was noted that one of the current major research challenges that confront agricultural researchers based in the university (University of Agriculture and Forestry, Ho Chi Minh City, to be specific) is the socioeconomic, cultural and biophysical causes and consequences of coffee expansion in the uplands of South Vietnam. In Vietnam, coffee now is one of the major export crops. In 1997 alone the production of coffee green beans reached 364,000 tons, the highest since 1990. The export totaled 310,000 tons in the same year (Hung 1998). It was also estimated that about 330,000 tons were exported in 1998. In terms of value, coffee is second to rice. As it is, coffee is expected to play a significant role in the modernizing period of South Vietnam. This condition makes expansion of coffee production even more lucrative and hence, attractive.

Objectives

- To provide a mechanism for the integration of biophysical, sociocultural, economic and institutional factors that would be useful to watershed management at different levels (local, regional, national) of selected Southeast Asian countries;
- To facilitate prediction of the long term impacts of different human activities on the biophysical characteristics of critical watersheds and their potential to provide ecosystem goods and services; and
- To use the results of watershed modeling in developing watershed management plans and training programs that would provide guidance for informed policy and decision making process.

Methods or Approach

During 1999/2000, the main focus was on selecting the potential site for expanded collaborative undertakings, determining the research priorities the selected collaborators, and formulating a research framework that would be adopted. To undertake these tasks, the team conducted exploratory visits and meetings with some institutions in Vietnam and Laos that were involved in natural resources management. After the visits, specific research collaborators were identified and consultative meetings were organized. Finally, a consultative workshop was held in May 2000 in Ho Chi Minh, Vietnam. In attendance were representatives from the Lam Dong provincial service centers of the Ministry of Agriculture and Rural Development

and Ministry of Training and Extension, Bao Loc Rural Life Center, and the People's Committee. Other participants included researchers from University of Agriculture and Forestry/Vietnam, University of the Philippines Los Banos/SEARCA, Local Government of Bukidnon and PCARRD.

Results and Discussion

After the exploratory visit, Vietnam was selected as the priority site for the replication and testing of SANREM tools and approaches. The choice was primarily because of the nature of land use transition occurring in the uplands of southern Vietnam—from traditional crops and natural vegetation to coffee. This parallels with the encroachment of vegetables and other cash crops in the Manupali watershed in Bukidnon, Philippines. The series of discussions with potential collaborators culminated in a consultative workshop with different upland agro ecosystem stakeholders. This workshop was organized by the UAF/Vietnam in close collaboration with SEARCA/SANREM based in the Philippines.

The workshop primarily aimed to a) discuss some lessons learned from SANREM/CRSP in the Philippines, b) examine broadly the socioeconomic and environmental issues related to coffee production, and c) determine appropriate methodologies to adapt in conducting the study on coffee.

The workshop agreed to deal with the following research questions: a) What factors would influence the upland farmers to adopt/adapt sustainable agriculture and natural resources management? b) How could farmers and policy makers balance the production and environmental protection? c) What factors affect land management decisions at the household, commune and district levels? d) What are the appropriate interventions and decision support tools to facilitate adoption of sustainable farming practices?

The participants of the workshop agreed to focus on three main hypotheses:

- Increasing commercialization and changing access to and control over the resources influence land management practices and decisions of farming households, community and higher policy making bodies.
- Change in environmental quality influence farmers and policy makers land management decisions.
- Change in resource tenure induced by commercialization influence land management decisions.

The discussion led to a consensus on the components of participatory action research (PAR) to promote sustainable agriculture and natural resources management (SANREM). This includes analyses of the existing agricultural systems in the uplands of southern Vietnam, specifically in the Province of Lam Dong. Site selected is strategic because at present, this is a locus of a rapid transition as compared with other provinces like the Province of Dac Lac which has already been dominantly covered with coffee. The case analysis focuses on the village of Loc Chau, District of Bao Loc. For case analysis, Participatory lifescape-landscape analysis will be employed. To validate and revalidate impressions and findings, consultations will be organized through the assistance of the People's Committee and the Bao Loc Rural Life Center.

Another component of the PAR framework is process documentation, an integral part of a participatory action research. This aims to ensure that the research process remains participatory throughout the life of the research. In the process of the undertaking the activities, sustainable agriculture capacity building needs will be identified. The work plan will feed this back to other partner institutions mandated to organized trainings for farmers/and other stakeholders. Towards the end of Year 3, a policy workshop will be organized to finally present the findings and their corresponding policy implications.

Impacts

The activities of Year 2 work plan has ensured that the strategic collaborators have been identified and have played significant role in the definition of the research problem and the framework. This is important if we are to succeed in promoting sustainable agriculture with due regard to the natural resources integrity. It is also important that the research problems are defined based on the perspectives and needs of the policy and decision makers. However, the concrete impacts of this process cannot be measured at this stage

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Replicating Models of Institutional Innovation for Devolved, Participatory Watershed Management

Introduction

The search for better natural resource management (NRM) is gaining attention due to concerns about the environment, food security, and poverty alleviation. The traditional way of addressing environmental problems has been a top-down bureaucratic approach wherein local people were passive beneficiaries of external interventions rather than active collaborators. That approach does not empower people and their institutions to participate in the process of defining actions that affect their socioeconomic and environmental conditions.

Today, there is an increased use of participatory, devolved and demand-driven approaches to natural resource management in response to the growing realization that people and their institutions play vital roles in managing resources effectively. In other words, the participatory approach to management includes local people in the process of change and development, enabling them to wisely manage their local natural resources.

There is a need for research to evaluate the performance of this approach and analyze cases where these approaches have been tested, identify important constraints, and isolate criteria and indicators of impact. SANREM has used a participatory approach to natural resource management in Lantapan, Philippines, since 1992. Within the Philippines, the Lantapan NRM process and experience is considered to be a significant advance in municipality-led NRM planning, building the decentralization process and development in local governance. It is a shift from traditional top-down planning approaches toward participatory, multi-sectoral planning and research-based decision-making. The undertaking resulted in the development of a model for municipal-led NRM planning and implementation that has received national attention.

From this experience, a replication process for this model has been initiated within the seven municipalities surrounding the Mt. Kitanglad Range National Park (MKRNP) in Bukidnon, Philippines. During 1998 to 1999, priority focus was given to analyzing the planning processes as adopted by the Local Government Unit (LGU) of Lantapan in developing the NRM plan. Surveys and a self-assessment workshop were conducted. A working team at the local level was organized as a pool of resource persons and advocates during the replication activities in the other sites. This was related to the objective of implementing an LGU-to-LGU model of sharing information and experiences. New linkages were set up with the Integrated Protected Area Management of Mt. Kitanglad through the Protected Area Management Board (PAMB). This new local NRM model has been replicated where a new Preventive Systems Approach to protected areas has evolved. Key factors affecting local NRM and their policy implications at the local and national level have also been identified and analyzed.

During 1999 to 2000, work focused on scaling-up the Lantapan experience in local NRM to municipalities in surrounding Mt. Kitanglad Range National Park and in Misamis Oriental. A new model for protected area management that entails a preventive systems approach is evolving from this effort. The performance of these models is being analyzed, evaluated and compared in municipalities that have similar or differing biophysical, socioeconomic, political and institutional conditions, while testing and fine-tuning the processes and assessing the impacts of implementation. The results will be packaged into modules that will serve as a decision-support system for local govern-

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ments and community stakeholders to further improve the processes of NRM planning and implementation. These experiences will be communicated nationally and regionally in Southeast Asia.

Goal

To provide tools for decision-makers and stakeholders to better integrate environmental knowledge with technical and institutional innovations to enhance the management of natural resources at the local government level.

Objectives

- Conduct an in-depth analysis of current methods in Lantapan's NRM planning, assess its impact to the local government's development and investment planning and policymaking, as well as, the participation of the municipal and village-level governments in the implementation of the plan.
- Scale-up the Lantapan model to other municipalities surrounding MKRNP in Bukidnon. This means directly assisting and coaching LGUs in developing their own NRM plans.
- Analyze, evaluate, assess and compare the performance of the NRM model in these different municipalities and develop these into modules that serve as decision-support to LGUs in pursuing local NRM planning and implementation.

Methods or Approach

Technical facilitation was the principal method used. Coaching sessions with the Natural Resource Management Councils (NRMC) of respective municipalities were provided as well as a capacity-building program to local NRM facilitators and NRMCs as a major part of the planning process. The methods in Lantapan have served as a template, but modifications to suit the conditions of a specific LGU are identified. This forms part of an adaptive research exercise concerning the Lantapan NRM methods and their extrapolation to other municipalities. Descriptive-correlation research, comparative case studies, policy review and analysis and impact assessment will also be implemented on a progression scale depending on the level of activities being implemented in each municipality.

Specific methods are identified for each activity. For the process analysis of Lantapan-NRM model, a survey was conducted using a structured questionnaire with a self-assessment workshop and personal interviews with key informants.

Results and Discussion

Analysis of Lantapan-NRM Method. This activity involved survey, interviews and workshops, conducted to analyze the planning process as adopted by Lantapan-NRMC in developing their Natural Resource Management and Development (NRMDP). A census of NRM members was accomplished. The respondents in the survey were selected LGU officials. Key technical persons at the provincial level also served as key informants. The activity provided the NRMC the opportunity to assess their own performance in relation to their roles as local planners. Results revealed that they were satisfied with the outcomes of their participation in the planning process, and their contributions to the NRMDP. In the self-assessment workshop, they graded their performance and listed the qualities they considered essential for an ideal NRMC. They also identified gaps and constraints to local environment and watershed resource management. To assess the Lantapan NRMDP's interface from planning to implementation, a survey was also conducted within eight months from its implementation. It revealed promising initiatives by the LGU in organizing a Project Management Team, budget allocation, and policy support.

Establishing Networks (PAMB and the League of Mayors). Collaboration with the PAMB was successfully established. This was done through presentations and discussions of the Lantapan NRM work plan the other Mayors during the PAMB Committee Meetings. This resulted to new key research and developmental activities and partnership with several LGUs and private organizations. Involvement of outside stakeholders in the protected area is integral to the success of protected area management. We believed that implementation of a municipal-level NRM program will reduce the negative pressures exerted by outside communities on the protected area, and would therefore better uphold the integrity of the national park. As a result of these exercises, a Preventive Systems Approach in protected area management was developed.

Technical Planning Facilitation. A framework for NRM provincial scaling-up was developed. It is currently used in replicating the Lantapan NRM planning process. The NRMDPs in Manolo Fortich and Baungon were completed and have been finalized for reproduction and implementation. These municipalities have already allocated funds to support the implementation of their NRM plans next year, and are in the process of setting up their project management teams. NRM planning processes are also underway in Libona and Impasugong.

One research aspect of the work plan is focused on the cost-efficiency and efficacy of devolved and participatory NRM planning and implementation. A key aspect is the identification of appropriate government framework to promote and support local initiatives, participation, and public-private partner-

ships in the arena of natural resource management.

Our initial analysis identified socio-political, technical, human and financial resources as key dimensions that affected the success of local NRM. To understand the complex web of their relationships, we identified specific elements under these domains and categorized them into the following factors: Enhancing, Resisting and Intervening factors. The Enhancing Factors include: The Philippine Local Government Code that provides the legal framework for NRM; the availability of Community-based NRM models; and the presence of external support and service providers. Resisting Factors include lack of technical capabilities, lack of proactive technical assistance from National Government Agencies, lack of clear financial support, lack of effective consensus-building tools, traditional political culture, and some unintended effects of protective rules. Some factors have additional intervening effects on local NRM that include local environmental conditions, political climate and political will. These factors are independent variables that affected the implementation of local NRM programs. With this, we shall begin examining the policy implications of these factors and their corresponding policy recommendations to promote and support local NRM.

Impacts

The positive response of the mayors in the Protected Area Management Board is a positive impact of this activity. Politicians and decision-makers are now finding environmental management integral to sustainable development. Implementing NRM programs at the municipal level is becoming a practical issue. There is now better understanding of the benefits of participatory processes for social capital enhancement aimed at improving the natural capital. As a result, political leaders now value local talents and skills more highly and also value the team approach in planning and decision-making. LGU officials acknowledged the importance of research-based decision-making. This is evident in the recognition of the need for a local research unit in the LGU structure to provide improved information availability, and tools for a sound-decision making process. The NRM plans have become implementing tools of the municipal land use plans. Since both land use and NRM planning are done simultaneously in the municipalities, these have become complimentary and dovetailing activities. Allocation of financial resources for NRM programs at all levels in the test municipalities has been secured during the planning process. The multi-stakeholder and team approach in planning provided a strong basis for participatory implementation using public-private partnerships. A lesson learned in this process is that NRM programs may not have to be a major expenditure activity. It can be done by the local people if provided an enabling environment and the necessary social support in which local skills and talents can be maximized.

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Capability Building for Natural Resource Management at the Local Level

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Introduction

In an effort to arrest environmental degradation in the Manupali watershed and promote sustainable practices, the human resources capability building and enhancement program was developed. The capability building process was divided into four major stages: training needs analysis (TNA), development of training materials, implementation of the training course, and monitoring and evaluation. Year 1 of the project covered the conduct of the TNA. The current year, Year 2, includes the development of training materials, implementation of the training courses, and monitoring and evaluation.

In keeping with the activities set for year 2, three streams of related trainings were undertaken. These were the Training of Trainers (TOT) for NRM and Sustainable Land Use Planning (SLUP), the Training-Workshop on NRM and SLUP, and Training Workshop on Conducting Economic Policy Analysis at a Landscape Scale: A Stella-based Approach to Dynamic Simulation.

Objectives

Training Materials Development

- To develop and package appropriate training materials consistent with the NRM framework for Manupali Watershed

Training Course

- To explain the concepts and principles of sustainable natural resources management and how these can be applied in specific environments.
- To provide an array of different methodologies for natural resources planning and management, with focus on participatory and creative approaches.
- To provide a venue whereby the target participants can be exposed to examples of sustainable natural resources management processes.
- To identify conditions that may hamper or hasten sustainable natural resource management and how these conditions will be addressed.

Monitoring and Assessment of Training Course Results and Action Plans

- To determine the effectiveness of the training course, and
- To determine mechanisms to address issues related to human resource capability building that may arise in the future.

Methods or Approach

The methods employed in TOT included the following: learning exercise, processing of the exercise, sharing by participants of their knowledge and experience about the topic, enrichment of participants' knowledge/experience through discussion and inputs, and synthesis to highlight the main aspect of the topic.

In the conduct of the "Training-Workshop on NRM and SLUP" for practitioners, a training module was prepared for the participants. The participants formulated their action plans using the basic principles and skills gained in the workshop.

Lecture and hands-on exercises were employed in the training-workshop titled "Conducting Economic Policy Analysis at a Landscape Scale: A Stella-based Approach to Dynamic Simulation." The participants were provided a manual on modeling rudiments. The participants were also given a manual on how the model works.

To monitor the progress of the action plans formulated during the training-workshop, the Central Mindanao University-Barangay Integrated Development Approach to Nutrition Improvement

(CMU-BIDANI) organized a team from various units of the university, together with those who underwent the NRM/SLUP training-workshop. The team focused on two main activities: the application of the NRM/SLUP concepts and principles, and the process of land use planning.

Results and Discussion

SEARCA and IIRR prepared a draft manual on NRM/SLUP that was used in the conduct of the training courses. This draft will be further developed into a Natural Resources Management Manual for possible use by local governments and development workers.

Two trainings were organized with a total of 31 participants from the Municipalities of Lantapan and Valencia, Bukidnon Provincial Planning and Development Office, CMU-BIDANI and SANREM/SCO. Resource persons were from SEARCA, UPLB, and Housing and Land Use Regulatory Board (HLURB) Regional Office. The HLURB was able to clarify major legal issues related to land use conflicts that are occurring particularly in Lantapan and Valencia. Examples include conversion of agricultural land to housing subdivisions and the construction of industrial plants in agricultural or urban areas.

During the TOT, the CMU-BIDANI participants crafted a proposed curriculum for Natural Resource Management Training for Local Community. On the other hand, the participants from the municipalities of Lantapan and Valencia came up with action plans towards drafting a Sustainable Land Use Plan for the Municipalities of Lantapan and Valencia in Bukidnon, Philippines. It was agreed that these action plans would be the basis for the monitoring activities that will be conducted by the CMU-BIDANI team.

Evaluation of the training-workshop on natural resources management and sustainable land use planning indicated the need for a follow-up training course to assess the extent of the accomplishment at the municipality and barangay levels. It was also refreshing to observe the support of the local government executive of the two municipalities. The participants suggested that the mayors of the municipalities concerned be encouraged to attend so that they will be properly informed of the plans of the groups who had undergone NRM/SLUP training.

Results of the CMU-BIDANI monitoring activities showed that most of the concepts that the participants learned were used in their respective land use planning activities, although they often were behind the planned schedule specified in their action plans. To some members of the municipal planning team, however, the concepts were not very clear, as they were not part of the original participants of the training workshop. The municipal development officer had to repeat the whole process with the new members. It is suggested that continued training on NRM/SLUP be vigorously pursued, especially since the SEARCA/SANREM trained only a limited number of participants. It is recommended that the municipalities initiate discussion for possible partnership with HLURB in relation to further capability building. It was also noted that capacity building for rationale land use planning should start from the barangay level, and barangay plans should then be integrated into the municipal comprehensive land use plans. This will ensure continuity and hierarchical consistency.

Impacts

As a result of these activities, a core group of trainers has been developed. Most of these trainers are from CMU-BIDANI, which has long been involved in training communities in various aspects of nutrition improvement. It has a network of trained community people who help carry out its programs and projects. The training activities related to NRM and SLUP are expected to enhance their experience in training and networking.

The participants in the TOT adopted the curriculum of the NRM-SLUP training-workshop for replication in the community. This curriculum aims to strengthen local community planning skills that are the foundation for the development of locally sensitive and realistic municipal comprehensive land use plans. With this curriculum, it is expected that their learnings from the training will be diffused to the barangay. In some cases, the new trainers may have to design similar training-workshops in other related areas of NRM based on the needs of the communities, e.g., solid waste management, river rehabilitation, agroforestry.

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Technical and Institutional Innovations to Evolve Agroforestry Systems for Sustainable Agriculture and the Management of Protected Ecosystems in the Framework of a Watershed Model

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Introduction

Human settlements within or close to the boundaries of the Kitanglad Nature Park (KNP), a protected area with high endemism of fauna and vascular flora in the Philippines, has led to agricultural encroachment, including the harvesting of wood and other forest products. In similar situations, legal protection or government-imposed restrictions alone, as currently evident in the KNP, are rarely sufficient to guarantee the continuing integrity of protected areas. New and credible systems are needed to bridge the gap between the immediate needs of local people and the long-term objectives of protected areas systems, a divergence of interests that has created and fueled bloody conflicts between management of protected areas and local communities.

This research employs buffer-zone agroforestry practices (van Orsdol 1987, UNESCO 1984) to protect the KNP and to sustain the agricultural resource base of the Manupali watershed. The development of complex agroforestry systems in buffer zones around protected areas is a technology option that may reduce pressure on forest resources and improve protected areas management (Michon 1991, Sayer 1991, van Orsdol 1987, UNESCO 1984).

Two conditions are hypothesized as essential for sustainable buffer zone management in the KNP and other protected areas in the tropics: (1) community-endorsed and supported enforcement of park boundaries; and (2) agricultural and agroforestry intensification within the buffer zone that enhances sedentary farming and income growth complemented by off-farm employment generation in the local and national economy.

Objectives

The project was implemented to meet two broad objectives:

- To broaden and deepen our knowledge base on the effective and cost-efficient technical innovations and farmer-driven Landcare approaches for fostering, expanding, and sustaining smallholder participation in and adoption of conservation farming in upland watersheds
- Build and nurture an enabling environment for the establishment, development and management of smallholder tree-based production systems as viable enterprises and a vehicle for reforestation of deforested upper watersheds.

Methods or Approach

Landcare, a partnership program that consists of government (local, national), farmers, conservationists, and community groups, is an approach to bringing local (not necessarily rural) communities together to identify and seek solutions to their problems as far as managing the natural resource base. Landcare is much more than just an innovative, participatory land conservation program. It encompasses environmental education in schools and in local communities, as it includes community-based land use planning and monitoring of land and water quality, farmer-driven and farmer-managed research and development and community participation in the allocation of public funds to support land conservation (Garret 1998, Garret and Mercado 1998, Campbell 1994).

The Landcare Approach is central to our research and extension approaches and methodologies for the expansion and enhancement of adoption of agroforestry technologies. The Farmer Field Schools

method (RECOFTC 1999) is also used to broaden and sustain adoption. This work plan had carried out preliminary marketing study about trees and tree products and the identification of various trees to diversify the species base on-farm. The market study employed questionnaire-based, semi-structured interviews and open discussions (Chambers 1994) to learn more and collect information about some marketing and related issues and concerns such as the reasons for planting trees, the most common forms in which wood is sold and cash income accrued, and buyers of wood. On-farm species trials, involving indigenous but mostly exotic species , were conducted to select the best species mix for sites of varying elevations .The methods employed in these trials are outlined in some key publications (Booth 1996, Franzel & Ndufa 1994) .

Through ICRAF's Dissertation and Thesis Affiliate Programme, a baccalaureate thesis 'Factors affecting adoption/non-adoption of natural vegetative strips in Lantapan' was completed, with technical guidance from the Centre's researchers. Using a questionnaire-based interviewing method, a randomly selected sample of 103 farmers from 7 of the 14 villages of Lantapan were interviewed. The study identified gender, size of household, marital status, educational achievement, land tenure status, length of residency, income, sources of information, training, availability of draft animals/tools, and availability of inputs (fertilizers, etc.) as independent variables affecting adoption behavior.

On-farm trials of indigenous and exotic tree species established three years ago to select the best species mix on sites of varying elevations, are being transformed into seed production areas to meet farmers' demand. Even though the trees in three of these trials are not ready to be harvested, farmers benefit from income generated by the sale of seeds.

ICRAF is working with a UPLB Watershed Modeling of Run-off and Erosion Study team to predict the changes in watershed functions as a result of changes in the coverage and distribution of tree-based production systems and vegetative buffer strips. Two UPLB graduate students calibrated the pcRaster model for estimating the flow of runoff and soil on the landscape, using data from the instrumented micro-watershed in Brgy. Songco. The masters student, Reynaldo L. Lanuza, recently completed his thesis "Modeling soil erosion in a watershed". Ms. Nenita de la Cruz, the Ph.D. student, has documented the land use changes of 40 parcels of land in a catchment area within the Manupali watershed. She will be validating the model with this data and the runoff and erosion data collected in the ADB and MSEC projects.

Results and Discussion

Assessment of adoption behavior. The adoption study offered some site-specific insights as to the constraints to enhancing adoption of NVS among some farmers in Lantapan. We used these recommendations to redefine and retool its research and extension efforts in the expansion and adoption of agroforestry systems and component technologies in Lantapan. For example, the project hired more facilitators and had organized weekly radio programs to provide more information and training for farmers on various land care activities.. Several workshops had been held to clarify land tenure issues and on income-generating activities such as the collection and marketing of tree seeds and the production and marketing of seedlings of both timber and fruit trees. To further simplify the laying out of contour lines, a requirement for determining where to cut out NVS, a new method is being field tested. With the advent of this method, a single farmer can establish several NVS a day, instead of the two to three people currently needed to perform a similar task. These are among some of the key retooling research and extension steps taken.

Development of seed production areas. Around the world, farmers currently depend upon more than 2500 tree species for the production of fruits, nuts, timber, fencing material, forage and a wide range of other products intended for household consumption as well as trade on local markets. Of great importance for millions of farmers also are the trees they plant for shade around homes or in their fields, as farm boundary markers and for shelterbelts and greenbelts to protect their soils, crops and communities. Support to farmers and small rural communities goes primarily to areas in the most critical situations such as obtained in Lantapan.

In addition to the lack of quality tree seed, the main constraint to tree planting in these areas is the challenge to demonstrate to people that planting trees is a worthwhile investment of their time and land. In the work with the Agroforestry Tree Seed Association of Lantapan (ATSAL), a farmer-operated seed collection and marketing association, this project has facilitated formation of a self-seed collection/ production, diffusion and marketing system. It, however, was observed that seeds were collected mostly from exotic plantations established about 2 decades ago and patches of natural forests that are not necessarily owned by ATSAL members . As such, these are not sustainable sources for seed.

Capacity building: Three formal courses and two training courses were conducted in 1999 to 2000. Trainings covered vegetative propagation and husbandry of fruit trees, seed collection, handling and plantation establishment and management, with

farmer trainers and local NGO staff as participants. The goal of training was to create the environment for changing the state-driven approach to forest management from its narrow focus that treats farmers as passive adopters of imposed forest management schemes and practices, to a broad focus that works with farmers as partners in the forest and natural resource management. Training is meant to support decentralized management of the natural resource base upon which resource-scarce farmers directly depend almost exclusively for their survival.

Linking farmers to markets: Because small-scale, resource-limited farmers, generally, do not participate fully in marketing activities, sufficient incentives for raising productivity are lacking and marketable surplus remain small. One of the major problems farmers face in Lantapan in these respects is the lack of adequate marketing information, particularly for trees and tree products (Koffa & Garrity, 2000).

Interviews and open discussions were held with 15 tree farmers; seven proprietors representing the industrial market (wood purchasing, processing and marketing industries); 10 employees from the industrial market sector; and three leaders of two tree farmer groups in Lantapan, Malaybalay and Valencia. Two workshops where tree farmers met with proprietors from the industrial markets were held to address the problem of inadequate marketing information. In addition, field trips were made to two major industrial markets and other wood purchasing and processing plants to have farmers learn about wood prices and wood quality.

The marketing case study found that tree farmers in Lantapan generally do not have any sense of wood quality. One hundred percent (100 percent) of the 15 tree farmers interviewed believe that if they sold many logs they should make as much money. During the visits to industrial markets, farmers learned that crooked and knotty logs demanded low prices compared to relatively straight and knot-free logs. The study also identified government-imposed restrictions on harvesting and transport of wood from private woodlots as a policy intervention that could act as a disincentive to tree farming not only for farmers in Lantapan, but in the Philippines as a whole. The study also identified *Gmelina arborea* as the most dominant species planted on-farm. When farmers were asked why *G. arborea* has been so popular, 67 percent said it was the ease with which the species is propagated and managed and 20 percent said because it seeded prolifically nearly throughout the year. The remaining 13 percent said they planted the species because government provided free seedlings.

The abundance of *G. arborea*, among other things, means an assured source of raw material for industrial and other markets for wood. For the farmers, however, this abundance resulted in an oversupply that eventually drove down prices in 1997, 1998, and 1999. The study defines and discusses a host of other constraints farmers face in the quest to commercialize tree farming as a key component of agroforestry systems, and has made a number of recommendations to deal with these problems.

Broadening on-farm species diversity: In Phase I of SANREM-CRSP, 15 trials were established on sites of varying altitudes to test the performance of 14 tree species for agroforestry. Another set of trials involving four promising tree species was recently established.

To develop complex agroforestry systems and component technologies that would reduce pressure on park resources and improve living standards of rural people, a diversified species based is a requisite item for success. Farmers need to diversify production because of market uncertainties and the vagaries of the biophysical environment where trees are grown. This species-site matching information is a significant contribution to the development of a decision-support system in the choice of the appropriate species mix for the diversity of microenvironments which Manupali's landscape represents.

Modeling land use changes: An interesting initial finding on land use changes is that most areas that used to be dominated by grasses are now planted to trees.

Conservation farming: For more than four years in Lantapan, ICRAF has been successfully engaged in research and extension activities that centered on natural vegetative strips (NVS) and ridge tillage as agroforestry technologies, to reduce soil erosion and increase soil fertility on sloping lands. During the past year, 250 farmers established, on the average, three natural vegetative strips (NVS) on their farms.

The Landcare approach: By April 2000, 52 Landcare groups with more than 800 members were operating in six villages in Lantapan. The technical backstopping and support from IEC provided by ICRAF, which facilitated this success after one year, included 42 slide shows on tree (fruit, timber) nurseries, and four cross visits to nurseries, the species site-matching trials and established NVS. In addition, 78 trainings were conducted on the tree nursery management and NVS establishment. Four thousand three hundred (4,300) farmers and other interested individuals actively participated in these activities. By March 2000, 63 communal and individual household nurseries were established. More than 40,000 seedlings of fruit and timber tree species had been produced in these nurseries and outplanted in the field and on-farm.

Impacts

Changes in land use. About the 3 years ago, *G. arborea* dominated the landscape of the Manupali watershed. Currently, a healthy mix of promising agroforestry tree species for cash, soil stabilization, fuel and local construction are being planted by smallholders as the result of the previous on-farm species trials and because of the continuous work with farmers to improve management skills. This change in land use is indicative of increased self-dependence of farmers and other local groups in the collection and handling of tree seeds and the development and management of tree-based production systems.

Grassroots institutional strengthening. As the basis of production for majority of the world's crops (trees included), seed is probably the single most important input in all crop-based production systems. From 1998 when its formation was facilitated with 15 farmers, ATSAL now has 65 members and is growing. ASTAL continues to produce quality seeds and develop the seeds into planting stocks that are sold for cash and planted on (their) farms and fields. There are continual efforts to improve ATSAL capabilities to engage into other livelihood activities such as beekeeping, backyard livestock husbandry, and small-scale wood processing ventures and marketing. Such opportunities and possibilities as mentioned will improve livelihood and the agricultural environment, both of which will ultimately strengthen grassroots groups and institutions.

Heightened environmental awareness. Through workshops, training, village assemblies and visits to nurseries and trial sites, a positive influence has been made on the lives of farmers (as individuals, households, organizations), the youth, teachers, cultural minorities (Tala-andig in particular), local governance, and local non-governmental organizations. For each of these groups, awareness about the need to protect the watershed and the Kitanglad Nature Park has increased.

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SANREM CRSP
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Weather Monitoring Using Automatic Weather Stations

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Introduction

Automatic weather stations (AWS), installed at three different altitudes in the Manupali watershed in the Philippines, provide detailed data about local climatic conditions that can be used for various purposes, including watershed-modeling efforts. Since December 1993, these weather stations have continuously provided hourly and daily averages of meteorological variables such as air temperature, relative humidity, rainfall intensity, solar radiation, wind direction and speed and soil temperature at three depths. To date, six years of meteorological data have been accumulated and have been disseminated.

Objectives

The weather-monitoring network was established with the following objectives:

- Provide detailed information about local climatic conditions.
- Assist and provide necessary weather information to other SANREM work plan holders and to contribute to watershed modeling efforts.

Methods or Approach

Regular onsite maintenance work is done to ensure the validity and quality of data being recorded by the AWS. Each month raw data were downloaded from the AWS' data logger to the storage module. Data were processed at Central Mindanao University and monthly summaries for each station were compiled. At the end of the year, an annual weather data summary from all the stations was compiled and the information was disseminated to various users, e.g. the local government of Lantapan, SANREM work plan holders, government agencies and private farming operations.

Results and Discussions

Summary for 1998

Annual Rainfall. The effect of the El Niño phenomenon is evident from the registered annual rainfall of the three AWS. The three-year mean annual rainfall (1994-1997) is about 40 percent higher than the 1998 annual rainfall. Individual station observations indicate that the effect is more pronounced in the lowland. Differences in the annual rainfall range from 28 to 50 percent, with the Kulasihan station exhibiting a difference of 50 percent. Figure 1.1 shows this abnormal situation.

Monthly Rainfall. On a monthly basis, our records indicate the absence of any rainfall for the first two months of the year followed by minimal rainfall during the next three months. In effect, the dry season was extended from five to eight months. The onset of the rainy season was observed only during the third week of June. This is one month later than the usual first or second week of May.

Moreover, the rainy months were interrupted by a brief dry spell in August, normally the wettest month for the entire watershed. The dry conditions were further aggravated by below-normal rainfall in October and November. Figure 1.2 shows this observation.

Air Temperature and Relative Humidity. Extreme air temperature variations in the area were minimal. The effect of elevation on air temperature is dominant. The tabular values show that the air temperature at the Bulogan station is about 22 percent lower than at the Kulasihan station while at the Alanib station it is only 13.55 percent. Maximum air temperature (34.4°C) was observed during the month of April while the minimum air temperature (14.4°C) was observed on March. As compared to the three-year mean, air temperatures were about the same.

The contrast of air moisture content or relative humidity (RH) in the morning and afternoon observations in the monthly tabulations is distinct. RH as high as 100 percent was observed in the morning and as low as 40 percent in the afternoon. This is particularly true in the lowland. On the average, air humidity was higher (86.1 percent) throughout the landscape compared to the mean of 79.1 percent.

Solar Radiation. Total solar radiation intercepted by the surface decreases with increasing altitude. This variation, however, is not more than 10 percent and could be attributed to more cloud cover in the higher altitudes. More solar radiation was intercepted during the months of March and April as a result of minimum cloud cover during these months. It is least during February for all stations.

Soil Temperature. Following closely the behavior of solar radiation, the mean monthly soil temperature variation depths of 5, 20 and 50 cms, are also minimal. Maximum soil temperature are usually observed during the months of April and May, for all stations, and lowest during the months of January and February. The effect of altitude on this element is also evident. It decreases with increasing altitude. For example, at a depth of 5 cm. at the Kulasihan station, the mean temperature is 35.4°C, at the Bulogan station, only 26.4°C. This is about 25 percent lower.

Summary for 1999

Annual Rainfall. Below average rainfall of 1998 or the result of the El Niño phenomenon has substantially been covered up by abundant rainfall in 1999. With the exception of The Alanib station AWS, the other two stations registered from 83-115 percent increase in this category. The Alanib station AWS data is incomplete because the data logger malfunctioned and failed to download during the month of June, July, August and October. The Kulasihan station and The Bulogan station registered 2739.6 mm. and 3263.4 mm., respectively.

Monthly Rainfall. While the onset of the rainy season was delayed in 1998, the following year was characterized by a wet January followed by a short dry spell in February. The customary dry months of March and April have rainfall over 200 mm. This lasted up to June. There were eight (8) wet month compared to only three (3) for 1998.

Rainfall Intensity. Five-minute rainfall intensity ranged from 6-10 mm. for The Kulasihan station and The Bulogan station. Similar trend was observed for the preceding year, including The Alanib station. When converted into mm/hr, this would be equivalent to 72-120. This data was obtained by considering maximum rainfall intensity for each month.

Air Temperature and Relative Humidity. Air temperature variation was affected by the shift of monthly rainfall for this year. Maximum air temperature (34.6°C) was recorded in July but the lowest was in February (19.5°C). The warmest month was July instead of April or March. The Bulogan station followed this closely with monthly extremes of 26.7°C and 18.8°C.

Relative humidity recorded was quite high with maximum value of 100 percent for most months and a minimum of about 52 percent. February had the driest air with an average of 84.3 percent.

Solar Radiation. Monthly solar radiation intercepted at instrument level for the year is about 10 percent lower compared to 1998. This could be attributed to more number of days with cloud cover or indicated by greater number of rainy days for 1999.

Soil Temperature. Soil temperatures at various depths of 5, 20 and 50 cm indicate that higher temperature are observed during the months of April and May while lower values are observed during the months of January and February. The effect of elevation is very evident and follows closely the variation of air temperature and solar distribution.

Impacts

The number and type of users, which have accessed summarized weather data, has increased from 17 users in 1994 to 158 users in 1999. The users are: government agencies, NGOs, corporate farms, undergraduate and graduate student researchers. Farmers have been benefited by these data through the local technicians of the Department of Agriculture. The technicians use our data as their source of information as to the right time to release the government subsidy to the farmers in order to avoid farming losses. This suggests that natural resource managers are becoming aware of the importance of agroclimatic information in decision-making. With the increase in the number of data users, CMU's College of Engineering has included dissemination of weather information as one of its extension activities.

The weather data have also been used in the agricultural engineering and environmental sciences program. Undergraduate students use actual data for their laboratory exercises. As a result, their understanding of weather variations is made simpler because of their familiarity with local conditions.

Publications and Presentations

The publications we have produced from the start of the project to date are the following:

Annual Weather Summary for 1994 (printed)
Annual Weather Summary for 1995 (printed)
Annual Weather Summary for 1996 (printed)
Annual Weather Summary for 1997-1999 (available on diskette)

SANREM Andes
Project Overview

Introduction

The SANREM Andes project conducts research and facilitates regional networking to address agricultural and natural resource sustainability in mountain regions. Globally embedded in the Inter-Agency network related to the United Nations Commission on Environment and Development's Agenda 21 (Chapter 13 on Sustainable Mountain Development), the Andean project pursues interdisciplinary and intersectoral scientific research to understand the principles underlying sustainability issues in mountain watersheds and landscapes.

The project's core activity (AND 07) bridges the gap between science (e.g., models and Decision Support Systems) and local people's perceptions of sustainability problems. An integrated research strategy is used to trace the link between the human factors (AND 02, AND 04) that drive changes in land and water resource use (AND 05, AND 08). When the results of these research efforts are packaged with a community dialogue methodology, local communities and other stakeholders have the opportunity to understand how their decisions affect land and water through time and space. Scaling up and transferring lessons learned is coordinated by AND 01 (coordination and networking) and AND 09 (regional node for training).

Project Objectives

The overarching objective of the Andean project is to advance sustainable natural resource management in fragile mountain landscapes through the creation and testing of participatory multi-objective, multi-scale, and multiple stakeholder decision-making methods and tools that will help highland communities make long-term environmental decisions.

To accomplish this principle objective, we are carrying out scientific research in key baseline mountain sites (Cotacachi and Nanegal, Ecuador), extrapolating the principles and lessons learned to similar areas, and building diverse local stakeholder capacity to utilize the results to create and manage self-determined sustainable systems.

Progress Toward Five-Year Indicators

Substantial progress toward goal indicators occurred during the year (refer to individual reports for more detail).

1. Scientific and Indigenous Multimedia Decision Support Platforms. Ten different images of each landscape were developed and analyzed through key informant interviews in Nanegal and Cotacachi. Nanegal community boundaries were defined and land use projections to year 2014 were determined. Twenty-four hand-drawn maps from informants and 47 referenced maps were elicited for GIS analysis. At Catholic University and the University of Georgia, a complete collection of maps were collated and digitized. Images from "self-diagnosis" in Cotacachi were collected and archived. Photographs of both Nanegal and Cotacachi landscapes were taken to document of landscape change from the present to 2020.

2. Case Studies of Landscape Level Decision Support Tools and Experiences. During 1999, the book, *Bridging Human and Ecological Landscapes* was finalized for publishing. It contains 17 chapters based on case experiences in the Nanegal region. In addition, SANREM Andes scientists drew on their research to publish extensively. In Cotacachi, water quality data empowered the indigenous people who have worked to improve natural resources.

3. Land Use Change/Hydrology Model. Thirty years of land use data were analyzed for the community of Nanegal. "Scenario building" projections of land use to 2014 were also completed. In Cotacachi, site selection of a representative first-order watershed was completed. Initial data collection was started for development of a GIS-integrated, erosion, nutrient cycling and crop growth model (EPIC model).

4. On-Site Databases Established. During 1999-2000, database offices complete with computers, scanners, and other equipment were established in both Cotacachi and Quito (Catholic University). University personnel and indigenous people were trained in computer basics. Twenty-five youths were trained in "memory banking" and data was deposited in the school (Palmitopamba) or in the computer at Jamric Mascaric (Cotacachi). Water quality and quantity data collected over past year also have been entered into the database. A meteorological station was established in Cotacachi.

5. Interactive Searchable Database Warehousing SANREM-Andes Data. The Web site at the University of Georgia (http://julian.dac.uga.edu/~sanrem) continues to be improved and analysis of data continues.

6. Case Study on Ethno-Geomatics and Ethno-Ecological Methods. The memory banking protocol has

been translated into Spanish by EcoCiencia in Ecuador and has been used with other groups. For example, a database based on the memory banking protocol is tied to an Ecuadorian project on indigenous property rights. Two workshops for NGOs and local communities were held during the year.

7. NGO and Scientific Personnel Trained in Future Visioning Methodology. Six people from Catholic University received extensive GIS training (40 hours). Also, five students were supported by the project and received field training in SANREM methodology.

8. Community Training in Water Quality/Quantity and Memory Banking. A training course was offered at EcoCiencia and in Cotacachi in memory banking. Two water quality/quantity training workshops were held during the year.

9. Training Manual on DSS tools for Mountains. An article was published in *Mountain Research and Development* on SANREM Andes approaches. Collaboration with ICIMOD on mountain ecoregional approaches continues.

10. Case Study of Future Visions Scenarios Method. In Georgia's Piedmont (Broad River watershed), the future visioning methodology was pretested. Questionnaires, photo-elicitation, and other research tools were tested and compared.

11. Memory Banking Methodology was translated into Spanish. Training in the method was conducted for local NGOs, Catholic University students, two middle school classes and professors, and indigenous people in Cotacachi.

12. Bilingual (English/Spanish) Web Site. The Web site is operational and improved (http://julian.dac.uga.edu/~sanrem).

13. UN Year of the Mountain. SANREM Andes scientists participated in the ongoing United Nations Forum on Mountains through papers at conferences, electronic conferencing, and serving on editorial and review boards. Andean collaborators (Mayor of Cotacachi) participated in Mountain Forum conferences held in France (June 2000).

Benefits to the U.S.

During the year, the primary contribution to the United States was the development of a methodology that can help local communities define, prioritize, and visualize consequences of environmental change, and then initiate sustainable planning. That methodology (future visioning) is just as relevant in suburban Atlanta as in the mountains of Ecuador. While the problems of Ecuador and the U.S. are different, local communities in both places face environmental issues. In many areas of the U.S., tensions are created between stakeholder groups as uncontrolled urban growth comes in contact with economically declining rural areas. In Ecuador, the stresses on limited resources due to poverty and population growth is the driving force of tensions between stakeholder groups at different scales. The future visioning methodology can help stakeholders define common goals for their communities.

Finally, the United States is one of the most mountainous countries in the world. The SANREM Andes project has played a key role in bringing the U.S. to the table at international discussions related to the UN Year of the Mountain (2002).

Year Two Impacts

Year two impacts have come at three levels: local communities, ecoregional (Andean), and international or global.

Impacts at Local Level. In Nanegal, impacts include: increased sustainable production in the bean/sugarcane intercropping systems; environmental awareness and biodiversity preservation enhanced through the school program of memory banking; knowledge erosion slowed through memory banking; and community efforts toward self-determination and legalization status advanced. In Cotacachi, SANREM played a role in empowerment of the indigenous peoples through the water quality/quantity work, and training of indigenous youth in computers and database management as well as the memory banking protocol. In fact, water quality/quantity became an important issue in the political campaign that was won by the present Mayor of Cotacachi.

Ecoregional (Andean, including Ecuador). SANREM helped raise awareness of mountain issues in its mountain-to-mountain exchange program between the Andes, Appalachia, and Himalayas. Vice President of UNORCAC, Magdalena Fueres, visited the US and Foxfire Foundation of Rabun County, Georgia, where she learned about their efforts to document local knowledge (see article in Mountain Research and Development). Lessons learned from participatory watershed management (a SANREM method) were utilized in workshops and Year of the Mountain (UNCED, Chapter 13) planning.

International. As a participant in the Inter-Agency network related to UNCED Agenda 21 initiative on mountains, SANREM Andes has published "lessons learned" in participatory watershed management and extrapolated these results to dozens of similar projects around the world. One case is the United Nations FAO Asian Watershed Management and Training network, which distributed 6000 copies of the SANREM lessons to its participants. Based on this work, an international conference is now being organized at Cornell University (USA). In conjunction with ICIMOD, the project has promoted the need to develop decision support tools adapted to mountains and not simply borrowed from flatlands.

AND 99-02. Ethnoecology: Stakeholder Perceptions and Use of Andean Landscape Maps and Models

The ethnoecology project seeks to describe and analyze local perceptions and understandings of the landscape *vis à vis* scientific measurements, rules, and models. In addition, on a finer level, it aims to disaggregate and compare local perceptions intra-culturally, i.e., between people belonging to different classes, between men and women, and between indigenous people and newcomers. Two methods, cognitive mapping and Thematic Apperception Tests (TATs), have been used to elicit the perspectives of people belonging to different socioeconomic, gender, and ethnic groups. A third method, the story completion test, will be used to frame modeler's rules and predictions in a format understandable to local people and subsequently test the fit between the scientists' models and local people's models of land use change.

Several achievements have occurred during the second year of the project. Forty-eight cognitive maps have been collected. These maps reveal what features are more salient than others to local people and therefore are more likely to be taken into account in their decision-making. A second stage of cognitive mapping has been undertaken in which informants were asked to map over a referenced map that was constructed based on the commonly recognized landmarks from the initial mapping exercise. The responses to the TATs varied most dramatically with respect to ethnicity and degree of integration, with indigenous people expressing more attachment to the natural environment and *mestizos* expressing more awareness of development change.

On the premise that decision-making can be severely limited by the lack of alternatives available to local people, memory banking was undertaken to conserve local knowledge and practices that are in danger of disappearing with rapid and misguided development. Conservation of the cultural legacy went hand-in-hand with the conservation of the biological legacy. A workstation was established in Cotacachi to facilitate documentation and transmission of indigenous adaptations.

Under the guises of this activity, research has also been undertaken that examines the changing role of women in biodiversity conservation. Accomplishments include mapping of home gardens, life history elicitation, social network analysis, and focused group discussions.

AND 99-03. Institutions and Natural Resource Management in the Andes: Advocacy and Action Coalitions Research in Ecuador and Peru

The purpose of the Institutions and Natural Resource Management activity is to increase the sustainability of Andean culture and environment through improved natural resource management partnerships and decisions. This will be done through the identification of sustainable natural resource management issues, the development of decision support tools, and the dissemination of these tools and other information to appropriate actors. This work is being done using an advocacy/action coalition framework which examines the relations among the state, the market, and civil society.

In Cotacachi, Ecuador, we have identified three key natural resource issues for study: mining, water usage, and governance of the adjacent bio-reserve. In-depth interviews were conducted with 19 key institutional actors at the local, regional, national and international levels. We will analyze recorded interviews, focus groups, and organizations' documents, using text analysis software to document their *mental causal models* (means-ends perceptions), context and process, legal and administrative patterns, and organizational discourse as a key to desired futures.

Interviews have been initiated in the central highlands of Peru, where research will center on communal land access, its management, and relation to market access and private land usage.

Research results suggest that the implications of devolution and privatization for natural resource management are rarely weighed by development professionals. Impacts thus far include awarding of SANREM's non-governmental organization (NGO) partners an important advisory and facilitating role in the implementation of policy around Cotacachi's "Ecological Canton" declaration, legitimization of the advocacy coalition approach within the World Bank, and use of the methodology in watershed research and in institutional planning with regional sustainable partnerships in Minnesota.

AND 99-03. Institutions and Natural Resource Management in the Andes: Organizational Capacity and Social Capital in Four Ecuadorian Indigenous Secondary Level Organizations (SLOs) and in Colonization Communities in Nanegal Parish, Pichincha, Ecuador

The purpose of the Institutions and Natural Resource Management activity is to increase the sustainability of Andean culture and environment through improved natural resource management partnerships and decisions. This will be done through the identification of sustainable natural resource management issues, the development of decision support tools, and the dissemination of these tools and other information to appropriate actors. This activity is an extension and modification of the social capital research carried out during the first five years of SANREM's Phase I work and developed from the advocacy coalition activity. The activity research assesses efforts by local communities and

secondary level organizations (SLOs) to empower themselves to bring about local development by strengthening organizational capacity as well as bridging and bonding social capital. As part of the synthesis from Phase I, a longitudinal comparative analysis of land use changes from four Nanegal communities combined interpreted information from aerial photographs and a satellite image of the area with data from the household census carried out by SANREM. These community-level land use patterns and changes were then related to social capital in the four communities. We also examined the relationship between social capital and organizational capacity in several communities. The quantitative study showed that an SLO with an efficient and flexible organizational style fostered internal community cooperation, an absence of conflict within its member communities, and cooperation among communities. A vertical and elitist style seemed to generate conflict within communities, and diminish internal community cooperation and inter-community collaboration. Impacts include an inducement of UNORCAC (a local indigenous peoples' organization in Ecuador) to be more inclusive in its search for leaders, and cross-fertilization with social capital research and application in the U.S. and in World Bank circles.

AND 99-05. Water Resources Management and Environmental Education in Two Andean Watersheds

The purpose of the Water Resources Management activity is to adapt, transfer and compare techniques and approaches for participatory water resource management and education to Ecuador and the Andean Region that have been developed at the SANREM Southeast Asia site and the United States. Water resources management activities in Ecuador were limited during 1999-2000 to a single, five-day bacteriological survey of surface and drinking water in Cotacachi with members of communities where UNORCAC (a local indigenous peoples' organization in Ecuador) is active. Water samples from 97 sites in 41 UNORCAC communities in the Canton of Cotacachi, Ecuador, were analyzed for the presence of coliform bacteria. Data from bacteria counts were entered into a computer database at PUCE. Bacteriological testing from sites along the water distribution systems from twenty-one communities indicated the presence of coliform bacteria, including *E. coli* at concentrations far above safe levels even for whole body contact. Bacteriological analysis of water in sites from 25 communities indicated no coliform contamination. The seven worst communities had total coliform levels that exceed above 1000 total colony forming units (cfu) per 100 ml of sample.

AND 00-07. Sustainable Mountain Futures: Linking People and Information for Effective Landscape Decision-Making in the Andes

The SANREM Andean project researches the gap between local decision-making realities and scientifically based decision-making processes for the purpose of creating negotiated future visions of the landscape. The purpose of this activity is to serve as the core integrating activity for the SANREM Andes project. It aims to design a research strategy and methodology that involve local populations in the integration, testing, ground-truthing, and adapting of decision support tools aimed at sustainability. During 1999-2000, significant new strides were made in developing the future visioning methodology. Both scientific and local data (qualitative, quantitative, maps, models, soils classification, etc.) were advanced in two Ecuadorian sites (Nanegal and Cotacachi). Land use projections to the year 2014 have been completed for Nanegal while a representative watershed in Cotacachi has been selected for similar work. Soil classification and mapping have been initiated (both indigenous and scientific). Some soil sampling in cultivated fields was initiated. Other measurements (terrace morphology, soil erodibility, and weather data) have also commenced in conjunction with the Land Use Change activity. Local visions of the landscape have been operationalized (10 visions in each area) and initial interviews were conducted with diverse stakeholders. In sum, during the past year excellent strides have been made in advancing both the theory and practice of participatory decision-making in the context of establishing environmental management priorities and planning. A parallel study area was opened in the Georgia Piedmont (Broad River Watershed) to test the future visioning methodology in the United States.

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Ethnoecology: Stakeholder Perceptions and Use of Andean Landscape Maps and Models

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Introduction

While policymakers involved in land use planning and natural resource management need to be informed about their options based on scientific data, policy development should also include a participatory approach – one where local people take part in the process (De Walt 1994; Sillitoe 1998). Since the local population will make, and live with, resource management decisions and practices, indigenous or local knowledge is extremely important and should be factored in during policy formulation. In addition, local people's perceptions of the landscape offer a model for operating within the landscape, and as such should be central to any decision support tool. Local perspectives and evaluation criteria need to be understood and integrated into holistic and realistic decision-making models.

The ethnoecology project seeks to describe and analyze perceptions and understandings of the landscape for people in two communities in Ecuador (Nanegal and Cotacachi) and to compare them with the scientific data relative to that landscape. On a finer level, it aims to disaggregate and compare local perceptions intraculturally, i.e., between people belonging to different classes, between men and women, and between indigenous people and newcomers to the communities. The goal is to infuse scientists' environmental assessments and "future scenarios" with a grounded understanding of local realities.

Learning how to understand a negotiated watershed management process, and developing research and training publications to extend the experience, is the essence of this project.

Objectives

This project aims to complement biological and economic research by focusing on interrelationships with significant sociocultural variables extant in the landscape. The specific objectives are:

- To map local realities and stakeholder perceptions as input to a "future scenarios" planning exercise.
- To "ground truth" or double check scientific models, rules, and predictions regarding land use change compared to what is happening on the ground.
- To put Decision Support Information to use by supporting local initiatives in biodiversity conservation emphasizing the role of local youth and women.

Methods or Approach

Two methods, cognitive mapping and Thematic Apperception Tests (TATs), were used to elicit the perspectives of people belonging to different socioeconomic, gender, and ethnic groups. Some common threads have been identified and these threads are used to compare the contextualized local knowledge with the objective and quantitative scientific models. A third method, the story completion test, will be used to frame modeler's rules and predictions in a format understandable to local people and subsequently test the fit between the scientists' models and local people's models of land use change. A fourth method, memory banking methodology, was used to conserve local knowledge and practices.

Cognitive Mapping. An equal number (24) of hand-drawn maps were collected from each of two communities in Ecuador (Nanegal and Cotacachi). The total of 48 hand-drawn maps came from informants representing different class, gender, and ethnic groups from the two communities. The maps will help identify the relative importance of environmental features to different groups. The social and cultural patterning of perception will also help explain differences in decision-making

among different stakeholders. In addition to free-style mapping, 47 referenced maps were elicited for GIS analysis.

Thematic Apperception Tests. Visions of landscape change derived from local perspectives were investigated through Thematic Apperception Tests (TATs). Four sets of photographs that illustrated different land use patterns and cultural situations were given to 47 key informants. Informants were asked to arrange the plates and tell a story about each plate and their arrangements.

Memory Banking. On the premise that decision-making can be severely limited by the lack of alternatives available to local people, memory banking was undertaken to conserve local knowledge and practices that are in danger of "disappearing" with rapid and misguided development. In order to document and conserve indigenous alternatives in agriculture and land use, local youth were trained in memory banking methodology (Nazarea 1998). "Memory banking" is a way to preserve farming knowledge accumulated over many lifetimes.

Schools also participated in *in situ* conservation of culturally significant plants in both Nanegal and Cotacachi. Along with this, a comparative framework of sociocultural marginality focused on gender, ethnicity, class, and age was constructed based on the investigation of social networks, home gardens, and life histories.

Results and Discussion

Cognitive Mapping. Forty-eight cognitive maps have been collected. These maps reveal a great deal about what features of the environment local people pay attention to; in other words, what features are more salient than others and therefore more likely to be taken into account in their decision-making. A second stage of cognitive mapping has been undertaken in which informants were asked to map over a referenced map that was constructed based on the commonly recognized landmarks from the initial mapping exercise.

In comparing the maps, the indigenous group from Cotacachi emphasized the natural environment whereas the people of Nanegal emphasized social and community infrastructure. Also, more people in Cotacachi tended to map vertically, apparently more with reference to their system of priorities than to any spatial orientation. It should be noted that verticality is a distinctive character of Andean mythology and art. It is interesting that it translated into a unique way of mapping the landscape.

Preliminary analysis of the maps for commonly recognized landmarks revealed that in Nanegal, people paid attention to (ranked according to frequency of representation): (1) park of Nanegal, (2) community of La Perla, (3) community of Palmitopamba, (4) football stadium of Nanegal and community of Marianita, (5) church of Nanegal, Alambi river, and community of Playa Rica, and (6) church of Palmitopamba and school of Palmitopamba. By comparison, people in Cotacachi paid attention to the following features of the landscape (likewise ranked): (1) town of Cotacachi and Cotacachi mountain, (2) Imbabura Mountain and church of San Francisco, (3) town of Quiroga, town of La Calera, and, Cuicocha Lake, (4) San Francisco park, (5) road to San Jose, road to Ibarra, road to Otavalo, 10 de Agosto Street, town of Imantag, and market, and (6) park of Matrize, church of Matrize, hospital, and stadium. These results were used as a basis for constructing referenced maps or maps in which commonly recognized landmarks are already indicated. The results of this second mapping exercise are still being analyzed but it seems that the referenced maps (generated for the purpose of having at least four common points for GIS analysis) considerably inhibited informants from representing their own vision of the landscape.

Thematic Apperception Tests. The responses to the Thematic Apperception Tests (TAT) varied most dramatically with respect to ethnicity and degree of integration. Indigenous people expressed more attachment to the natural environment while *mestizo* newcomers to the area expressed more awareness of development change.

In order to carry out the TATs, the project documented resource management practices of various ethnic, gender, and socioeconomic groups in the area. Photographs that depicted various stages of development and commercialization were selected. Informants were asked to place sets of three TAT plates in order according to their own perspective, and to tell a story about the progression as well as each of the individual plates. The results still have to be quantitatively analyzed but an observation regarding the execution is worth reporting because it supports the results of our work with TATs in other areas. People more integrated into the market and the development arena practically demanded to know the details about the photographs (where? who? sometimes even why?) before they would tell any stories while people who were less integrated would start telling stories with no such preoccupation. A parallel contrast seems to apply to men compared to women. On the whole though, the TATs were viewed with great interest and informants had little difficulty in responding to the stimuli. We expect that the analysis will round out the findings from the cognitive maps and provide us with a better understanding of how local people "see" and behave in relation to their environment and how their decision-making is influenced by their position in society.

Memory Banking. Young people from Nanegal and Cotacachi were trained in youth-led memory banking (or the documentation of their elders' knowledge and time-tested strategies). Conservation of the cultural legacy went hand-in-hand with the conservation of the biological legacy. Traditional edible and medicinal plants were also collected from older farmers and gardeners and planted as *in situ* collections in school gardens in Cotacachi and Nanegal.

In this connection, too, folktales were collected and archived in both areas. A workstation was established in Cotacachi to facilitate documentation and transmission of indigenous adaptations.

Thirty-five local stories comprised of folk tales, myths, and legends have been taped, transcribed, and translated. They have been archived in Ecuador and at the University of Georgia's Ethnoecology/ Biodiversity Laboratory. The tales incorporate a lot of trickster elements in which the less powerful (e.g., the rabbit) ultimately outwits the more powerful (e.g., the fox). Particularly in Cotacachi, the stories also attest to the intimate connection between people and natural features. In many cases, mountains and rivers are addressed as ancestors or deities and given human attributes. This is less so in Nanegal, which is understandable since the *mestizo* settlers have had a shorter history in the area and may have forgotten some of the stories of their origin. The purpose of documenting these stories is twofold. Primarily, the initiative is a complement to youth-led memory banking. Second, the folklore will be studied for the structure of storytelling in these areas. The insights gained from this exercise will guide the "packaging" of modelers' rules and predictions for the story completion test.

A final component of this research is a dissertation project on the changing role of women in biodiversity conservation. Home gardens of key informants were mapped to gauge changes in agrobiodiversity through time in relation to women with different degrees of integration to economic development. Life history elicitation, social network analysis, and focused group discussions were also undertaken to investigate women's own perceptions of changes concomitant with development and their assessment of how these changes have affected their lives. Local women expressed appreciation from the fact that their voices were being heard and decided to make concrete plans to "intervene" in their own "development."

Impacts

As part of the memory banking activities, 25 youth were trained in documenting the knowledge of their elders in the community. Two *in situ* genebanks were established, one in Ulpiano de la Torre High School and the other in Palmitopamba Elementary School. Knowledge about plants cultivated in *in situ* genebanks were documented by the youth. Herbarium specimens were also preserved in the schools.

Documentation of local stories (legends, myths, and folktales) has increased the interest of indigenous leaders to start conserving traditional knowledge. The local organization (UNORCAC) is planning to air some of these stories regularly in their radio program.

Results of the youth-led memory banking research were disseminated to a large audience during the anniversary of Ulpiano de la Torre High School. Fifteen participants presented the results of their studies to students, teachers, parents, and guests.

Approximately 30 women attended a meeting in Palmitopamba to identify major problems in their community. According to the women, this was the first such meeting in 10 years and they said the meeting opened the communication lines among the members of the community. They also planned to develop some projects that will help improve the condition of women.

Publications, Presentations and Other

Nazarea, Virginia D. 1999. Collecting traditional knowledge about herbs. International Herb Conference. Athens, Georgia.

Nazarea, Virginia D. 1999. Colporteurs, seedsavers, and jumping genes. Center for the Humanities Lunch-in-Theory Series. Athens, Georgia

Nazarea, Virginia D. (ed). 1999. Ethnoecology: Situated Knowledge/Located Lives. Tucson: University of Arizona Press. 299 pp.

Nazarea, Virginia D. 1999. Lenses and Latitudes in Landscapes and Lifescapes. *In* Ethnoecology: Situated Knowledge/Located Lives. V.D. Nazarea, ed. Pp. ?. Tucson: U. of Arizona Press.

Nazarea, Virginia D. 1999. Locally-initiated and locally-sustained memory banking and *in situ* conservation. Invited lecture to EcoCiencia. Quito, Ecuador..

Nazarea, Virginia D. 1999. Praxis Award. Washington Association of Professional Anthropologists. Recognition for memory banking project; relevant application of anthropological concepts.

Nazarea, Virginia D. 1999. A View from a Point: Ethnoecology as Situated Knowledge. *In* Ethnoecology: Situated Knowledge/Located Lives. V.D. Nazarea (ed). Pp. 3-20. Tucson: University of Arizona Press.

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Institutions and Natural Resource Management in the Andes

Advocacy and Action Coalitions Research in Ecuador and Peru

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Introduction

The overall purpose of this project is to increase the sustainability of Andean landscapes and lifescapes through improved natural resource management partnerships and decisions. The research assesses ways in which local communities empower themselves for place-based development by strengthening both bridging and bonding social capital and building advocacy/action coalitions of market, state, and civil-society entities around common desired futures.

Natural resource decision-making can be understood by examining relationships among three institutional sectors: market, state, and civil society. Appropriately balanced and linked, these sectors can reinforce one another and promote sustainable development.

The market provides production incentives and assures efficient distribution of traded goods and services. However, the market does not effectively reduce poverty nor ensure environmental sustainability. Well-organized governments can regulate and provide incentives to the market sector when such market failure occurs. A robust and diverse civil society reduces transaction costs in the other two sectors by building trust, diversifying social networks, and providing social values for the state's regulation of the market. A healthy civil society generates both bridging and bonding social capital, creating opportunities to conserve and enhance natural capital.

Objectives

The objectives of this activity are to:

- Identify and analyze Sustainable Natural Resource Management (SNRM) issues and decision points within local, regional, national and international contexts.
- Develop Decision Support tools that encourage SNRM strategies appropriate for different institutional levels and different institutional actors.
- Disseminate SNRM Decision Support (DS) tools and publications to appropriate actors at appropriate levels throughout the Andes and beyond; Train people to implement and evaluate the efficiency and effectiveness of DS tools.

Methods or Approach

Relations among the state, market, and civil society are researched using an *advocacy/action coalition* framework. Organizations, agencies, and firms coalesce around concrete issues to achieve common ends. *Mental causal models* are specific perceptions of the relation between means and ends (desired futures). Most organizations accept information supportive of their interests or values.

Based on participant observation in the Canton of Cotacachi, we have identified key natural resource issues: mining, water usage, and governance of the Cotacachi-Cayapas Bioreserve. In-depth interviews were conducted with 19 key institutional actors at local, regional, national and international levels. Many interviews covered more than one issue area. Confirmatory focus groups are being conducted with local institutional actors with similar desired futures. One focus group has been completed on the topic of irrigation and drinking water (water quality and quantity). We plan to do at least two confirmatory focus groups on each issue area—each based on a potential advocacy coalition. This should encourage formation of advocacy coalitions. A

heterogeneous focus group would follow should reconciliation of different entities' desired futures appear possible, or if common means for reaching similar futures might result.

We will analyze recorded interviews, focus groups, and organizations' documents using text analysis software to understand means and ends, context and process, legal and administrative patterns, and organizational discourses. The coding protocol for text analysis was completed and later revised. All 19 interviews have been coded, although some recoding will be necessary. Scanning of organizational documents has been completed, but their coding has not.

Grupo Yanapai has initiated interviews in the central highlands of Peru. Research will center on communal land access and management, and their relation to market access and private land usage. We will characterize the property rights, customary arrangements, and regulatory framework for the management of agricultural and grazing lands, livestock (sheep and llamas) and water. Issues will be assessed comparatively, taking into account different approaches to governmental decentralization and privatization in the two countries.

Results and Discussion

We have completed an initial review of the recent decision history of natural resource management worldwide to identify decision tools used to promote desired futures. That annotated bibliography has been circulated to the Global team. A first draft of the advocacy coalition theoretical perspective has also been completed. We have begun training Andean students in the U.S. in content analysis for decision framing. We have installed the text analysis software in Ecuador and Peru initiated training there in May 2000.

The principal investigators were invited to share their work on social capital and advocacy coalitions with the Poverty Section of the World Bank in April 2000. They made two presentations to World Bank personnel in Washington, and conducted a videoconference with Rumanian grassroots leaders working with the Social Fund of the Bank. Subsequently, Cornelia Flora met the Rumanian group face to face in Washington. A trip to Bulgaria is planned where C. Flora and Veronica Nyhan, of the World Bank Poverty section, will lead several social capital workshops with Bulgarian and Rumanian grassroots leaders.

Using N-Vivo software, we have analyzed the CONDESAN electronic conference dialogue on local governments and devolution. We found only five mentions of natural resources in the course of the entire dialogue, suggesting the need for explicit attention to natural resource management as a part of the strategy of devolution and decentralization, as it is not a high priority item until explicitly linked to local issues.

Impacts

The Ecuadorian SANREM partners are involved in implementation of policies surrounding the declaration of Cotacachi as an "Ecological Canton." The research on advocacy coalitions and government decentralization dovetails nicely with the Instituto de Estudios Ecuatorianos' (I.E.E.'s) other applied work with the municipality on local democracy. The Ecuadorian partners have influenced the citizen-based Cantonal Assembly and its working committees, which link civil society organizations with local government. This participatory approach contributed to the indigenous mayor's landslide reelection in April 2000, and assures a favorable climate for our research.

The esteem with which Fundación Heifer (the Heifer Foundation, an American NGO), I.E.E., and Terranueva are held by different institutional actors in the canton, when coupled with the information and local knowledge being generated through the advocacy coalition research, presages more visible impacts in the next couple of years. We anticipate that in one of the three issue areas, our research process may contribute to the resolution of institutional conflicts.

In Peru, the groundwork is being laid for some significant impacts. Grupo Yanapai's great strength is its field team and their participatory methodology. The advocacy coalition approach will allow them to combine that participatory methodology with network building at the regional and national levels. This will contribute to the reduction of bottlenecks that limit the utility of participatory work at the grassroots level. They have made progress in resolving certain outstanding land and governance issues among communities in and near the Municipality of Quilcas. Yanapai built understanding between the presidents of the two communities by arranging for them to visit the southern highlands (neutral territory) together. A Yanapai member accompanied them.

The World Bank, already interested in the SANREM-supported work on social capital, recently utilized the advocacy/action coalition approach in other countries. We were able to share it with the Social Funds in Romania and Bulgaria in order to build positive social capital for development.

We have shared the methodology and theory with colleagues in Peru and Argentina who work with indigenous communities vis-à-vis sustainable agriculture and natural resource management issues in the Andes.

In December 1999, preliminary interviews were conducted jointly with the National Argentine University of Comahue in Patagonia with remnants of Mapuche communities there. The Floras applied parts of the advocacy-coalition focus group methodology to natural resource management watershed research and to the planning process of four Regional Sustainable Development Partnerships in Minnesota. Clearly this SANREM research has had an effect in the U.S.

Presentations

Flora, Cornelia. 1999. Exploring the borders: Gender, diversity, agriculture and food. Panel presentation, Rural Sociological Society, Chicago, August 7, 1999.

Flora, Cornelia and Jan Flora. 2000. Building Social Capital for Development. Two invited presentations on the SANREM Andes research at World Bank, April 10 and 11, 2000. Also presented to a working group on social capital in Romania via satellite.

Flora, Jan L. 2000. Manejo de Recursos Naturales y Coaliciones de Persuasión/Acción [Management of Natural Resources and Advocacy/Action Coalitions]. Presentation to Geography Department, Catholic University, Quito, Ecuador, May 29, 2000.

Flora, Jan L. 2000. Natural Resource Management in the Northern Andes of Ecuador. Presentation to *What's Up in Sustainable Agriculture?* Luncheon series, Dept. of Agronomy, University of Minnesota, Feb 23, 2000.

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Institutions and Natural Resource Management in the Andes

Organizational Capacity and Social Capital in Four Ecuadorian Indigenous Secondary Level Organizations (SLOs) and in Colonization Communities in Nanegal Parish, Pichincha, Ecuador

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Introduction

The overall purpose of this project is to increase the sustainability of Andean landscapes and lifescapes through improved natural resource management partnerships and decisions. The research assesses ways in which local communities empower themselves to bring about place-based development by strengthening organizational capacity and both bridging and bonding social capital.

Objectives

- Analyze the capacity of Cotacachi and other institutions to manage natural resources.
- Develop Decision Support tools that encourage sustainable natural resource management (SNRM) strategies appropriate for different institutional levels and different institutional actors.
- Disseminate SNRM Decision Support (DS) tools and publications to appropriate actors at appropriate levels throughout the Andes and beyond; train people to implement and evaluate the efficiency and effectiveness of DS tools.
- Train NGOs and other interested parties in decision support analysis.

Methods or Approach

Our social capital research has been extended from four Nanegal communities, carried out in SANREM's Phase I (1992 - 1997), to the examination of the relationship between social capital and organizational capacity in four secondary level organizations (SLOs) and a sample of member communities (five communities per SLO). One of the four SLOs is UNORCAC (The Union of Peasant Organizations of Cotacachi).

Dr. Thomas Carroll, emeritus professor of economics, George Washington University, and Dr. Anthony Bebbington, geography professor from the University of Colorado at Boulder, devised a series of key informant questionnaires aimed at obtaining information regarding organizational capacity, and social capital (including external networks, and internal and external conflicts — the latter being a negative indicator of social capital) at both the SLO and the community level. Four constituent communities were chosen from each of the four SLOs. Five leaders were interviewed in each SLO and each community. This provided a total of 20 "trials" (cases) at the SLO level and 100 "trials" at the community level, much as soil scientists take multiple samples from the same field. By assigning characteristics of the parent SLO to each community respondent, we were able to do path analysis (n=100) of the relationship between SLO leadership style (each of which included a bundle of social-capital and organizational-capacity characteristics) and community social capital. In addition, Mary García has completed an excellent in-depth qualitative study of UNORCAC, based on the interviews with the five leaders and several former leaders of this SLO, and it will be published in year 3.

In addition, Patricio Fuentes and Jan Flora carried out a longitudinal comparative analysis of land use changes of the four Nanegal communities. The study combined interpreted information from aerial photographs and a satellite image of the area with the household census carried

out by Terranueva and Fundación Heifer (HPI-Ecuador) in Phase I. These community-level data of land use patterns and changes were then related to social capital in the four communities in a draft paper that will be revised for submission to a journal, and for publication in Spanish in Ecuador.

Results and Discussion

A monograph on types of community capitals in Cotacachi was published in Spanish by the Ecuador team and is already sold out in Ecuadorian bookstores. The monograph is based on a review of existing written assessments (*diagnósticos*) of UNORCAC in the highland portion of the canton, supplemented with key informant interviews. The monograph discusses the four capitals framework — financial, social, human, and natural — to suggest policies and key decision points.

A near final version of UNORCAC's history and a qualitative-quantitative analysis of its institutional capacity, as well as a draft of the comparative quantitative analysis of the four SLOs and their communities were compiled during 1999-2000.

We analyzed quantitative data comparing the capacity of four indigenous secondary level organizations in Ecuador. The analysis was conducted in collaboration with Dr. Tom Carroll of George Washington University, with funding from the Danish government and a modest contribution from SANREM. We found that organizational leadership style at the level of the SLO has a substantial effect on community social capital. Two dimensions of SLO leadership were identified: one was presence or absence of an open, reflective, and negotiating style; the other had a bureaucratic, vertical and more elitist style at one end of the continuum and organizational efficiency and flexibility at the other. An efficient and flexible style fostered internal cooperation and an absence of conflict within its member communities, as well as cooperation among communities. A vertical and elitist style seemed to generate conflict within communities, and diminish internal community cooperation and collaboration among communities. Interestingly, communities characterized by more diverse leadership tended to belong to SLOs that lacked open and reflective leadership and had a more vertical and elitist governing style. It is as if a more authoritarian and/or less conciliatory SLO encourages a greater diversity of leaders at the community level, perhaps in reaction to a more controlling parent organization.

The preceding quantitative research results are supported by Mary García's qualitative study. She finds that UNORCAC, which tended toward the vertical organizational style, has been most successful at fostering cultural cohesion (particularly recuperation of the Quichua language among young people) at gaining government services for the rural areas where most indigenous inhabitants live, and at political mobilization. It has also been successful at getting grants, particularly from international donors. Weaknesses include failure to build strong links with the communities and a complete incapacity for economic self-sustainability. The dependence of the organization on outside funds is virtually total (which is related to the weak links with member communities). The fiscal crisis of the Ecuadorian state and a shift of local power to an alliance of indigenous groups and progressive mestizos, calls into question the clientelistic politics of the 1980s and early 1990s, and demands greater emphasis on economic regeneration involving alliances of state, market, and civil society organizations. Only then will the circular labor migration of so many males from rural households be halted.

Impacts

The institutional study of UNORCAC contributed to the decision to elect a woman as vice-president of the secondary level organization, as the SLO took to heart the conclusion in the comparative study that it was not encouraging women and youth to participate in organizational leadership. In April 2000, the female Vice President of UNORCAC became a member of the Council of the Canton of Cotacachi, elected by vote of the people of the canton. Organizational leaders are discussing alternative community building strategies laid out in the report prepared by Mary Garcia. More formal presentations of the results to UNORCAC is planned in 2000-2001.

The World Bank has used a version of the questionnaire developed by Thomas Carroll and we anticipate that they will be an interested consumer of the approach used to decant the number of indicators used in this unwieldy instrument. The World Bank may also be interested in the results of the quantitative paper relating organizational capacity and social capital at the SLO and the community level.

The Organizational Capacity activity principal investigators currently have an extensive research and outreach agenda regarding social capital in rural U.S. communities. The methods and results used in Ecuador and the U.S. inform one another and strengthen theory and application in both settings.

Publications and Presentations

Baez, Sara, Mary Garcia, Fernando Guerrero y Ana Maria Larrea. 1999. Cotacachi: Capitales comunitarios y propuestas de desarrollo local. Quito: Ediciones Abya-Yala. (A co-publication of Ayuda Popular Noruega, SANREM CRSP Ecuador, Instituto de Estudios Ecuatorianos and Terranueva.) 101 pp.

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Water Resources and Environmental Education in Two Andean Watersheds

Introduction

Water quality and quantity have been getting more attention as indicators of land use. Degradation of water quality due to increases in population, waste disposal and intensive land use in agriculture has been noticed by the inhabitants of the communities in Canton Cotacachi, Ecuador. Inhabitants noticed flow reduction in local springs and considered that it may be related to deforestation, new agricultural and horticultural activities, overgrazing and other resource management activities in the region. UNORCAC, which is an organization that represents 43 communities in the canton, felt the need to do something to improve water quality in nature and to maintain high quality drinking water. This project addresses UNORCAC's concerns by training and equipping residents of the watersheds to be water quality monitors and provide scientifically valid water resource data. The resulting information will be presented in formats appropriate to interest groups, including teachers, decision-makers, the scientific community and the general public.

Objectives

- Provide technical support to citizen monitoring groups for collection of data on water quality and quantity at Nanegal and Cotacachi sites.
- Integrate the water work plan with the "futures scenarios" project.
- Establish partnership and linkages for research, outreach and training/education activities in Andean region.

Methods or Approach

The citizen-based water quality monitoring participatory research approaches being used in Ecuador were modeled after the Alabama Water Watch, a citizen volunteer program that is being developed and implemented in the United States. The training workshop design and training materials were adopted from the U.S. program. The water quality parameters and test kits selected are being successfully used by U.S. citizen monitors, most of whom had little technical background. Manuals and other reading materials for the workshops have been translated to Spanish and community developers helped customize them to the local situation.

There are two research methods that are being undertaken in the field. Water chemistry determinations are compared with standard values and indicate water quality. Water was also monitored for the presence of coliform bacteria. High counts of coliform bacteria, especially *Escherichia coli*, indicate fecal contamination and the possible presence of pathogens.

1. *Water Chemistry*. Water quality is determined by measuring seven parameters (air and water temperature, pH, hardness, alkalinity, dissolved oxygen and turbidity) with a customized standard water quality test kit (LaMotte Company) that uses colorimetric techniques.
2. *Bacteriological Survey.* The bacteriological monitoring is conducted using a relatively new technique for measuring concentration of *E. coli* and other coliform bacteria in water samples. This method uses one milliliter of water sample, collected using a sterile, plastic pipette and squirted into a 10 mL bottle of sterile, liquid medium. The medium (with color indicators for coliforms) containing the water sample is poured onto a sterile, plastic dish, which is designed to induce the liquid to solidify. Incubation of sample plates is conducted at room temperature or at a higher controlled temperature (35° C is suggested), which allows for growth of the bacterial colonies and permits enumeration in about 36 hours. No incubators, sterilizers or glassware are needed for this technique, and necessary

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supplies (which cost about one dollar per sample) are easily transported to remote areas for sampling scores of sites per day. Following the incubation period, bacterial colonies of *E. coli* and other coliforms are enumerated and reported for feedback to the communities.

Results and Discussion

From July 21 to 27, 1999, Sergio S. Ruiz Cordova, Hector Ballesteros, Aurelio Vicuña, Nicolas Gomez and Julian Pillaluisa visited 97 sites along 39 of the 43 UNORCAC communities in the Canton Cotacachi, plus the cities of Quiroga and Cotacachi. Two of the communities had no running water at the time of the visits and were thus not sampled, and two communities are remote and are not included in the project. Seven physical and chemical parameters were measured at every spring and water storage tank from 15 water systems and water samples were collected for coliform bacteria analyses. A total of 291 bacteria plates were used during this survey to assess water samples from these sites plus samples from two randomly chosen houses in each community. Data from bacteria counts were entered into the computer database at PUCE. Bacteriological testing from sites along the water distribution systems from nineteen communities indicated the presence of *E. coli*, as well as of other coliforms (Table 1). Samples from Cumbas Conde, Morales Chupa, and Tunibamba Bajo were positive only for other coliforms. *E. coli* counts in samples went from 33 to 5,333 in 100 mL, which is above safe levels for whole body contact according to EPA standards. Bacteriological analyses of water in sites from 17 communities, plus the cities of Cotacachi and Quiroga, indicated no coliform contamination at all. The City of Cotacachi houses more than one-third of the total population of the Canton (about 50,000 people). The communities of Arrayanes, El Batán, Guitarra Urco, San Martin, San Miguel, Turuco and Ugshapungo had some of the most contaminated sites with levels above 1,000 total coliforms in 100 mL of sample.

Impacts

Water quality and quantity played an important role during the last political campaign in Cotacachi and the SANREM Water Resources Management Program was an important factor in the election of several UNORCAC members as municipal leaders in their communities. Opposing political parties argued the inefficiency of ruling leaders to address water issues and the lack of studies on drinking water quality. However, UNORCAC leaders, strong supporters of the acting mayor, answered back with the results of the bacteriological survey conducted by SANREM in July 1999. The SANREM goal of providing local decision-makers with appropriate data, decision support tools and methods was accomplished when the time came for individuals and organizations to elect their municipal leaders for the forthcoming four years. The community-based water quality-monitoring program as participatory research with local citizens from all UNORCAC communities has strengthened the unity of indigenous and mestizo people. Water resources used to be the center of confrontation and still are in some areas, but interest is developing in citizen monitoring, and in becoming knowledgeable about the issues related to water quality. The SANREM water quality-monitoring program is strengthening the municipal and the indigenous organizations in Cotacachi.

Table 1. Total *E. coli* and other coliform bacteria detected in water samples from UNORCAC communities and the cities of Cotacachi and Quiroga taken during the bacteriological survey conducted in Cotacachi, Ecuador in July 1999.

Community	*E. coli* (cfu/100 ml)[2]	Other Coliform Bacteria (cfu/100 ml)[2]
Alambuela Alto	183	611
Ambi Grande	0	0
Anravi	0	0
Arrayanes	3667	2389
Ashambuela	0	0
Azaya	67	356
Chilcapamba	0	0
Chilcapamba Bajo	0	0
Colimbuela	0	0
Cotacachi[1]	0	0
Cuicocha Centro	0	0
Cumbas Conde	0	100
Domingo Sabio	0	0
El Batan	1556	2941
El Cercado	0	0
El Morlan	167	222
Guitarra Urco	4333	8944
Iltaqui	0	0
Imantag Centro	0	0
Morales Chupa	0	100
Morochos	67	100
Perafan	0	0
Peribuela	150	400
Piava Chupa	0	0
Piava San Pedro	0	0
Pilchibuela	0	0
Quiroga*	0	0
Quitugo	111	100
Quitumba	50	100
San Antonio de Punge	33	100
San Ignacio	0	0
San Jose de Punge	167	222
San Martin	1067	689
San Miguel	533	1778
San Nicolas	150	500
San Pedro	50	217
Sta. Barbara	0	0
Topo Grande	117	372
Tunibamba Bajo	0	100
Turuco	2222	5241
Ucshapungo	5333	1778

[1] Cotacachi and Quiroga are cities not included among the 43 affiliated to UNORCAC.

[2] Cfu = colony forming units.

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Sustainable Mountain Futures

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Introduction

The research problem selected by the SANREM Andes team grows from a scattered but growing literature on eco-regional approaches to sustainability. Eco-regional approaches were stimulated by the Rio Earth Summit and have led to new initiatives (methods, tools, and models) that integrate information for research priority setting, problem identification, and organization of research and development in contexts of multiple resource use, multiple scales, and multiple (often conflicting) stakeholders. The new emphasis has increased attention to the role of information technologies, GIS, expert systems and modeling.

The purpose of this activity is to design a research strategy and methodologies that involve local populations (and related stakeholders) in the integration, testing, ground-truthing and adapting of decision support tools aimed at sustainability. This research addresses the gap between local decision-making realities and scientifically based decision-making processes for the purpose of creating negotiated future visions of the landscape.

Objectives

- Integrate data from the SANREM-Andes activities (land use/biodiversity, hydrology, ethnoecology, institutions) into a futures scenario modeling process at two Ecuadorian test sites (Nanegal and Cotacachi).
- Test and refine the participatory future scenarios modeling exercise with a hierarchy of decision-makers (internal and external) connected with the landscapes around Cotacachi and Nanegal.
- Extrapolate the Futures Scenario methodology to other global mountainous landscape/watershed projects as a contribution to Agenda 21, Chapter 13.

Methods or Approach

The methodology of "Sustainable Mountain Futures Scenario Building" involves the following steps:

- Identify multiple decision-makers (internal/external), scales, objectives and record their diverse (and often conflicting) visions of desired future conditions, emphasizing water quality, land use and biodiversity as impacted by lifescape system drivers of economics, institutions, and culture.
- Utilize extant simulation models and other modern and traditional decision support tools (GIS, maps, RS, off-the-shelf hydrology and land use change simulation models, indigenous mapping, etc.) to create *in situ* scenarios of future conditions based on both quantifiable and qualitative variables.
- Present the alternative scenarios and future visions in various media forms (visual, oral, written) as an interactive, user-friendly platform for stakeholder debate, priority setting, planning, policy, and technology generation related to natural resources.
- Create databases that remain with our partner communities but are linked outward whenever possible to other testing sites through the Internet.
- Collaborate in a tropical mountain network aimed at co-testing and adapting this methodology of facilitating fit between science and local knowledge.
- Disseminate relevant decision support tools, methodologies, and lessons learned through training, publications, and teaching to other mountainous areas and projects.

Results and Discussion

During 1999-2000, significant new strides were made in developing the future visioning methodology. Both scientific and local data (qualitative,

quantitative, maps, models, soils classification, etc.) were advanced at both Ecuadorian sites. A parallel study area was initiated in the Georgia Piedmont (Broad River Watershed) to test the future visioning methodology in the United States.

In Ecuador, land use projections to 2014 have been completed for Nanegal while a representative watershed in Cotacachi has been selected. Soil classification and mapping has been initiated (both indigenous and scientific) while some soil sampling in cultivated fields has commenced. Other measurements (terrace morphology, soil erodibility, weather data) have also commenced in conjunction with the Land Use Change activity (AND 08). Local visions of the landscape have been operationalized (10 visions in each area) and initial interviews conducted with diverse stakeholders. In sum, during the year excellent strides have been made in advancing both theory and practice of participatory decision making in the context of establishing environmental management priorities and planning.

In the development of the comparative visions of different stakeholders (objective 2), a GIS database for the Cotacachi region was established that includes data on soils, topography (scale: 1:50,000), land use, ecological zones, population, educational levels, poverty levels, and agricultural production. This database is being used by the land use change/soils (AND-08), water (AND-05), and ethnoecology (AND-02) project in their work. The maps were digitized and have been placed in Arcview. The database is being refined and will be passed to host country collaborating organizations (UNORCAC and Cotacachi Canton) for their own development plans. Maps produced specifically by the project include digitized land use, topography, and hillshade maps for the Palmitopamba community. Land use data from a 30-year period at the Nanegal site has been projected to the year 2014 in an effort to create plausible situations of the future landscape under different scenarios.

Scientific Models. To assess land use change in the Cotacachi area over the past 30 years (1963, 1980, and 1994) aerial photographs were purchased. Hernan Velasquez, Professor of Geography and Director of Natural Resources Information in the Ministry of Agriculture, is working on the initial hot-interpretation that subdivides the study area into four land use categories: crops, pastures, forest and brushland. To compliment land use change research with comparable data on biodiversity, Dr. Marcia Penafiel (CDC-Quito) has begun to collect data on vegetative diversity transects in selected sites (terraced, non-terraced, fields, forests, etc.) within the Ambi watershed and the nearby Cotacachi-Cayapas Ecological Reserve. The combination of the two studies has been designed to replicate previous SANREM research in the Nanegal area.

In the case of Nanegal, Dr. David Stewart analyzed land use patterns using maps produced between 1966 and 1990. The relative proportions of each major land use type (pasture, short-cycle crops, scrubland, and forest) and all pair wise combinations (e.g., land used for mixed pasture/crop) were tabulated for the entire SANREM study area. The main results, with transition frequencies weighted by area, were tabulated. The areas devoted to each major land use were then projected based on the transition frequencies, assuming the conditions (sociological, economic, and environmental) contributing to observed changes during the 1966-1990 time period remain in force. These calculations will allow us to create future scenarios and images of the landscape under different conditions. The future scenarios of scientists will be compared to local people's visions of the future in a workshop in August, 2000.

During May, 2000, a new Andean Project (AND 08) was initiated (W. Miller and F. Zehetner). Soil sampling commenced to prepare a level two soil survey with mapping units relevant to both the Soil Taxonomy system and to local soil management schemes. The area under study extends from Cotacachi west to Morochos and Lake Cuicocha, and northward up the lower slopes of the Cotacachi volcano towards Iltaqui and TopoGrandes. The soils are clearly Andisols, weakly developed sandy and silty volcanic deposits with large accumulations of organic materials in the to 20-30 cm above stratified mixed ash and mud flow deposits. Soil maps and complete soil descriptions are being collected. In addition to the soil mapping, fertility tests are being carried out under different cropping systems, terrace morphology and erosion is being studied as is soil erodibility based on a rainfall simulator.

Local Models. Understanding the local perspective is derived from research in the ethnoecology project and the comparative visions project of the Sustainable Mountain Futures activity (AND-07). Progress on the comparative landscape visions during the year included the compilation of materials used in the production of images for the mapping exercise. The list of materials includes ten image types for La Calera Community, Cotacachi, Ecuador, and ten image types for Palmitopamba Community, Nanegal, Ecuador. They include, for example, topographic, soil, land use, ecological, individual, water maps, three-dimensional models, aerial and black and white photographs, and SPOT satellite images.

Semi-structured interviews were used to ask local people to: 1. locate the general area; 2. locate their position on the image; 3. discuss specific features; 4. discuss distance and borders; 5. discuss land use and land change; 6. discuss the image's utility. Different stakeholder groups were inter-

viewed (farmers, planners, townspeople). Based on an analysis of these interviews, the preliminary conclusion is that local people may not talk about the landscape in the same way as governmental or non-governmental officials. The analysis also indicates several interesting hypotheses that will be tested in the coming months (e.g., reflecting stakeholder differences in scale, social location, differential knowledge, and readability of maps). In addition, during the first six months of 2000, the images were further refined for readability and comparability. A "maqueta" (three-dimensional diorama) was built of both Palmitopamba and Cotacachi. Community meetings were held to arrive at consensus on what items would be displayed. Key themes in the development of the physical model were: social living areas, basic services, appropriation of natural resources/consumption of production, and natural resources.

To help support the production of maps and models for the project, six people from the host country collaborating organization, Catholic University, received extensive GIS training (40 hours) during a two-week period in February, 2000. These individuals were: Aurelio Vicunia, Hernan Velasquez, Zvetlana Costales, Monserrat Jejia, Pau Arrellano, and Andrea Carrion. In addition, two graduate students from the University of Georgia received training.

Since one of the objectives of the SANREM future scenarios methodology is its transferability and its usefulness in the United States, a research project was carried out with the planning commissions and Board of Commissioners in Oglethorpe County, Georgia for the Broad River Watershed. Through a graduate seminar of Dr. R. Rhoades, students carried out ethnographic research on different stakeholder groups, designed a series of tests to arrive at present preferences and "desired future conditions," and conducted a 10 percent random phone sample (including time series data from earlier surveys). The objective of the research was to define and use stakeholder values (consensus and conflict) to make smarter environmental decisions. This research has been written up, discussed in public meetings, and made available to local decision-makers who are presently formulating a new land use zoning-plan for the county.

Impacts

Although it is too early to define empirical impacts, the stage has been set for impacts in subsequent years. We have learned quite a lot about the process of community decision-making in situations of multiple scales/multiple users. "Stakeholder" can be a difficult concept since the same individuals and groups can belong to different and overlapping stakeholder groups. Also, we have learned that in participatory decision-making, the goal is decision insight not necessarily consensus. We have learned that there are key value trade-offs in any change situation. The fact is that disagreement is inevitable and that such differences in interpretation and opinion need to be discussed. The role of science is to provide solid qualitative and quantitative information on the different possible scenarios. Science, however, must be tempered with the visions and values of local people. We feel this participatory "future visioning" methodology, once developed, will be as valuable in the United States as in developing countries.

Publications and Presentations

Fueres, Magdalena. 1999. Women at the Border/ Women at the Helm. Lecture at University of Georgia, Department of Anthropology, December 13, 1999.

Rhoades, R. 1999. Lessons learned and lessons to be learned in sustainable land management. Keynote Address to International Forum. *Protecting Our Previous Heritage: Sustainable Land Use for the 21st Century*. Bangkok, Thailand. July 14, 1999.

Rhoades, R. 1999. Opening Keynote Welcome Address. International Conference *Operationalizing Integrated Conservation and Development Strategies: Lessons Learned Linking People, Projects, and Policies in Tropical America*. Quito, Ecuador, May 9, 1999.

Rhoades, R. 2000. Anthropological research and planning with communities: The Sustainable Futures Methodology. Seminar Lecture, Contextual Research Group. Feb. 14, 2000.

Rhoades, R. 2000. SANREM presentation before Oglethorpe County Rotary Club. March 10 and March 24, 2000 (with Drs. Jerry Johnson and Bruce Maxwell, Montana State University), Lexington, Georgia.

Other

Rhoades, R. 2000. Appointed to Editorial Advisory Board of Mountain Research and Development in May 2000. Centre for Development and Environment, University of Berne, Switzerland. Also, he continues as Board member of IBSR.

Rhoades, R. 2000. Organized full-day workshop on sharing "Future Visioning" methodologies between SANREM-Andes and Montana State University, March 25, 2000.

Rhoades, R. 2000. Panel Discussion Member. Challenges and Opportunities of Interdisciplinary Research and Grants: A Panel Discussion. Institute of Behavioral Research Seminar, University of Georgia, Feb. 8, 2000.

SANREM West Africa

Project Overview

Introduction

West Africa is a unique arid and semiarid region of the world where agriculture and livestock are characterized by a fascinating blend of cultural, socioeconomic and biophysical features. The complex interactions and dynamics of the human populations and their crop and animal systems affect natural resource management in virtually every community within this vast region. These systems include nomadic, transhumant and sedentary agro-pastoral systems. Because these systems by their nature must compete for the same natural resources the potential for conflict always exits.

Presently, increasing human population pressure and poverty, newly evolving social organizations, and increasing variability in weather and climate are further complicating what has historically been a delicate, though sustainable, balance among natural resource users in the region. In areas where viable community-based natural resource management approaches are evolving, negative trends of accelerated environmental degradation and greater competition for natural resources are being counterbalanced. Nevertheless, the situation remains very tenuous. It is essential that natural resource management institutions and strategies be adapted and diffused to concerned stakeholders throughout the region. This will assist not only in improving natural resource management within the region but also in providing information on conflict avoidance techniques.

The SANREM West Africa project is supporting natural resource management (NRM) decision-makers at multiple scales with appropriate data, tools and methods for analysis and capacity building to make informed decisions concerning conflict and NRM problems associated with the agricultural and pastoral systems of West Africa.

Project Objectives

- Establish a multi-year database for modeling the dynamic interactions between the local populations, their NRM technologies and practices at the enterprise or local government landscape/lifescape scale (Target: local, national, and regional researchers).
- Develop biophysical and socioeconomic models that provide cost-effective decision-maker aids for the local government assessment of potential NRM technologies and practices that may be applied at the enterprise or local government landscape/lifescape scale (Target: decision-makers and researchers at all locals).
- Develop a participatory NRM model at the local (Commune) level in the context of West African decentralization and interacting and competing agricultural and pastoral systems (Target: local and national governments and researchers and NGOs).
- Reinforce local government capacity and the ability of local officials to effectively manage their natural resources through the development of a prototype NRM plan at the Commune level (Target: local, national governments, NGOs).
- Expand local capacity building through the identification and application of NRM conflict mitigation strategies (Target: local to regional GOs, NGOs, and communities).
- Disseminate information on NRM models, conflict management methods and associated decision-making tools throughout the West African Sahel (Target: national and regional researchers and the development community).

Progress Toward Five-Year Indicators

Good progress is being made in all activity areas of SANREM WA. Although it is too early to assess long term project impact, the SANREM WA project is on track in achieving its objectives during the past year. This can be seen through the following indicators:

Multi-year database established on NRM technologies/practices: WAF 99-04, 06, and 07 have established point of departure data sets for both socioeconomic and biophysical parameters. Economic and socio-institutional surveys and benchmark characterization of soil, weather and cropping systems have been completed.

Biophysical models designed and providing decision-making information: Data is being prepared for analysis and development of biophysical and socioeconomic models (WAF 99-04 and 06).

Participatory methodology for assessing alternative technologies and practices established: The Natural Resource Management Advisory Committee (NRMAC; WAF 99-07) in the Commune of Madiama has been established as a forum for local discussion, analysis, and development of systems for NRM conflict prevention, mitigation and resolution, as well as planning sustainable and profitable natural resource use.

A prototype NRM Plan developed at the Commune level: The social, political and institutional foundations for the NRM planning infrastructure are being developed through training of the members of NRMAC (WAF 99-07).

NRM conflict mitigation strategies identified and applied: Training in Holistic Resource Management (HRM) consensus building and in conflict prevention, resolution, and mitigation strategies for local leaders, technical assistance providers, and NRMAC members has already led to increased dialog and conflict resolution between villages within the commune.

Information on NRM and conflict management methods and decision-making tools disseminated: The SANREM WA Workshop on Conflict and NRM (WAF 99-05) has called attention to the SANREM WA's commune-level focus and the participatory methodology for developing social infrastructure at this level. Regional collaborators will be closely following the evolution of this experiment in decentralized NRM.

Benefits to the U.S.

The benefits of the SANREM CRSP West Africa Project to the U.S. are that we are building the basis for increased food security under conditions of conflict over natural resources. In so doing, increased stability in the region will promote economic development leading to increased trade with the U.S. and less need for humanitarian assistance and military intervention. In the long run, increased biodiversity and vegetative cover will minimize negative impacts from global climate change. Finally, lessons learned in NRM and conflict resolution strategies can be adapted and applied in the U.S.

Impacts

The Year 2 impacts of the SANREM CRSP West Africa project directly affect the natural resource management decision-making knowledge, self-confidence and capacity of leaders in the Commune of Madiama, Mopti Region, Mali. The lessons learned from this experience will have a broader impact on community leaders throughout the Niger Delta Region and across Mali and the Sahel.

WAF 99-01.
Coordination and Management of SANREM CRSP-West Africa

Coordination between partners at the local, regional and global levels has been a key and continuous objective of the SANREM West Africa regional program management. The PLLA (Participatory Landscape/Lifescape Appraisal; February 1999) laid the foundation for our program to initiate collaboration between the Institute d'Economie Rurale (IER), CARE-Mali, Virginia Polytechnic and State University, Washington State University, and the population in the Commune of Madiama, Mali. On this basis, benchmark characterization studies were initiated concerning the economic, socio-institutional, meteorological, soil fertility, and crop management aspects of natural resources in Madiama. With these activities underway, in collaboration with the three initial village-level user-groups, all ten villages in the Commune were organized into user-groups and united to form a Commune-Wide Natural Resource Management Advisory Committee (NRMAC). The NRMAC functions in liaison with locally elected officials, government authorities, technical agents, and the SANREM CRSP-West Africa research partners (IER, CARE-Djenné, Virginia Polytechnic and State University, Washington State University, and the Center for Holistic Management). Training of community leaders and members of the NRMAC in Holistic Resource Management and Conflict Mitigation Strategies has set the stage for more instrumental natural resource management activities in the coming year.

WAF-99-03.
Cattle and Manure Management Strategies to Increase Soil Phosphorus Level in Western Niger

The purpose of this activity is to provide a scientific basis for policy recommendations concerning the role of phosphorus in grazing land management. The results from this study demonstrate that phosphorus concentration in fecal excretion is 50 percent greater for animals receiving phosphorus supplement compared to those that did not receive any supplement. However, phosphorus supplementation did not have any impact on animal performance (at least during the period of the study). It is unlikely that animal owners will be interested by this outcome. However, at a community level, if farmers and herders are organized, phosphorus supplementation and manuring may be a way to increase considerably nutrient availability in soils.

WAF 99-04.
Modeling Community Socioeconomic Linkages and Growth: Toward Sustainable NRM Agro-Pastoral Systems Under Environmental Stress and Conflict

The primary purpose of this activity is to provide decision-makers at the commune, national and regional levels with socioeconomic information that will assist in prioritizing future sustainable natural resource management research and development interventions. NRM strategies that produce desirable biophysical results and promise region-wide economic growth and development are most likely to be sustainable in the long run. A number of biophysical interventions have been evaluated and identified as potentially important for individual actors within the agro-pastoral systems of Northern Mali, providing both biophysical and economic improvements. The growth and development implications of these interventions for the region's economies are less well understood. To the extent that income-improving interventions in one sector produce different long-term impacts on other sectors, sector-level NRM strategies may be better prioritized to maximize growth and development and thereby serve to minimize income and food-security related conflicts. To assess the differential impacts, this research will build on the Social Accounting Matrix (SAM) methodology to develop production, income and employment multipliers for a representative community within the Arid Northern Mali region. Intensive income/expenditures and environmental surveys of the target community will provide the data necessary to develop the accounting matrix framework. Extensions of this research (Compute General Equilibrium analysis) will provide additional information to policy makers at the local, national, and regional levels.

WAF 99-05.
Workshop on Conflict and NRM: Emerging Lessons and Directions from West Africa

In keeping with this activity's purpose, SANREM West Africa (SANREM-WAF) project participants (who are also natural resource stakeholders in the Mopti region of Mali) and other interested parties from around the West Africa region and the world came together for an annual workshop to review and discuss emerging strategies to manage conflict and natural resources management in the Sahel. This recurrent workshop provides a forum for researchers, development practitioners, and the donor community interested in conflict and natural resource manage (NRM) in agro-pastoral systems to present and discuss results, strategies, program directions, and impacts of collaborative research in these overlapping domains. This year's workshop introduced SANREM WAF's commune-level focus and the participatory methodology for developing social infrastructure at this level. Regional collaborators will be closely following the evolution of this experiment in decentralized NRM.

WAF 99-06.
Creation and Support of a Commune-Level NRM Advisory Committee

The purpose of this activity is to create and support a representative commune-level committee that serves as an effective communications and advisory bridge between SANREM program activities and the present and future decision-makers at the supra-village (i.e. commune) level in Mali. This goal as well as other activity objectives have been met during the second year of project implementation. A Natural Resource Management Advisory Committee (NRMAC) constituted of representatives from the ten villages in the Commune of Madiama, Mali (NRM user groups and committees, and World Bank NRM Project village committees) was established on 10 October 1999. The underlying foundations to ensure that this committee can become a viable media for transmitting science-based information on NRM and conflict management are being established through the following endeavors: (1) four Holistic Management and Conflict Resolution workshops have been conducted for SANREM CRSP-West Africa collaborating partners (IER, regional NGOs, decentralized government service providers, and NRMAC representatives); (2) NRM technologies have been tested in collaboration with village NRM user groups (WAF 99-07); and (3) benchmark biophysical and economic data are being adapted for use in decision-maker models (WAF 99-03, -04, -07). The baseline Knowledge, Attitudes and Practices (KAP) questionnaire and household sampling framework were finalized in August 1999. Survey interviewers were trained and the questionnaire was pre-tested in October 1999. Data collection was completed by December 1999 and a report submitted in February 2000. In April 2000, a half-time CARE-Djenné agent was hired and assigned to facilitate the institutional training and development of the NRMAC.

WAF 99-07.
Testing and Demonstrating Natural Resource and Conflict Management Technologies and Practices to Increase Food Security and Income Generation in Madiama Commune, Mali

This activity uses a participatory and collaborative research process to identify, characterize and test existing and alternative natural resource management (NRM) technologies with the aim of increasing options available to farmers in the Madiama Commune, Mali as they seek to improve their food security and income generating capacity. Essential accomplishments for this past year included the establishment and training of three NRM users groups at the village and commune level; a soybean production trial based on local needs; and the quantification of biophysical benchmark characteristics of local NRM technologies and practices.

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Cattle and Manure Management Strategies to Increase Soil Phosphorus Level in Western Niger

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Introduction

Soil fertility depletion on smallholder farms is considered to be one of the fundamental causes for the declining food production in Africa. Results from a Participatory Landscape/Lifescape Appraisal (PLLA) in Mali indicate that poor soil fertility is one of the major constraints identified by villagers. In Niger, Mali's landlocked Sahelian neighbor, the sandy soils are also inherently low in soil fertility and nutrient deficiency is a major constraint to crop production.

The dominant ethnic groups at the Niger research site are the Djerma and Fulani. Historically, the Djerma were well known as skilled cavalrymen. Today, horses and cattle are an important source of wealth for the Djerma despite being sedentary agriculturalists. Many Djerma live in the Niger River Valley where they cultivate millet, sorghum, rice, corn, and tobacco. They also cultivate cotton and peanuts as cash crops. The Fulani are West Africa's pastoralists. Historically the Fulani were almost entirely transhumant (i.e. they moved continuously from one area to another grazing cattle). Due to environmental and economic changes, the Fulani are increasingly becoming agro-pastoralists, both cultivating crops and herding their own and other people's cattle.

Even though ruminants are integrated in nutrient cycling in agro-pastoral systems, their contribution is insufficient. Manure availability is an important limitation to soil fertility improvement. In addition, manure use is regulated by farmers' perceptions and understanding of soil fertility, by their perception of livestock's role in soil fertility management, and the management of livestock and related resources at the community level. Soil nutrient management is subject to cultural practices at the communal as well as the individual farm level. The purpose of this study is to identify alternative management strategies to enhance the role of livestock in nutrient transfer in the Sahelien landscape.

Objectives

The specific objectives of this research are:

- To estimate the effect of phosphorus supplementation to cattle on fecal phosphorus output;
- To estimate millet response to enriched manure application compared to direct application of phosphate fertilizers to cropland; and
- To investigate farmers' perceptions and understanding of soil fertility, the role of livestock in soil fertility management, and to assess the contribution of communal action to soil fertility improvement.

Methods

A supplementation experiment was conducted from February 17 to June 7, 1999, in the village of Boundou, which is one of the International Livestock Research Institute's (ILRI) research sites. Thirty-six cattle ranging in age from 2 to 3 years old were used for the experiment. Feed supplements were distributed daily at three treatment levels: 500 g DM (dry matter) cowpea hay plus 0 P_2O_5; 500 g DM cowpea hay plus 15 g P_2O_5; or 500 g DM cowpea hay plus 30 g P_2O_5. Total fecal material was collected to estimate the effect of phosphorus supplementation on feed intake and on the quality and quantity of manure. Vegetation samples were collected to estimate the quality of available forage. Each lot was tethered on a plot to allow the deposition of about 6 tons of manure per hectare for millet production. Millet was planted in June and harvested in November. Samples of grain, vegetative parts and soil were collected to estimate productivity and nutrient content. Laboratory analyses are ongoing.

Interviews were conducted in the

village of Katanga, Niger, to assess farmers' perception of soil fertility and the importance of livestock in the management of soil fertility (33 of 57 households in the village participated). Focus group interviews were conducted in Katanga and Falanga (4 to 6 people per group in a total of 6 groups for each village). Each group of farmers discussed their own concept of soil fertility and described what they do as a community to improve soil fertility and to manage natural resources.

Results and Discussion

Data analysis is underway for this activity. Results reported here are first assessments of all information gathered. The goal of this research was to use qualitative and quantitative methods to elucidate alternative ways to improve soil fertility management. The supplementation experiment showed that nitrogen (at this level) did not have any significant effect on the concentration of nutrient in the feces, and no significant effect on the quantity of fecal material excreted. However, the quantity of fecal material excreted on a daily basis by animals receiving cowpea hay was higher compared to the others. Phosphorus (P) supplementation did result in a significantly higher concentration of P in the fecal material of animals receiving P supplement compared to those not receiving the supplement. There was no difference between those receiving 15 g of P_2O_5 compared to those receiving 30g. Data collected for the millet experiment are being analyzed.

The results from our study demonstrate that phosphorus concentration in fecal excretion is 50 percent more for animals receiving phosphorus supplement compared to those who were not receiving any supplement. However, phosphorus supplementation did not have any impact on animal performance (at least during the period of the study). It is unlikely that animal owners will be interested by this outcome.

The interview data are also being analyzed. The first observations indicate that 92 percent of the Fulani used manure every year to fertilize more than half of their fields compared to only 15 percent of the Djerma. More than 80 percent of Fulani and Djerma use only fallow and/or manuring as soil improvement methods. As a result, less than 20 percent of the Fulani and Djerma use other means of soil improvement. Even though the Fulani do not own their lands, the fertility level of their fields is higher than the Djerma's lands. This is the case due to a number of socioeconomic and ecological reasons. First, the Djerma are unable to manure their fields as frequently as the Fulani. The Djerma have land tenure rights, but own inadequate livestock to produce sufficient quantities of manure to enhance soil fertility levels in their fields. They are able to negotiate additional manure supplies from the Fulani, but they are expensive. Second, although the Djerma (as the landowning group in the area) have established conservation rules, the rules as they exist cannot maintain fertility levels of the fields given nutrient uptake by plants. Lastly, the parcels that the Fulani cultivate are quite small relative to Djerma holdings. Additionally, these parcels are manured approximately eight months of the year. At the community level, natural resource management practices vary. Conservation rules are enforced by the Djerma whereas the Fulani use an area until resources are depleted and then they move on. The focus group interviews reveal that in villages where customary institutions are functioning, the people enforce rules and natural resources are better managed.

However, at a community level, if farmers and herders are organized, manuring can be a way to increase soil nutrient availability considerably. In fact, in a region of Maradi, Niger, some local communities under NGO guidance are organizing their land use so that the cultivable land area of the village is under a three-part rotational pattern. The pattern consists of the following: one part is issued as fallow land where animals graze; another part is designated as cropland, and another part is identified as a Fulani settlement area (night corrals are moved from one spot to the other to facilitate the distribution of manure on the entire area for the full year). Our results may be of interest in such situations.

The interview results indicate a need for more collaboration among ethnic groups for enhanced manure utilization to improve soil fertility. While the cost of manuring prevent Djerma farmers to manure their lands, on the other hand, it reduces the quality of crop residues available to Fulani herders. The community has to understand that manuring benefits all of the community and both groups should work toward the improvement of soil fertility.

Two publications are planned. The first will be on "the influence of phosphorus supplementation on feed intake, nutrient content of defecation and weight change of grazing animals" and the second will be on "farmers' perceptions of soil fertility and the role of livestock on soil fertility improvement." The results of this research will be used in the dissertation to partially fulfill the requirement for Gnoumou's Ph.D. All data needed for this activity were collected. Data analysis is on-going and final results should be available by December 2000, the expected date of completion of the program.

Note

This activity was also supported by the Rockefeller Foundation through the African dissertation award, and the ILRI-ICRISAT/Sahelien center, which provided their facility and guidance.

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Modeling Community Socioeconomic Linkages and Growth: Towards Sustainable NRM Agropastoral Systems Under Environmental Stress and Conflict

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Introduction

Natural resource management (NRM) strategies that produce desirable biophysical results and promise region-wide economic growth and development are most likely to be sustainable in the long run. A number of biophysical interventions have been evaluated and identified as potentially important for individual actors within the agro-pastoral systems of Northern Mali, providing both biophysical and economic improvements. The growth and development implications of these interventions for the region's economic sectors are less well understood. To the extent that income-improving interventions in one sector produce different long-term impacts on other sectors, sector-level NRM strategies may be better prioritized to maximize growth and development and thereby serve to minimize income and food-security related conflicts. To assess the differential impacts, this research uses the Social Accounting Matrix (SAM) methodology to develop production and income multipliers for the targeted community within the arid Northern Mali region (Madiama). The linkages and growth consequences for four socioeconomic institutions (farmers, agropastoralists, sedentary pastoralists, transhumant pastoralists) have been examined. Intensive income and expenditure surveys and secondary data collection within the targeted community have provided the data necessary to develop the accounting matrix framework.

Objectives

- Develop a Social Accounting Matrix (SAM) model of a representative landscape/lifescape (community) in Northern Mali that disaggregates the NRM-related economic activities of pastoral and agro-pastoral/sedentary sectors and analyze the dynamics of the economy including the sector linkages and potentials for sector and economy-wide growth in production, income, and employment.
- Identify high potential sectors for sustainable NRM interventions that may ameliorate conflict by generating greater community-wide growth and development including the identification of priority research and investment alternatives that further high potential alternatives.
- Expand the SAM model to the larger, regional area (arid/semiarid region) and expand the scope of analysis to include environmental accounts. The analysis will refine the analysis of the dynamics of the regional landscape/lifescape economy and identify high potential sectors for sustainable NRM at the regional level.

Methods and Approach

A Social Accounting Matrix (SAM) model has been developed to meet the objectives of the study. The SAM model is a modified input/output model that accounts for income effects and linkages of specific production activities among stakeholders. The model is a flexible and powerful tool that can be adapted to specific needs, and therefore allows analysis of economies in diverse social and cultural settings from the village level to national economies. SAM models can bridge the gap between microeconomic household-production models and macro-level (national or regional) models such as Computable General Equilibrium (CGE) models extensively used in macro-policy analysis. A SAM is a particularly complementary framework for CGE models since

it requires the same basic data and, at the same time, provides a model that can be used to calibrate CGE models.

Results and Discussions

Analysis of the data so far has shown the openness of the Madiama economy to the rest of the world and the importance of agricultural and livestock production in the economy. The livestock activities have strong linkages with agriculture. Crops, particularly rice and vegetables have important production and income impacts. Retail (microentreprise) is less important than crops or livestock in terms of its impact on overall production and has a relatively small income effect.

The agropastoralist group benefits most from unit increases in activities suggesting that this diversification strategy is successful. Farmers, sedentary and transhumants pastoralists have respectively decreasing shares of impacts. Relatively low SAM multipliers for pastoralists (particularly transhumants) implies that they cannot be impacted significantly through policies that stimulate general economic growth. This is probably due to their relative isolation from the other stakeholders during large parts of the year. Consequently, it appears that only interventions targeted specifically at transhumant pastoralists will be able to induce income increases. This result, if verified by subsequent analyses, has important implications for conflict mitigation strategies in the delta region.

The results of this preliminary analysis will be expanded in the future to include policy implications of alternative commune actions and implications for conflict resolution in the commune. These analyses will disaggregate some production sectors in order to achieve more detail and understanding of the commune economy. For example, the retail (microentreprise) as well as the livestock sector will be disaggregated into sub-sectors since components seemingly differ with regard to export opportunities, owner characteristics, etc. In addition, cereals will be disaggregated in order to investigate the consequences for tradable cereals (e.g., maize) and their effects on overall growth. Finally, for natural resource use implications, the natural resource sector will be disaggregated.

Consequently, only interventions targeted specifically at them will be able to induce income increase. This result if verified by subsequent analyses (of disaggregated SAM) has important implications for conflict mitigation strategies in the delta region of the Niger River: specific interventions must be targeted at the pastoralists in order to impact them.

Impacts

After building and analyzing the disaggregated SAM models, a return trip to Madiama to present the results to the NRMAC and other SANREM CRSP-West Africa partners is planned. Such input from the SAM effort should help guide SANREM interventions in the future.

Publications and Presentations

Kaboré, Daniel P., Breima Traoré, Daniel B. Taylor, Peter Wyeth, Mike K. Bertelsen, and David Holland. 2000. Modeling district-level linkages and growth: Towards sustainable natural resource management in agricultural and pastoral systems under environmental stress and conflict in the Niger Delta Region of Mali. Selected paper, American Agricultural Economics Association Annual Meeting July 30-August 2 2000, Tampa, FL, USA.

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Workshop on Conflict and Natural Resource Management: Emerging Lessons and Directions From West Africa

Introduction

Emerging strategies to manage conflict and natural resources in the Sahel were reviewed and discussed at a SANREM-sponsored workshop in Mali in February 2000. This recurrent workshop provides a forum for researchers, development practitioners, and the donor community interested in conflict and natural resource management (NRM) in agro-pastoral systems to present and discuss results, strategies, program directions, and impacts of collaborative research in these overlapping domains.

This year's workshop introduced SANREM West Africa's (WAF) commune-level focus and the participatory methodology being used to develop social infrastructure at this level. Regional collaborators will be closely following the evolution of this experiment in decentralized NRM.

Attendees included SANREM West Africa project collaborators, natural resource stakeholders from Mali's Mopti Region, and other interested parties from West Africa and around the world.

Participants met at the Institute of the Sahel (INSAH) to discuss current research on conflict and NRM in the region. Researcher participants from eight CILSS (Interstate Committee on Drought Control in the Sahel) countries made presentations, in addition to those made by SANREM CRSP-West Africa collaborators. Participants included regional NRM Research Pole representatives from Senegal, Burkina Faso, Niger, Guinea Bissau, Cape Verde, Mali, Chad, and Mauritania. The United States Agency for International Development (USAID) and CARE-Mali representatives were present. Although invited, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Center for Research in Agroforestry (ICRAF) remained unrepresented.

Objectives

Review the present (annual) state and progress of strategies to deal with conflict and NRM in agro-pastoral systems.

Results and Discussion

Dr. Keith Moore introduced the SANREM CRSP-West Africa project with a presentation of core SANREM principles. The importance of community participation in NRM decision-making was underlined. In addition to the importance of participation, the SANREM-WAF project takes into account the decentralization process in West Africa. The SANREM CRSP project in the Madiama Commune, Mali is based on both of these factors.

Dr. Lassine Diarra, a SANREM principal investigator with the Institute for Rural Economy (IER) introduced the model of the Holistic Resource Management and the model for conflict resolution around which SANREM interventions will be organized. He introduced the concept of the whole, conceiving natural resources as a totality. Then, he explained how the community must define their goals in terms of the quality of life, production, and landscape that they want to have in order to achieve integrated management.

Dr. Neville Clarke, another SANREM principal investigator based at Texas A&M University, presented the collection of models tested by the SANREM Global project in West Africa. The objective of these models is to evaluate the impact of new technologies and policy options. Once tested in Mali, these models will be ready for dissemination in other West African countries.

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The NRM Research Pole Coordinating Committee member presentations began with François Lompo, who introduced the Pole. The Pole has created a space for scientific activities in NRM characterized by diverse yet complementary activities organized in four domains: soil and water conservation; agro-climatology; soil and water management in irrigated zones; and soil nutrient fixation.

Burkina Faso has a *Programme National de Gestion des Terroirs* (a national program of local, normally village-level, land use management, similar to the SANREM landscape lifescape approach). It began with a pilot project in five regions and has now increased to 50 sites. Cape Verde has several different NRM projects, including a SANREM watershed management project. NRM research activities in Guinea Bissau have just only begun in the last eleven months. The Government of Mali has a good deal of experience in increasing agricultural productivity as well as in characterizing the rural environment. CARE-Mali has also worked in renovating irrigated perimeters in the Niger Delta region with peasant organizations. Mauritania has a strategic plan that emphasizes a systems approach in five different agro-ecological zones. They are experimenting with how to adapt transhumant animal husbandry with a participatory, community-based natural resources management approach (*gestion des terroirs*). In Niger, they have a Rural Master Plan that coordinates the national ministry's strategy with the national NRM research plan. Major research questions focus on food security linking research with extension. Senegal has its research organized into five laboratories: plant, animal, forestry, oceanography, and macroeconomic. The Community-Based Natural Resource Management Project of the Ministry of Environment and Nature Protection is targeting twenty rural communities (Communes). Chad uses a participatory, community-based natural resources management approach (*gestion des terroirs*) approach and conducts research on the interaction between animals and plants. They also have an analytic framework to study land tenure systems. Environmental protection has a community orientation. INSAH has been coordinating several research activities across the Sahel in collaboration with ICRAF, ICRISAT, and AGRHYMET (West Africa Regional Center for Training and Application in Agriculture, Meteorology and Hydrology, a CILLS Organization).

Dr. Neville Clarke from SANREM's Global Project presented several models including a GIS approach, crop simulations (EPIC) and food security analyses for 2015 as policymaking aids. A key question was raised concerning the value of all of these different models, to which he responded that each model has its own objective, the important thing is to have a good database that can be used by all these different models. There were also questions on the capacity to distinguish millet and sorghum, and how to monitor pasture lands.

Mr. Boureima Traoré presented the methodology and process for establishing the NRMAC in the Madiama Commune of Mali. IER began by organizing NRM committees in each village of the Commune. Three of these villages had been already organized by the PGRN (World Bank village-based NRM project) and were directly incorporated into the process. Each village sent four or five representatives (including at least one woman) to a commune-level meeting to discuss the objectives of the NRMAC and to elect a standing committee of 14 members. Local officials and development agents also participated in the discussions. Several questions were raised about the legality of the committee, and the problem of managing transhumant herds and or herders who cross through several Communes.

Dr. Lassine Diarra continued with a presentation of the Holistic Management model and a description of conflict management techniques and strategies that were the subject of NRM Advisory Committee (NRMAC) and development agent training in November 1999. He began with a presentation of a graphic portraying the two images of women (an old one and a young one; few in the audience saw more than one woman) to demonstrate the significance of differences in perception. He also introduced the four pillars of the ecosystem: the water cycle; the nutrient cycle; succession; and energy flow. Then, the tools with which to manage these systems: human creativity; rest; fire; living organisms; technology; grazing or overgrazing; animal impact; and money and labor. All solutions for the holistic management of resources must past certain tests: sustainability; cause and effect; the weak link; marginal reaction; the source and use of energy and wealth; gross profit; society and culture. Holistic management is an iterative process. It is necessary to plan (with hypotheses which are likely to be false), monitor, evaluate and replan.

Mr. Boureima Traoré presented some data from the socio-institutional survey of five villages in the Commune of Madiama. There are two dominant ethnic groups (Marka and Peuhl or Fulani). The majority of household heads and their wives turn to the village head for the resolution of NRM-based conflicts. According to the men, the most serious problems which they face is the conflict between farmers and herders, and for the women, it is the lack of potable water.

Dr. Peter Wyeth presented some data from the economic analysis of Madiama Commune based on the Social Accounting Matrix (SAM) work of Daniel

Kaboré. These data indicated the importance of micro-enterprises in the generation of revenue for the Commune.

Dr. Oumarou Badini described the soybean trials, the planned transformation of soybeans into soumbala (a highly valued local sauce which depends on a diminishing resource which soy may be able to replace), and the collection of biophysical and meterological data. The trials were spread across thirty sites with different types of soil and different cultural practices in both flooded and drylands being taken into account. This data will contribute to mapping the spatial variation found in the commune, supported by aerial photos. Some questions were asked about the abundance of data, the spatial representation of data, and the taking into account of animal impacts on the soil.

Dr. Mike Bertlesen then presented the LandSat image of 30 November 1999, demonstrating the vegetal cover of the Commune. Geo-positioned coordinates for various sites have been identified to groundtruth the image, i.e. verify what is observed in the satellite images with what it found on the ground. Digitalization of the data will improve overall usefulness of the GIS analyses. The presentation drew out questions as to how representative the Commune of Madiama with respect to the rest of the Niger Delta and on the possibility of conducting diachronic analyses of degradation.

Dr. Lassine Diarra introduced the SANREM CRSP - West Africa program for Year 2000-2001. He began by presenting the NRMAC list of priorities by village. The research program for the year has four core elements: decision-making aids for soil fertility improvement; decision-making aides for pastureland improvement; development of evaluation tools; and reinforcement of the NRMAC. The Holistic Management model will drive the research conducted with the NRMAC.

Dr. Neville Clarke described plans for testing decision-making tools at the national level in collaboration with other SANREM CRSP - West Africa partners.

Subsequent discussion addressed questions concerning the involvement of fisherfolk, women, inter-communal relations, land tenure issues, socio-economic dimensions of the Holistic Management model, and herd management. After responses were made to these questions, members of the NRM Research Pole Coordinating Committee proposed the following recommendations: integrating water management techniques with soil fertility management; improving manure quality; increased specification of the integrated model for a whole commune; better integration of fallow in animal feeding strategies; use of natural rock phosphate to improve soils; developing a plan for the adoption of new technologies; and encouraging the production of mixed forages. The committee also suggested that mineral analysis of soils, along with organic matter and farmer perceptions were the best indicators of improved soil fertility (yield would be a poor indicator), as well as indicate the impact of training through changes in behavior.

Impacts

Information and ideas for improved approaches to conflict resolution and NRM in the Sahel were exchanged among regional stakeholders. SANREM WA's commune-level focus and the participatory methodology for developing social infrastructure at this level has been presented. Regional collaborators will be closely following the evolution of this experiment in decentralized NRM.

Publications and Presentations

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Goebel, Jeff. 2000. A Conflict Resolution Workshop: Mopti Region, Mali (November 1999). SANREM CRSP - West Africa Working Paper No. 00-05. OIRD/ Virginia Tech and CRRA/Mopti.

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Creation of a Community Level Natural Resource Management Advisory Committee

Introduction

Supra-village natural resource management (NRM) issues and conflicts identified during the PLLA (February 1999) and the decentralization of NRM decision-making responsibilities to the Commune-level require that the skills and infrastructure to deal with them are available in the community. Such a decision-making structure has not previously existed in contemporary Mali. SANREM WA has sought to fill this void by facilitating the creation and developing support for a prototype commune-level NRM advisory committee. Creation of a representative commune-level committee serves as an effective communications and advisory bridge between SANREM program activities and the present and future decision-makers at the supra-village level, as well as a forum for discussing and planning for NRM and resolving supra-village conflicts involving NRM.

A Natural Resource Management Advisory Committee (NRMAC) constituted of representatives from the ten villages in the Commune of Madiama (NRM user groups and committees, and World Bank NRM Project village committees) was established on 10 October 1999. The underlying foundations to ensure that this committee can become a viable media for transmitting science-based information on NRM and NRM conflict management are being established: (1) four Holistic Management and Conflict Resolution workshops have been conducted for SANREM CRSP-West Africa collaborating partners (IER, regional NGOs, deconcentrated government service providers, and NRMAC representatives); (2) NRM technologies have been tested in collaboration with village NRM user groups (WAF 99-07); and (3) benchmark biophysical and economic data are being adapted for use in decision-maker models (WAF 99-03, -04, -07). The baseline Knowledge, Attitudes and Practices (KAP) questionnaire and household sampling framework were finalized in August 1999. Survey interviewers were trained and the questionnaire pretested in October 1999. Data collection was completed by December 1999 and a report submitted in February 2000. In April 2000, a half-time CARE/Djenné agent was hired and assigned to facilitate the institutional training and development of the NRMAC.

Objectives

- Establish committee and support regular committee meetings.
- Test extent to which science-based information on NRM can help local decision-makers to manage inter-village NRM conflicts.
- Baseline Knowledge, Attitudes and Practices (KAP) Survey.

Methods or Approach

Villagers in all ten villages in the Commune of Madiama, Mali, were informed by SANREM CRSP-West Africa collaborating partners (IER/Mopti researchers, the Mayor of the Commune, the Head of the Madiama Branch of the Mopti Rice Office and a representative of the World Bank NRM Project) about the objectives, value and role of the NRMAC and its constituent village committees with the view to eliciting membership of each village.

In each village, an assembly was held under the direction of the village chief to select a diverse group of delegates (four or five) to represent the village in a commune-wide general assembly held to elect the NRMAC. According to the importance of the activity, each village selected either two herders, two farmers, or one of each.

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In addition they also selected two or three more villagers to represent women, hunters, and crafts/ forest gatherers.

Results

User groups had already been developed in the three PLLA villages of Madiama, Nerekoro, and Tombonkan (see WAF 99-07) and The World Bank NRM Project (PGRN) villages of Torokoro, Tatia-Nouna, and Bangassi already had their own Village NRM Committees. These committees met and selected their representatives. The four additional villages of Siragourou, Promani, Tien-Douganani, and Toumadiama were completely new to the idea of village NRM committees and the meetings in those villages were more extensive. Initially, Promani and Siragourou declined to participate, but later Promani sent four representatives to the General Assembly meeting. Each of the nine villages and the local irrigation management committee sent three to five representatives (45 in all including seven women) to the General Assembly meeting on 10 October 1999. A representative from Siragourou joined the committee after the General Assembly meeting.

The General Assembly meeting was opened by the Mayor of Madiama Commune. A presentation was made by IER researchers of SANREM CRSP - West Africa on the objectives, the role and structure of the NRMAC. Translations into Peul and Bambara were provided. Also participating in the meeting were an additional 15 to 25 representatives of IER, CARE, PGRN agents, the deconcentrated government services, and elected Commune representatives.

Participants were divided into four commissions: organizational and administrative issues; dryland farming, rice farming and fishing issues; livestock, hunting, gathering, and craft issues; and the role of women. After these commissions reported their conclusions to the plenary assembly, elections were held for positions on the NRMAC. The results of the elections are as follows:

Executive Board:

President	Issa Sao	Madiama
Administrative Secretary	Abdoulaye Cissé	Tombonkan
Communication Secretary	Mamadou Koïta	Madiama
Organization Secretary	Amadou Konaté	Madiama

Commission Leaders:

Dryland Farming	Lassine Babayogo	Torokoro
Fishing	Amadou Kentao	Nouna
Rice Parcels	Kola Moussa Sao	Madiama
Women's Affairs	Kadidia Konaté	Madiama
	Moussa Kabayon	Tien-Dougourou
Livestock	Amadou Cissé	Nérékoro
Hunting	Malick Camara	Bangassi
Crafts / Forest Gathering	Fanta Koïta	Nérékoro
	Mama Traoré	Nouna

The NRMAC selected two women and three men to participate in the Holistic Resource Management Workshop. The committee expressed an interest in training all NRMAC members in the national language.

Twenty-seven SANREM CRSP-West Africa collaborators participated in a five-day Holistic Resource Management Workshop on Consensus Building and Conflict Resolution (1-5 November 1999). Participants included ten IER scientists, three U.S. scientists, seven deconcentrated government service agents, the Mayor and his adjoint, and the five representatives of the NRMAC. After the workshop, NRMAC members (under the guidance of the HRM trainers) reviewed the workshop for the full NRMAC and then led the partners in a transect tour and an HRM-focused discussion of natural resource features of the Commune.

In preparation for the next year's activities, the NRMAC took it upon itself to visit each village and develop a list of priorities to focus SANREM research activities. These lists, and the committee's consolidation of them were presented to IER and U.S. scientists at a meeting on 1 February 2000 in Madiama. All NRMAC members, development agents, technicians, and local officials were present. An extended discussion ensued in which the committee's priorities were focused on two biophysical themes — improved soil fertility in croplands and improved pasture management — and one institutional theme — reinforcement of NRMAC member capacities. These were integrated into the work plan submitted to the SANREM CRSP Management Entity in March.

The baseline KAP questionnaire and household sampling framework were finalized in August 1999. Survey interviewers were trained and the questionnaire pretested in October 1999. Data collection was completed by December 1999 and preliminary analyses were submitted in a report in February 2000. Key findings include the importance accorded village headmen in situations of conflict over natural resources and the seriousness with which conflict between herders and sedentary farmers is perceived. In depth analysis of this data is on going.

From 2 to 17 May 2000, three three-day workshops were conducted with the NRMAC: Two in Holistic Management and one in Conflict Resolution. These sessions included the new CARE/Djenné SANREM Facilitator, Abdoulaye Touré. Committee members learned to evaluate different options for improving NRM in the Commune. An extended discussion focused on the use of fencing to enclose and thereby protect pasture from grazing. Group discussions were encouraged and the committee evaluated several proposals to improve soil fertility and the productivity of wetlands. The Conflict Resolution workshop was a success and is having an important impact on committee member self-esteem.

Lessons Learned

Encouraging and inciting participation in community activities is time consuming and difficult to schedule at the outset, especially when local people and researchers have no previous experience with participatory methods. The behavior patterns of different partners not only must be coalesce into a coherent program, but also their schedules must coincide so the fundamental communication necessary for collaborative participation can occur. Each aspect of the participatory process must be negotiated among all participants and structural impediments must be removed. Scheduling and other obligations impinge on collaborative action because it takes time to develop coordinated activity schedules for different partners. Conflicting obligations of the various partners also inhibit the necessary consensus building for collaborative action. Coordination of IER/Mopti, CARE/Djenné, and U.S. scientists has suffered due to the limited time available to U.S. scientists in Mali at the outset of activities when coordination efforts are most intense. Fortunately, these obstacles are being overcome and Madiama Commune leaders and NRMAC members have been adaptable to the timing constraints of their SANREM CRSP-West Africa partners.

Impacts

It is still early for the NRMAC to have achieved any substantial impacts on NRM in the Commune of Madiama. However, the committee members were highly satisfied with the consensus building and conflict resolution training they received during the HRM Workshops. The workshops have given community members the tools and the space to address issues that they would otherwise avoid. As a result, interethnic discussions have been initiated and relations are improving. Committee members are using their consensus building skills and say that they have managed to bring the villages of the Commune closer together. They are still expecting easy answers to be given to them, but have begun developing the skills to discover their answers for themselves.

Publications and Presentations

Kodio, Amadou, Keith M. Moore, Salmana Cissé, Aliou Traoré, and Boureïma Traoré. 2000. Etablissement d'un Comité Communal de Gestion des Ressource Naturelles (CCGRN) dans la Commune de Madiama. SANREM CRSP - West Africa Working Paper No. 00-01. OIRD/Virginia Tech and CRRA/Mopti.

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SANREM CRSP
Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program
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Testing and Demonstrating Natural Resource and Conflict Management Technologies and Practices to Increase Food Security and Income Generation in Madiama Commune, Mopti Region, Mali

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Introduction

Food shortages and conflict over the use of natural resources due to loss of soil fertility, increases in soil erosion and the poor management of wetlands and pasturelands are serious problems for the villagers in Mali's Madiama commune and the Sahel region as a whole. A participatory and collaborative research process was used to identify, characterize and test existing and alternative natural resource management (NRM) technologies with the aim of increasing options available to farmers in Madiama Commune as they seek to improve their food security and income generating capacity.

Management practices were evaluated for their potential to improve the options available to decision-makers, including farmers and pastoralists, for managing their natural resources and generating greater income. New approaches for avoiding and managing conflict were also tested, since improved natural resource management (NRM) practices will reduce the pressure on resources over which conflict occurs.

The NRM technologies and practices being researched concern agroforestry technologies, wetland and soil water management, soil fertility management and diversification strategies. The assessments involve both modeling and field trials. The program is unique in that technical assessments are combined with process-oriented conflict management tools.

Conflicts over natural resources occur because the stock of these resources is decreasing as the number of people depending on them increases. The biophysical and economic benchmark characterization and modeling will show how to slow or reverse the diminution of resource stocks. The process-oriented work involves the local population in development, dissemination and application of research results and should lead to improvement in the effectiveness of communal approaches to avoid conflict over resource management.

Essential accomplishments for this past year included the establishment and training of three NRM users groups at the village and commune level, a soybean production trial based on local needs, and the quantification of biophysical benchmark characteristics of local NRM technologies and practices.

Objectives

The overall purpose of this research is to improve food security and income generation by identifying, characterizing, testing, modeling and demonstrating cost-effective natural resource management technologies and practices. Specific objectives to be executed in sequential order are as follows:

- Establish local NRM users groups, identify local available practices and establish biophysical and socioeconomic characteristics of soils, weather, cropping patterns, and natural resources management systems at the local (commune) level.
- Field test, simulate and assess the benefits costs of alternative NRM technologies and practices in collaboration with village level NRM groups.
- Disseminate test results and evaluate impact.

Methods

NRM users' groups are established and trained at the village and commune level to elicit collaboration in program

activities. Consensus building, holistic management, and enterprise facilitation approaches are used.

Through a sample survey and field monitoring carried out in the research area at designed sites, local and alternative technologies are characterized, taking account of biophysical, social and economic variables. Benchmark sites are established to build the databases, obtain basic model parameters, and determine baseline variables. Sites are established in three villages in the research area and will be extended to the other seven villages of the commune. At each site, data on weather, soil, crop and crop management are monitored and recorded.

Weather Monitoring: To monitor environmental factors, an automatic weather station is installed in Madiama village. The station records hourly and daily data on air and soil temperature (maximum and minimum), total rainfall, total solar radiation (rate and flux), wind speed and relative humidity. Since rainfall should be measured no more than 3 kilometers from the research plots, a rain gauge will be installed in each village this coming season.

Soil Monitoring and Characterization: Soil water content is evaluated every two weeks in all sites. Also, soil fertility and chemical properties are evaluated using the following parameters: pH, total nitrogen content, available phosphorus, organic matter content and cation exchange capacity. In May 2000, soil monitoring was reinforced by a soil survey of the commune that will lead to the construction of soil maps and land use maps of the commune. The geographic data obtained from the mapping will then be digitized or scanned into the computer using GIS software.

Cropping Systems Monitoring: For each crop in these systems, data are collected to identify crop type, variety, establishment methods, plant densities, phenology, morphology, growth parameters, crop management /cultivation practices, and crop performance. Harvest dates, yields and yields losses, due to weeds, diseases and insect pests, are recorded. Each operation that farmers carry out on the selected field plots is also recorded, including the date, labor time, materials, and any animal power used.

Data collected from the biophysical monitoring is processed to establish a multi-year database used for validating and adapting models and to enhance the characterization and understanding of NRM technologies and practices. The generation of the database will be an ongoing process as teams from Mali and US continue to collect and integrate relevant data.

Results and Discussion

Users' groups were formed as the first part of our fieldwork in Madiama this past year to help build relationships and get the process started. Most of our activities revolved around the benchmark characterization studies to help build the database for modeling work and the evaluation of alternative NRM technologies. Also, based on discussions with village groups and farmers, one field test of soybeans was started this past season to provide the necessary substance around which discussions among partners could focus.

From the 10 villages of the Madiama commune, the three villages in which the PLLA was conducted in February 1999 were chosen as research sites for this first year of fieldwork. Local chiefs and village residents, in collaboration with WSU and IER scientists, set up a user group in each village. They chose user groups of 10 members in Madiama, 10 in Nerekoro and 13 in Tombonkan. Each group includes the village chief and a minimum of two women. User groups in Bangassi, Tatia-Nouna and Touroukoro had already been created to work with the PGRN (Natural Resource Management Project, funded by the World Bank), and have been directly associated with SANREM activities. The NRM user groups chose collaborating farmers for the field tests, including the benchmark characterization studies and soybean trials. Contact with farmers and herders was maintained throughout the season through field and house visits by two IER/Mopti field agents based in Madiama and twice-monthly visits by two IER/Mopti researchers.

Formal meetings with farmer groups took place at the middle and end of the cropping season to discuss achievements, expectations and difficulties of NR users in these sites. Also, in all 10 villages, organized meetings took place in October to establish the commune level advisory group (see WAF 99-06). Initial training in communal approaches to natural resource management and conflict avoidance and management was completed in November 1999. In preparation for the communal research-planning meeting in February, the users' groups prepared village level lists of priority research concerns contributed to the NRMAC in Madiama. Among the priorities in every village, degraded soils and pastures were cited as major natural resource constraints (NRMAC, February 2000). A detailed annual report in French has been produced with the collaboration of the two field agents stationed in Madiama.

Besides the establishment and training of the users' groups, the research focus this year has been the characterization of climate, soils, crops and existing cropping systems. The basic parameters are being quantified to build the database needed for the modeling work and for use in the performance evaluation of current and alternative NRM systems.

The database for the three main soil types, (sandy, clay and loamy-sand) representing 96 percent

of all soils sampled in the three villages, is being established. Plot records have been established for each selected field. To complete the soil database, a comprehensive pedological soil surveys were done in Madiama, Tombonkan and Nerekoro in September 1999. Thirteen soil core samples were taken. For each soil horizon, layers depth, texture, color and pH were determined in the field. A preliminary report in French entitled "Caracterisation des Sols de Madiama" was written and is available. A base map (scale: 1/40000) of the commune and surrounding areas constructed from aerial photographs (1991 and 1973) and a satellite image scene from November 1999 are available. Using this base map, a soil survey covering the whole commune of Madiama has just been completed. Soil and land uses maps will be derived from this work.

To monitor weather factors, and build a weather database for the commune and the region, an automatic weather station with data logger was installed in Madiama village in June 1999. A partial weather database comprising hourly and daily weather data on air and soil temperatures (maximum and minimum), relative humidity, total solar radiation (flux and rate), wind speed and total rainfall is available. (Data for the modeling and characterization of crops were curtailed due to a malfunction of the weather station.) Also, historic weather data (since 1953) from nearby sites in Djenne, Sofara and Mopti have been obtained.

Overall, 38 fields (32 for input/output follow up and six for crop growth parameters assessment) comprising the main soils and crops of the sites have been monitored. These are in addition to the 12 fields where soybean production was tested. In some of the fields in Madiama, the impact of trees on crop productivity is being evaluated. For each crop in these systems, a database is being prepared for the CropSyst cropping system model.

A research activity to introduce soybean in rotation with millet/sorghum was conducted last year. This activity was designed as an initial experiment to demonstrate to the populations of Madiama one type of SANREM intervention. It was justified on the basis of strong interest among Madiama households to find an alternative to the disappearing *nere* fruit used in making soumbala, a popular food condiment. Also, promising test results of soybean had occurred in similar areas of Mali. Unfortunately these results were not borne out in the Madiama test. Although the plants grew and the pods formed, the beans did not develop and there was no crop. This is attributed to the late onset and short duration of the rainy season in 1999. Although this rainfall pattern is unusual and researchers expect soybeans to be normally successful in this region, it was decided not to continue with this test.

Impacts

This research activity aims at finding in a participative and collaborative environment, the best methods, tools, and practices that will contribute to improve the options available to stakeholders in Madiama and in the region. While it is too early for physical impact on the environment to be expected, sound working partnerships have been established. In the villages, IER/Mopti, Virginia Tech and WSU researchers have built up a chain of trust through meetings and contacts with the population starting with the PLLA, the establishing of the NRM user groups, and continuing visits to the sites.

Publications and Presentations

Badini, O. and O. Doumbia. 2000. Caractérisation des sols de la commune de Madiama. SANREM CRSP - West Africa Working Paper No. 00-04. OIRD/Virginia Tech and CRRA/Mopti.

Diallo, Ibrahim. 1999. Rapport Annuel. November 2000. SANREM/IER Madiama.

Other

Unpublished biophysical databases for soils, crops, weather and management systems exist and are being completed. Base maps of Madiama commune at a scale of 1/40000 and photographs taken in the field are available.

SANREM Global
Project Overview

Introduction

The Global Project supports natural resource management decision-makers at national to global levels, assists regional projects in their assessment of decision-maker priorities, develops decision support tools and methods, and facilitates exchange of information and knowledge among the regional projects. This project comprises three types of activities, all of which are geared to promote sustainable natural resource management:

- Assessment of decision-makers' priorities and decision-support opportunities
- Knowledge capture and information exchange
- Development of a Global Decision Support System (methods and tools)

The Global Project is managed by the Management Entity at the University of Georgia. The Global Decision Support System activity is led by the Impact Assessment Group at Texas A&M University. The institutional partners for the Global Project include the following: Centre Regional de Formation et d'Application en Agrometerologie et Hydrologie Operationnelle (AGRHYMET-CILSS), The United Nations Food and Agriculture Organization (FAO-FIVIMS Secretariat and FAO-WAICENT), the Government of Kenya (Various Ministries), Institut d'Economie Rurale (Mali), Institut du Sahel (The Sahel Institute, Interstate Committee on Drought Control in the Sahel, CILSS), Iowa State University, Kenya Agricultural Research Institute, Ministry of Environment, Ministry of Rural Development and Water (Mali), Office of Environmental Planning (Mali), SANREM Regional Projects: West Africa, Southeast Asia and the Andes, University of Georgia, and the USDA J. Phil Campbell, Sr., Natural Resource Conservation Center Agricultural Research Service in Georgia.

Project Objectives

- To identify priority needs of national, regional, and global natural resource management decision-makers and to develop methods and tools that can help them make better-informed decisions;
- To facilitate information exchange among SANREM's regional projects and between SANREM and other institutions; and
- To help landscape-scale research initiatives (implemented by regional projects) identify decision-makers' needs, and to develop tools and methods that can be used to make better-informed agriculture and natural resource management decisions.

Progress Toward Five-Year Indicators

The SANREM Global Project has made progress toward all of the following indicators during the past year. Specific progress is described in Global Project activity reports.

Outputs Supporting Local-To-Provincial (Landscape) Level Decision-Makers

1. Methods developed to assess the priorities and needs of local-to-provincial (landscape) level agricultural and natural resource decision-makers and at least three documented case studies of their application.
2. Methods and tools designed to conduct *ex ante* assessments of alternative technologies, practices, and policies in the context of common goals, weighted tradeoffs, etc, at the landscape/ lifescape scale and at least three documented case studies of their application.

Outputs Supporting National-To-Global Level Decision-Makers

3. Methods created to assess the priorities and needs of national-to-global level agricultural and natural resource decision-makers and at least three documented case studies of their application.
4. Methods investigated and produced to assist in the evaluation of priorities and impact (*ex ante* and *ex poste*) of research and development investments and at least three documented case studies of their application.
5. Methods developed to assist in the evaluation of consequences of policy options for enhancing food security, reducing poverty, and improving environmentally sound use of natural resources; and documented case studies of their application.
6. Enhanced institutional capacity to use models and methods for improved national, regional, and global natural resource management decisions and case studies from at least two regional and two global institutions.

Outputs Supporting Information Exchange

8. Methods generated to translate relevant statistical data defined by political boundaries to watershed/landscape boundaries for sub-national decision-makers and three documented case studies of their application.
9. Methods produced to assess impact of technology and policy options related to food security and sustainable development at the level of major world watersheds and two documented case studies of their application.
10. Methods developed to extrapolate the impact of research policy change to geographically equivalent areas across multiple political boundaries and three documented case studies of their application.
11. Methods or processes advanced to transfer information, tools, etc. from a landscape in one geographic region to another region and at least one case study describing transfer among two SANREM regional projects.

Specific progress has not been made toward three of the Global Project's five-year evaluation indicators. This is largely due to the fact that these indicators will be accomplished during the fourth and fifth years of project implementation, building upon activity successes that will have developed incrementally. These indicators include the following:

7. Online database that includes descriptions of difficult decisions by specific decision-makers in different biophysical and socioeconomic circumstances; and information and tools that can be used to support a broad range of decisions-makers.
12. Methods to aggregate research results from one to a higher or lower scale, demonstrated in at least two case studies.
13. Awareness and application of SANREM methods documented in at least four case studies (one for each project).

Benefits to the U.S.

Methods being developed as part of the Assessment of Decision Maker Priorities activity (GLO 31) are being refined for use in the Southern Piedmont region of the United States. This activity will assist researchers with priority setting at the USDA's Agricultural Research Service experiment station in Watkinsville, GA.

Researchers and anyone with an interest in sustainable agriculture and natural resource management have access to SANREM research results via the SANREM Web site. A search bibliography containing abstracts, work plans, newsletters and other documents is now available. Publications are being added as part of an ongoing effort. The Web site also provides access to results of electronic conferences on sustainable agriculture and natural resources management that SANREM has helped to facilitate.

With regard to the Global Decision Support System activities, refinements in the models and methods developed under SANREM are equally applicable in domestic contexts to analyses that are done by Texas A&M University on both *ex ante* and *ex poste* assessments of the impact of technology and policy options. These models provide a holistic approach to impact assessment and improved capacity for quantitative analysis of economic, environmental, and biophysical factors involved in these assessments.

Year Two Impacts

Completion of the three-year study on development of the integrated set of models in East and West Africa provided proof of concept of the approach, models, and databases that are available to national research partners and decision-makers in Mali and Kenya. The same suite of models is being evaluated by the International Agricultural Research Centers and the CRSPs for use in providing quantitative impact statements to USAID on research funded by this agency.

Pilot studies on FIVIMS in Mali have led to the establishment of a National Task Force on Models for Food Security. This will bring together plans for the application of the GDSS and other models for use in planning and evaluation of interventions for enhanced food security and the National Environmental Plan. The results of this pilot study will be applied to similar analyses by other countries in the region through relationships with INSAH and AGRHYMET.

Advances in methodology provided new capabilities to link biophysical, economic, and environmental assessments of the *ex ante* and *ex poste* impact of technology and policy options as they affect food security and the sustainable use of natural resources. National partners as well as planners and decision-makers in the U.S. will make applications of these methods in other developed countries.

GLO 99-21.
Decision Support System for Global Level Analysis

Research under the Decision Support System activity set is being implemented to develop a suite of integrated models that provide a holistic approach to assess options for new technology adoption or policy that support decision makers at several levels. The type of decision-makers the activity is designed to support includes those who develop and implement strategies for sustainable food security methods and poverty reduction. As one component of the suite of models, the Global Agricultural Sector Model (GASM) is being expanded and applied to new levels. GASM is a world trade model that addresses supply and consumption. It is being used at national levels to assess the role of global markets on food security in developing countries. Several accomplishments were achieved this year. Rice was the newest commodity to be added to the GASM model. Studies of the impact of climate change, El Niño effects and greenhouse gases have been completed. Substantial progress has been made in the project's capacity for acquisition, management, and analysis of satellite imagery and ability to link this information to ground-based data, with particular emphasis on obtaining better methods to assess the environmental impact of management options that enhance sustainable food production. Solid linkages have been made with the monitoring functions of the World Food Summit and the Convention to Combat Desertification. Research to develop and evaluate methods that support these international treaties is moving ahead. Linkages with the United Nations World Agriculture Information Center (WAICENT) have been established and a jointly funded collaboration is underway. Linkages to EROS and other sources for satellite imagery have been established and preliminary studies have been done to use this linkage in multilayered Geographical Information Systems (GIS) approaches that define and link biophysical and natural resource management information.

GLO 99-22.
Sustainable Development and Food Security in Watersheds of the World

The overall goal of this activity is to develop an integrated suite of models to assess the economic, environmental and societal impact of the introduction of technology, practice, policies, or regulations that affect or are affected by agricultural production and its use of natural resources at the watershed level. As such, this project seeks to transpose data from politically defined boundaries to major river basin watersheds of the world. Accomplishments for this year include the following. Hydrological data on the Nile River Basin were acquired from the United Nations Food and Agriculture Organization (FAO) and will be added to the FAO WAICENT (World Agriculture Information Center) database. Proof of concept for analysis of the environmental impact of technology at the watershed level was demonstrated using SWAT, SWERB, PHYGROW, and EPIC models for smallholder dairy technology in Kenya's Sondu River basin.

GLO 99-23.
Development of Economic and Biophysical Models

This activity involves research to develop the biophysical and economic models that are used in the integrated Global Decision Support System (GDSS) project. Biophysical models describe the function of crop and livestock species in developing country scenarios and are used as inputs to the SANREM Global Project economic and environmental models. Economic models at both the sector and household level are being developed and linked with other models in the GDSS to estimate the consequences of technology or policy options. Economic models provide input to biophysical and environmental models in an overall holistic analysis. Accomplishments to date include the following. Major progress was made in developing the methods that allow for modeling the utility of new technology in areas geographically equivalent to those in which the technology was developed. Geographical Information Systems (GIS) methods linking agro-environmentally defined zones and politically defined entities permits coupling of data derived from a given location with that which is acquired by census or other means along politically defined boundaries. Results show the impact of the Sorghum and Millet Collaborative Research Support Program (INTSORMIL) technology using these new methods for technology developed in Mali and exported to Senegal and Burkina Faso.

The Agricultural Sector Model for Mali was used to evaluate a series of alternative scenarios that forecast the quantity and price of food in the year 2015 assuming various levels and kinds of interventions. Quantitative estimates confirm the qualitative expectations of shortfalls that will occur, given continuing practices and trends. Scenarios involving both self-sufficiency and free market importation of food were evaluated. Increases in land use and yield of major crops resulting from both policy changes and the introduction of new technology were modeled. These preliminary outputs provided focus to the planning workshop on the Mali Food Insecurity and Vulnerability Information Mapping System Global Terrestrial Observing System (FIVIMS-GTOS) Pilot study. These studies are antecedent to broader studies that include estimating the environmental and societal impacts of alternative scenarios.

GLO 99-24.
Geographical Information Systems (GIS) and Spatially Explicit Analysis

One important common denominator for linking biophysical, environmental, and economic models into a holistic approach is geography. Situations and their outcomes involved in sustainable production of food are spatially linked. Understanding and modeling them requires development of enhanced methods for spatially explicit analysis (or, in other words developing models such that they correspond to the same geographic location). Development of enhanced methods for spatially explicit analysis of economic, biophysical, and environmental information is a key component of the research to develop the Global Decision Support System (GDSS) project. This activity seeks to do that through development of the Spatial Characterization Tool (SCT) and the Almanac Country Tool (ACT). The two main benefits of these tools are that they allow users to see data output in a meaningful way while also organizing databases. A number of accomplishments have been achieved this year including the following. A fundamental building block for the GDSS has been developed and used to define spatially coherent sampling frames and to use them for several analyses. The applications of this method include construction of target area descriptions to define points for further in depth study that will be representative of the geographic diversity of an area. Simulation models are used to estimate in missing data needed to run other models. In present studies in Mali, Senegal, and Burkina Faso, sampling methods were used to link crop simulation models with economic models, reconciling the issue of matching biological responses to data collected by census or sampling within politically defined boundaries. Feasibility studies have demonstrated the capability to link satellite imagery with ground based data for further analysis. The Almanac Characterization Tool underwent further development, adding to its utility and flexibility. The Mali Almanac Characterization tool was completed and is undergoing testing with national partners.

GLO 99-25.
Interactive and Participatory Delivery System

The SANREM Global Project is developing a variety of tools that fall within the Global Decision Support System (GDSS). GDSS is designed to help natural resource managers with difficult decisions. This activity involves the effort across all parts of the GDSS development to involve decision makers, analysts, and research collaborators in developing countries to develop the suite of models that compose the GDSS. The goals of this activity are increased capacity and tools that are responsive to user needs. The following accomplishments have been completed this year. Memoranda of Agreement have been signed with key national, regional and global partners and collaborators. Plans of work leading to the development of delivery systems through pilot studies on Food Insecurity and Vulnerability Information Mapping System (FIVIMS) have been jointly prepared and adopted. As part of the total GDSS effort, the Mali FIVIMS pilot study has been initiated and a National Task Force on Food Security Models has been established in the Government of Mali to interface with this work. A FIVIMS-UNDP (United Nations Development Program) sponsored development of a Mali Food Security Mapping System is under development and will form a focal point for introduction of the GDSS models. The initial Workshop for the Kenya FIVIMS study has been planned and two preparatory meetings with senior officials of the government have been held. Long-term training has been initiated and regional training workshops scheduled.

GLO 99-26.
Collaboration with Regional SANREM Projects at Local Levels

This activity is designed to develop and extend impact assessment methods from the household to watershed and regional levels through active collaboration with SANREM's regional and global projects. This year's focus has been with the SANREM West Africa Project. A regional agricultural sector model for the Mopti Region was developed and provided to this project. Texas A&M University representatives participated in the meeting of the NRM Coordinating Pole on "Lessons Learned and Future Plans for West Africa – Conflict Resolution and Natural Resources Management." Contacts for future regional activities in Senegal and Burkina Faso were established. A second planning session was held with the West Africa Project leadership regarding the next steps in bringing together the GDSS models and outputs and those of the West Africa Regional Project.

GLO 99-31.
Assessment of Decision-Maker Priorities and Decision Support Opportunities

Within the context of providing support to natural resource management decision-makers, the Assessment of Decision-Maker Priorities (ADMP) project is geared to understand the desired outcomes, issues and difficult decisions of natural resource managers. Identifying and understanding these issues is being undertaken in order to ensure that the support designed to help decision-makers actually corresponds to their needs and demands particularly in settings where national governments are yielding decision-making authority to local branches and citizen groups. The ADMP has accomplished several

objectives during Year 2. Most notably, assessments have been completed at each of the regional sites (Mali, the Philippines and Ecuador) and work was initiated in the Southern Piedmont of the United States. Interview protocols were designed following an iterative process, a literature review was conducted, syntheses were compiled and an electronic consultation of experts was facilitated. In the upcoming year, an additional expert consultation will take place, an overall synthesis will be compiled, and the results will be disseminated and posted on the SANREM Web site. In particular, results will be shared with all SANREM investigators engaged in decision-support activities in order to analyze the goodness of fit between identified needs and tool design.

SANREM CRSP
Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program
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Communications

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Introduction

The purpose of communications and information exchange activities is to promote an awareness of the research and other efforts undertaken by the SANREM CRSP. These activities also seek to enhance sustainable agriculture and natural resource management through sharing, facilitating and disseminating information about SANREM research.

Communications efforts are aimed at both a research and a general audience, both in and outside of the SANREM program. For example, while publication of journal articles is an essential component of any research program, access to research results in that venue is limited to a narrow, scientific audience. Recasting research results for broad audiences that can benefit from SANREM activities provide a means to expand their impact.

The focus of Year 2 (1999-2000) communications activities was to build on past efforts and support SANREM's five-year goals by making knowledge accessible to decision-makers and researchers.

Objectives

- Generate awareness of SANREM research and activities;
- Share information and data generated by SANREM partners; and
- Promote understanding of sustainable agriculture and natural resources management issues (in particular as undertaken by SANREM).

Methods or Approach

The primary vehicles for communication and information exchange that were utilized during Year 2 were print and electronic media, face-to-face interactions and audio-conferencing.

Face-to-face communications, electronic workshops, conferences and other meetings were organized to bring together researchers and facilitate exchange of experience.

A number of publications such as newsletters, reports and other documents were produced to communicate SANREM research and activities.

The SANREM Web site was enhanced to provide access to research materials and facilitate online reporting.

Research materials are being collected and archived at the Management Entity and access to these materials via Internet was initiated during Year 2.

Results and Discussion

SANREM Web Site. The SANREM Web site is a critical means of communicating about the program. During Year 2, the Web site was updated and some technical findings, papers, conference proceedings, and abstracts were posted. A physical and digital archive of the results of past, current and future SANREM CRSP research has been established at the Management Entity. A searchable, bibliographic database was launched that provides access to approximately 50 citations and abstracts (when available) for SANREM publications. The semiannual report (Year 2) and work plans (Years 1, 2, and 3 of SANREM phase II) became available on the SANREM Web site. The Phase I Impacts document was prepared for access via Internet. Adding to the database is an ongoing process and full text versions of many documents will eventually be available.

An administrative database to facilitate access to SANREM reports and review of work plans was established. The SANREM-Global and SANREM-Andes Projects used the new online reporting feature for submitting their contributions to the semiannual report. The system was also used for work plan review.

SANREM and FAO Collaborate to Enhance Participation through Virtual and Web-based Networks. SANREM collaborated with the Food and Agriculture

Organization, the Government of the Netherlands, and the International Institute for Sustainable Development to implement a Web Forum on Multifunctional Character of Agriculture and Land (MFCAL). One component of the Web Forum that was managed by SANREM was a virtual conference, an interface to the face-to-face preparatory FAO/NL Conference for the Commission on Sustainable Development's 8th session. The Virtual Conference brought together 1300 virtual participants from over 80 countries to take stock of progress to date on Chapters 10 and 14 of Agenda 21 and to outline the way forward. Insights generated by virtual participants were summarized and used in the dialogue by conference delegates. The outcome of this activity has provided inputs to the FAO task managers report on Chapters 10 and 14 of Agenda 21 and will be input to the CSD-8 Conference in April 2000. The Web-based FAO Web Forum received the greatest number of 'hits' in the history of the FAO web page. The Web Forum and Virtual Conference were seen as new way to enhance participation and input both in preparation and during UN conferences.

FAO Task Manager's Report to the Commission on Sustainable Development. SANREM was invited to contribute to the FAO Task Manager's report of progress related to Chapter 14 of the Earth Summit, Integrated Planning and Management of Land Resources. Carla Roncoli led the effort with input by Julia Earl and Constance Neely. There were two results. Firstly, SANREM now has a good review of current advances in integrated management of natural resources done by Roncoli. Secondly, SANREM is cited as one of example of those advances in the final document.

Commission on Sustainable Development-8. SANREM collaborated with United Nations FAO, the Government of the Netherlands, and the International Institute for Sustainable Development (IISD) to implement a Web Forum. SANREM managed a virtual conference during Maastricht, an interface to the face-to-face preparatory FAO/NL Conference for the Commission on Sustainable Development's 8th session. The outcome of this activity has provided input to the FAO task managers report on Chapters 10 and 14 of Agenda 21 and provided input to the CSD-8 Conference in April 2000. SANREM Acting Director Constance Neely served on the U.S. delegation to CSD-8 as a technical advisor.

Integrating Food Security into the Research Agenda of the National Agriculture Research Systems (NARS). The Research, Extension and Training Division (SDR) of the Food and Agriculture Organization (FAO) of the United Nations, in partnership with SANREM and in collaboration with the NARS Secretariat of the Global Forum on Agricultural Research (GFAR) hosted an electronic consultation. From April 10 to 28, more than 30 experts came together for a consultation via Internet to lay the groundwork for an electronic conference to take place June 5 to July 14, 2000.

Retreat. The SANREM Management Entity Acting Director Constance Neely, and Program Associate Julia Earl participated in and co-facilitated a two-day working retreat with USAID Program Officer Christine Bergmark and Clara Cohen, AAAS fellow, as well as Ed Kanemasu, director of International Agriculture at the University of Georgia. The retreat provided an opportunity for both USAID and the Management Entity to gain a clearer understanding of on-going initiatives, visioning for the remainder of Phase II, and tasks and goals related to that vision.

Visits With Program Managers. Constance Neely and Christine Bergmark conducted day-long visits with each SANREM Project Manager at their respective institutions. The meetings allowed for an active exchange of perceptions regarding current program status and future desired goals.

Annual Meeting. A Joint Meeting of the Board of Directors, Technical Committee, External Evaluation Panel to took place in December 1999. SANREM researchers presented overviews of their projects.

Reports and Publications

- The 1998 annual report was published in August and submitted to USAID on time.
- The 1999-2000 semi-annual report was published in December and submitted to USAID on time.
- Two editions of the SANREM newsletter were published since June.
- A revised Year 2 work plan was published in August 1999 and the Year 3 work plan was published in April 2000.

EGAD Review. SANREM provided a comprehensive review of progress toward intermediate results for USAID strategic objective 2.

E-News. An electronic news service was initiated in March; information is sent to CRSP directors, SANREM partners, and others once or twice per month.

Other activities to generate awareness of SANREM research included:

Invited Presentations

- Constance Neely presented a seminar on SANREM research for USAID in Washington, D.C., February 2000.
- Gladys Buenavista presented a seminar on SANREM research for the Board for International Food and Agricultural Development (BIFAD) in Washington, D.C., March 2000.
- A poster presentation on SANREM activities was prepared and displayed at the University of Georgia's Ag Showcase in Fort Valley, September

9, 1999.

- Participation in University of Georgia's Ag at the Zoo Day in March 2000 provided an opportunity to educate people about the SANREM program and help raise awareness about the need for land use planning. A game based on a research tool that SANREM Andes uses to identify what landscape features a community values was developed to explain SANREM activities to the public.
- Julia Earl described her work in international development, including SANREM, at the dedication of the University of Georgia's new Master's International Agriculture

Senegalese Visit. Four representatives of the Senegalese Community-Based Natural Resources Management Program (CBNRM) visited SANREM and the USDA Agriculture Research Station to learn more about both projects work in the areas of participatory natural resource management. Virginia Polytechnic and State University (VTU), a SANREM partner, manages the CBNRM Program. VTU's management of the Senegalese program coupled with their administration of the Mali project provides a dynamic opportunity for cross-fertilization of ideas and lessons learned. Fascinating similarities and common challenges faced by the Mali, Senegalese and Southern Piedmont projects emerged during the visit despite different agro-ecological and socioeconomic circumstances.

Ethiopian Visit. A delegation of four Ethiopian agricultural scientists spent three days at SANREM Management Entity office to learn about the program's watershed research. As a result of the meeting, Jean Steiner and Gladys Buenavista visited Ethiopia as part of an InterCRSP review of watershed research.

Monthly Reports and Annual Impact Statements to Dean. Each month, SANREM accomplishments are reported to the Dean of the College of Agriculture and Environmental Sciences at the University of Georgia. Impact statements on SANREM activities were submitted to the Dean of the College of Agriculture and Environmental Sciences at University of Georgia. These statements will be used to generate press releases and reports to state and federal legislators.

Impacts

These activities are expected to increase access to and utilization of research results methodologies by natural resource managers and planners. This would include users at multiple scales from governments, the Food and Agriculture Organization (FAO), Consultative Group on International Agricultural Research (CGIAR), and other audiences.

Publications and Presentations

SANREM CRSP. 1999. Revised Work Plan and Budget for 1999-2000 (August 30, 1999). 1999. SANREM CRSP, Watkinsville, Ga. 368 pp.

SANREM CRSP. 2000. The 2000-2001 Work Plan and Budget. SANREM CRSP, Watkinsville, Ga. 272 pp.

SANREM CRSP. 1999. Annual Report 1998-1999. 1999. SANREM CRSP, Watkinsville, Ga. 215 pp.

SANREM CRSP. 1999. EGAD Review: SANREM CRSP Progress Toward Intermediate Results for Strategic Objective 2

SANREM CRSP. 1999. Semi-Annual Report: 1999-2000. SANREM CRSP, Watkinsville, Ga. 118 pp.

SANREM Newsletter Summer 1999

SANREM Newsletter Fall 1999

Outputs of the SANREM, FAO, NL E-Conference were used to develop two key papers for the FAO/ NL Conference on the Multifunctional Character of Agriculture and Land.

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Assessment of Decision-Maker Priorities and Decision Support Opportunities

Introduction

The SANREM CRSP is centered on supporting and informing natural resource management decisions. This project emphasizes the need for a better understanding of the difficult natural resource management decisions being faced by a variety of decision-makers at various levels in the decision-making hierarchy especially in settings where decentralization is in progress. This effort is being carried out collaboratively between the Global and Regional Projects in Mali, Ecuador and the Philippines. From the local to regional level the ADMP is undertaking participatory appraisals of what potential decision-makers identify as desired outcomes, issues, and critical decisions related to natural resource management. The ADMP is congruently identifying perceived needs in terms of specific decision support including information, decision support tools and capacity building as well as who decision-makers must collaborate with to effectively address the issues. Concurrent decisions and similar and divergent desired future conditions are being stressed. A key piece of this research is to identify critical institutional actors who are part of concurrent decision-making with important impacts for natural resources. Within this project, a participatory methodology is being developed and refined for eliciting this information from decision-maker informants. Based upon the assessments in Ecuador, the Philippines and Mali, the project will compare the demands of decision-makers with the currently available decision support tools. SANREM will use the outcome of this work to identify potential research on decision support processes and to identify key points and issues where decision support tools might be utilized effectively and efficiently. The output will be used in collaboration with the Decision Support System activity.

Objectives

The primary objectives of the ADMP project are to develop a methodology for understanding the needs and priorities of agriculture and natural resource decision-makers at multiple scales; and to establish a participatory monitoring and evaluation framework that can be used to prioritize research oriented toward integrated concurrent decisions by multiple decision-makers at multiple levels. This will be done in order to ensure that decision support activities aimed at informing natural resource management decision-makers respond to the real demands of decision-makers in settings where devolution of or shifts in power are in progress.

Methods or Approach

A variety of methods are being employed for the assessment of decision-maker needs. These methods include:

- Develop a participatory methodology to understand the priorities, issues and difficult decisions that natural resource management decision-makers and key actors currently face (particularly in the context of decentralization). The methodology will also enable SANREM to identify support opportunities such as identifying how to characterize natural resource decision-makers and stakeholders, types of desired natural resource outcomes, types of natural resource decisions faced (trade-offs, etc.), sources of support (information, tools, and training) and the framework in which to elicit these responses.
- Identify desired natural resource management outcomes and the constraints to decision-making in pursuit of these outcomes through participatory appraisals

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(focus groups and interviews) in Mali, the Philippines, Ecuador and the Southeastern U.S. Identify what is perceived as the needed support to make these decisions.

- Validate the demand side of difficult decisions and potentially useful tools, information, and capacity building through electronic fora, to facilitate decision-making as articulated in the appraisals. Then, assess the supply/support side of decision-making.
- Synthesize and prioritize decision-maker needs and opportunities from the three regions and the electronic conference to help focus decision support research activities of SANREM, and its collaborating partners such as FAO, INSAH, CIAT and others.
- Establish a participatory monitoring and evaluation framework within the context of landscape level decision-making and stakeholder benefits optimization to aid in the prioritization of participatory research efforts.

Results and Discussion

Findings. Activities undertaken during Year 2 have yielded insightful results relative to the development of the assessment methodology and the types of priorities faced by NRM decision-makers.

Methodology Design. Development of the assessment methodology has followed an iterative process of interview protocol design, field-testing and further modification of the protocol. Several key findings were derived from both the assessments conducted in the field and the expert consultation during which the assessment methodology was analyzed and further refined. Principal investigators found the need to use a variety of terms based on both the setting and interview participant in order to elicit useful responses regarding decision-making priorities, needs or issues; while at the same time not misleading participants in terms of potential development assistance from SANREM. Networking and requesting additional suggested participants from interviewees was a useful technique to identify all relevant decision-makers. Diagrams drawn by assessment participants to identify the linkages between actors, issues, natural resources and nodes of interaction were piloted in the Philippines and Mali. These visual diagrams were not useful as an assessment technique. In both cases interviewees preferred to discuss verbally the relevant NRM issue components rather than to map them. When conducting interviews regarding a particular natural resource issue with formally recognized individuals within a decision-making hierarchy (such as government ministries), special attention must be paid to be inclusive of women and other disenfranchised groups as these people are not often recognized (or have the status) as decision-makers. In keeping with SANREM's commitment to respect for and inclusion of people at the grassroots level, assessments were initially conducted at the local level first and then on to higher administrative levels. However, starting at the national level with a few reconnaissance interviews then going to the local level was identified as a potentially useful way to identify the breadth of issues confronting NRM decision-makers within a given country.

Decision-Maker Priorities. The assessments conducted in Mali, the Philippines, Ecuador and the Southern Piedmont of the United States identified NRM priorities relative to two broad categories: a) environmental management and production strategies and b) the decision-making process and/or administrative issues. Some of the environmental management issues identified by assessment participants included: balancing biodiversity and agricultural production; the effects of pollution from gold mining; the environmental and economic costs and benefits of cotton production intensification; deforestation and urban consumption; dryland and wetland pasture management; and promoting and managing sustainable economic growth.

In addition to specific environmental issues, assessment participants identified a variety of priorities or needs that may be categorized as decision-making processes and/or administrative issues. Some of these topics included: tension between vying national environmental ministries; conflicts between stakeholder groups over a shared resource; governmental financial constraints to implement sound NRM practices; the need for supra-village NRM structures in light of government decentralization; greater access to sound technical information; stronger partnerships between local governing bodies and civil society; access to decision-support tools; and gaps between and within levels of a decision-making hierarchy and the need for greater coordination among decision-makers. (Specific results from these assessments may be found in relevant publications available from SANREM.)

Interestingly, although some of the very specific features of natural resource problems may have varied, the ADMP project has found that domestic issues of concern mirror international ones such as competing land use by multiple stakeholders with mixed objectives.

Expert Consultation. Following assessments conducted in Mali, the Philippines and Ecuador, an expert consultation was facilitated by the ADMP project. The consultation took place using an electronic chat room during which time the emerging results of the assessments as well as potential improvements to the methodology were discussed. Participants in the expert consultation found that

difficult decisions faced by NRM decision-makers often involve conflict. In these cases advocacy coalitions may play a vital role in the decision-making process. In the process of applying the methodology, the principal investigators found that using contextually specific terms is important to elicit the issues with which decision-makers are grappling. Experience from England and Ecuador has demonstrated the importance of incorporating a component in the assessment during which participants articulate a desired future state (as well as identifying the positive features of their current situation). "Engaged research" was identified as an effective method for researchers to apply in order to incorporate the full participation of researchers and local partners, as well as maintaining focus on the real needs of local participants. Incorporating validation workshops into the research design was suggested as a useful means to verify information gathered from the assessments and to be inclusive of assessment participants.

Publications and Presentations

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Global Decision Support System

Project Overview

Introduction

The Global Decision Support System (GDSS) is a suite of computer models currently under development that will help developing countries predict the impact a change in technology or policy has on food, agriculture and natural resource use. The models will allow a manager — for example a policymaker or government leader — to develop scenarios and test different options before implementing a new practice. The idea is that foreknowledge of a decision's impact should lead to better decision-making at national, regional and even global levels.

GDSS also will include critical foundation data for spatially explicit analyses, i.e. using geography as a common denominator, data from many sources can be analyzed as it applies to a location. GDSS, which is comprised of geo-referenced economic, environmental and biophysical models, will provide a means to assess the interactions between land use and the natural resource base. It will also provide access through global networking to other models and sources of relevant information.

GDSS is being developed and adapted so it will be useful from the farm level to the global level. Methods are developed in collaboration with ultimate decision-makers and use relevant real-world assessments to refine and validate the models. This approach produces methods tailored to needs of specific users who participate in their development. The case studies also provide early useful products from the analysis.

GDSS development is being linked to regional and other global SANREM activities by parallel development of methods and databases useful to regional projects and by mutually beneficial collaboration on specific assessment tasks within regional projects. The products of GDSS will be incorporated into the SANREM global information system.

Objectives

- Develop improved capability to make informed decisions relating to the consequences of adopting specific agricultural and natural resource management technology, practices and policy on sustainable agricultural development with a focus on the landscape/lifescape level of integration
- Develop the capability to assess the impact of policy and management decisions related to the general area of food, sustainable agriculture and natural resource management at levels of government ranging from provincial to global.

Relationships Between GDSS Activities and the Relationship of Activities to Case Studies

As noted in the revised work plan for year two of SANREM II (31 August 99), the six activities under this set are being concurrently developed under five specific applications. The relationships are shown in the following table, which summarizes the indicators in a matrix showing activities (the approved work plan) and the applications. Progress is reported under each activity, but the matrix is useful in establishing the relationships between them. As noted in the work plan, the SANREM agenda is being supported by several other grants, which directly contribute to achieving its goals.

Progress

The overall plan for the Global Decision Support System (GDSS) has been solidified in this reporting period by collaborative agreements with FAO and our regional and national partners. Plans are on track for both the Mali and Kenya pilot studies for FIVIMS-GTOS with the major planning workshop for the Mali study completed in early December 1999. A pilot study for the watersheds activity has been completed. Exciting new results linking satellite imagery and related information from the Almanac Characterization Tool are demonstrating the utility of the methods for assessing the status of natural resources in West and East Africa. These results directly support the West Africa Project in the Mopti region of Mali. The agricultural sector models at country and global levels have been extended, incorporating a stochastic element that allows estimates of risk of adoption of new technology or policy options. Analyses using the agricultural sector model for Mali are providing projections for the status of food security in the year 2015 with current practices and various options for intervention. Linkage with the Global Project's Global Knowledge Base has been initiated.

SANREM Relationship Activities and Case Studies
Global Decision Support System

Performance Indicators Summary

Activity / Application	Global Decision Support	Analysis at Watersheds Level	Economic and Biophysical Models	Geo-Referenced Spatial Analysis	Delivery System and Regional Collaboration
Pilot FIVIMS-GTOS in Mali and Kenya	Apply GASM impact of global markets on food security at national levels	Assessment of production and environmental interactions at watershed levels	Models and data to assess outcomes of policy options and technology on food security and use of NRM	Geo-referenced data for model input, methods for extrapolation to equivalent areas, framework for analysis and data	Long and short term training of national partners, transfer of data bases and models national and regional application
Sustainable Development at Watershed Level	Satellite imagery for assessment of land cover/land use	Linking economic, environmental and biophysical variables at watershed levels for regional and global implications	Economic, environmental and biophysical models linked to watershed models	Geo-referenced data for model input, methods for extrapolation to equivalent areas, framework for analysis and data	Participation with national and regional partners and delivery of methods and data
West Africa Extensive Lands - Food Security and NRM, NASA	Satellite imagery for assessment of land cover/land use	Application of watershed models as appropriate	Combine GDSS biophysical models with data and methods for satellite imagery for assessment of interactions	Geo-referenced data for model input, methods for extrapolation to equivalent areas, framework for analysis and data	Collaboration with AGRHYMET, INSAH, and ILRI for delivery to their clientele of methods and data
Collaboration with SANREM West Africa Project	Apply GASM impact of global markets on food security at regional levels Satellite imagery for assessment of land cover/land use	Niger River - Mopti Delta Region Analysis using GDSS	Derivatives of Mali models for Mopti region to provide economic, environmental and biophysical data to augment West Africa Project studies	Geo-referenced data for model input, methods for extrapolation to equivalent areas, framework for analysis and data	Cooperation with West Africa Project and their decision-makers at local and regional levels for delivery of methods and data

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Decision Support System for Global Level Analysis

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Introduction

USAID, FAO and other donor development agencies have ongoing and emerging programs that assess the global status of hunger, trends in food insecurity and vulnerability, and the capacity to produce food, fiber, and forest products in a sustainable manner. Information to support these programs comes from sources that range from local to national to global (e.g. satellite imagery). In addition, USAID needs methods that can be used by their collaborators to assess the impact of research investments in both *ex ante* and *ex poste* analyses.

The SANREM Global project at Texas A&M collaborates with several key programs to develop methods that extend the breadth and depth of food security analysis at the global level. Methods are being developed to assess the current status and trends in food security, the factors that determine food security status, and the impact of alternative strategies, policies, or use of new technology on food security.

Global assessment methods draw, in part, on aggregated national information and analyses for their synthesis. Satellite and related imagery are also used to provide global estimates of food production, relevant natural resource statistics, and meteorological data and analyses. SANREM Global/Texas A&M works with organizations that have a mandate to conduct global assessments and to develop or extend the assessment at national, regional and global levels.

Objectives

- Expand and apply the Global Agricultural Sector Model (GASM) to development of national and regional impact assessment methods.
- Use the Texas A&M suite of impact assessment methods to expand the ability to interpret satellite imagery for decision-making at national, regional and global levels
- Expand and apply the Texas A&M impact assessment methods to improve international organizations' capability to monitor the status and progress towards achieving the goals of conventions and treaties dealing with food, agriculture, and natural resources.

Methods or Approach

GASM is a world trade model that covers supply and consumption in and between more than 30 world regions and a growing number of commodities. It will be used in national and regional level analyses to project the impact of change on food availability and cost in other parts of the world. GASM will be a component of the development of methods based on specific case studies in developing countries and in multinational settings. Collaboration with FAO, NASA/NOAA and the EROS Data Center is being established to access primary and secondary satellite imagery data and to jointly develop and extend the Texas A&M methods to provide analysis at multiple levels of scale. FAO collaboration on Food Insecurity and Vulnerability Information Mapping System (FIVIMS) with the Worldwide Agricultural Information Center (WAICENT) provides a mechanism for broad technology transfer to developing country decision-makers.

Results and Discussion

Global Agricultural Sector Model (Objective 1)

The Global Agricultural Sector model (GASM) was expanded to incorporate the rice international trade market. Global ASM can now be used to examine developments regarding the production of corn, hard red spring wheat (HRSW), hard red winter wheat (HRWW), soft wheat (SOFT), durum wheat (DURW), sorghum,

soybeans, and rice as it influences U.S. and world production, consumption and trade.

The Global ASM has been applied in a number of contexts regarding the effect of forces in the environment and the policy arenas. These studies have largely involved the effects of El Niño Southern Oscillation phase information, climate change and greenhouse gas emission reduction.

a. El Niño Southern Oscillation (ENSO) Studies. The value of ENSO information to agriculture was evaluated with the Global ASM. Consideration of the uncertain strength of ENSO events and worldwide production information raises the value of ENSO information by two-fold with respect to the average ENSO effects. The economic damages to agriculture arising from a climate change induced shift in El Niño Southern Oscillation (ENSO) event frequency and strength was examined. The damage estimates are in the $3 to 4 hundred million U.S. dollar range if the frequency of ENSO events changes. However, annual damages rise to over $1 billion if the events also intensify in strength. Event anticipation and crop mix adoption by farmers can help offset the damages but cannot fully alleviate them. In Africa, corn, wheat, and, to a lesser extent, rice production are all lower during an El Niño event. World crop prices are higher for rice, but lower for corn and wheat. Projected global climate change is estimated to increase world grain production and lower prices.

b. Climate Change Studies. The costs of the latest forecasts of weather alterations due to climate change was investigated using Global ASM and a model of forest and agriculture that used Global ASM features. Climate change was found to be beneficial in both cases. Studies were also done on climate effects on pests and agricultural variability.

c. Green House Gas Emission Reduction Studies. The economic potential of agriculture to participate in Greenhouse Gas Emission mitigation efforts was analyzed. Results indicate that agriculture's contribution to GHGE reduction can be significant. An examination was done on the preferred emission reduction strategies at different carbon prices. Another study examined the impacts of joint implementation of Annex B country on GHGE and also estimated the associated impacts on price and welfare change in agricultural products.

Satellite Imagery (Objective 2)

A concept for a virtual landscape, based on heuristic rules bases, is being developed. The virtual landscape model will allow biophysical models such as EPIC and PHYGROW to simulate crop and forage yield as landscape composition changes over time and as cropping systems extensify or intensify. A hierarchical structure is being added to PHYGROW that allows a more complex, spatially-coherent analysis to be conducted. This enhances the sensitivity and resolution of economic and environmental analyses using other models in the Global Decision Support System (GDSS). Land cover and use estimates are being enhanced by using a combination of EROS crop intensity level maps, the vegetation map of Mali, NDVI data, CCD precipitation data and the numerous environmental layers in the SCT/ACT to establish a sampling framework to support the evolving use of linked virtual landscapes. WinDISP3 methods have been acquired and used to compare NDVI greenness indices and CCD precipitation estimates with biophysical models, targeting use of these methods as part of the approach to assessing impact relative to the combination of food security, desertification, and famine early warning systems.

Linkages to International Organizations (Objective 3)

Plans for Collaboration: Ongoing dialogue with colleagues in FAO Headquarters over this reporting period, participation in FIVIMS meetings in Washington and ongoing e-mail dialogue has produced specific plans and joint funding for collaborations. A major new proposal for FAO funding was submitted in May 2000 and being sent to upper level administration in FAO for consideration. Letters of intent were signed with the FAO FIVIMS Secretariat and WAICENT regarding joint sponsorship of FIVIMS-GTOS Pilot Studies in Mali and Kenya

Collaboration with FAO-WAICENT on Software for a Common Modeling Environment: A series of meetings have been held between the SANREM Global Team and FAO WAICENT (World Agricultural Information Center) to collaborate on integration of the Common Modeling Environment (CME) in the WAICENT Key Indicator Mapping System (KIMS) toolkit environment. The CME is a set of middleware that provides streamlined methods to link models with varying input and output requirements. FAO-WAICENT provided the SANREM-Global Team $50,000 to cover costs of staff interactions in 2000 and to assist in conducting a systems analysis and integration test for infusion of two models in the KIMS environment. A detailed task plan was developed with the first milestone being completion of software tests in August 2000. CME is a 100 percent JAVA application that appears to be highly compatible with the JAVA system being implemented by WAICENT. Programmers on both teams are actively working on internal linkages that will be suitable to test remote access to pre-configured PHYGROW and EPIC model runs used in the Mali and Kenya impact analyses over the Web via the FAO WAICENT gateway. A more complete description of the CME can be found at http://cnrit.tamu.edu/CME. Recent discussions with FAO WAICENT are leading to development of a substan-

tial proposal to collaborate on assisting FAO to add analytical capacity to their emerging vision of new information delivery system for agricultural, natural resource, economic and socio-cultural information in a distributed manner.

Impacts

Quantitative estimates of ENSO effects provides decision-makers in developed and developing countries with an important planning tool to assess risk and uncertainty. They enable better decisions on methods to control greenhouse emissions. GASM provides a means of introducing world market effects into country level models to assess options to enhance food security.

The use of satellite imagery to assess the status of natural resources in fragile ecosystems of the developing world will provide decision-makers with an affordable mechanism to improve planning for sustainable enhancement of food security and to monitor status of relevant ecosystems.

The establishment of a network of sites with databases and models with FAO and other partners will provide a mechanism for analysts in developing and developed countries to more effectively use the products of the GDSS and will provide for improved quality of decision-making at all levels on food security and sustainable use of natural resources.

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Sustainable Agriculture and Natural Resource Management
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Sustainable Development and Food Security in Watersheds of the World

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Introduction

Traditionally, agricultural statistics and models dealing with production are organized by political boundaries. However, environmental and natural resource implications or consequences of production are often best analyzed at landscape and watershed levels that transcend these boundaries. Methods are being developed to improve the ability to transpose data and results from politically defined boundaries to watersheds. As one moves to national, multinational, and global levels of analysis, the impact of agricultural production practices must be considered at the same levels. This often involves looking at the downstream implications of upstream farming practices in the waterways of the world. This research adopted existing models such as SWAT and SWERB to assess the impact of changes in agricultural production in the Kenya's Sondu river basin. Due to lack of external funding and re-prioritization, components of this activity have been incorporated into the 2000-2001 work plan and this activity is eliminated.

Objectives

- Acquire access to or obtain the relevant information on the watersheds and major river basins of the world to serve as input for analysis of the environmental impact of agriculture and use of natural resources.
- Develop and demonstrate the utility of geo-referenced holistic methodologies to evaluate options for the use and conservation of natural resources, the consequences of changes in agricultural production technologies and practices, and the environmental consequences of related policy and regulatory options at the watershed level.

Methods or Approach

Establish functional relationships with relevant databases and their sources to provide input for development and use of integrated impact analysis methods at the watershed and major waterway levels. A combination of the ACT and SWAT, PHYGROW, and EPIC models was used to assess the impact of smallholder dairy technology in the Sondu river basin. The Sondu River feeds into Lake Victoria.

Results and Discussion

Objective 1 World Waterways
Data on relevant hydrologic factors for the Nile basin were obtained. These will be incorporated into the Global Project's and the FAO WAICENT's data systems.

Objective 2 Environmental Impact of Small Holder Dairy Technology in the Sondu River Basin - Kenya

Impact analyses were completed on the effects of human population expansion and infusion of dairy technology from the period 1980 to 2010 in the Sondu River basin in Western Kenya. This was part of the larger impact assessment of smallholder dairy technology in East Africa. To assess changes at a watershed scale, projected land use from the agricultural sector model was linked with the SWAT basin hydrology model, thereby allowing basin-scale assessment of environmental impacts, including laminar flow of runoff, soil erosion, and soil loading. The Sondu River basin was chosen because of its diverse environmental types and because a high proportion of its land area possessed 4 of the 7 dairy production zones that were derived via spatial extrapolation with the ACT tool of Kenya. Also, the Sondu River, located on the northern edge of Lake Victoria in western Kenya, is one

of many watersheds that drain directly into that lake; therefore, it represents how land use change impacts water flows and sediment flows in this important body of water.

Population data and demographic survey data were used to estimate land use within the watershed for each of the smallholder dairy scenarios. Population densities were calculated on a 2.5-minute grid scale for the years 1960 to 1990 (NCGIA, University of California Santa Barbara; Africa Data Sampler, population density as calculated by Diechmann). The population densities were used to determine land use at the household (farm) level and to estimate the number of households within each grid. A traditional (unimproved) dairy technology scenario was assumed for 1980 while current adoption scenarios were used for 1990 and full adoption of the households in 2010 was derived from focus groups of regional experts. The adoption of smallholder dairy technology influenced maize production and caused land use changes by increasing the amount of Napier grass at the expense of native pasture. Land area for all crops, with the exception of potatoes, increased with the movement from Traditional Dairy technology to Full Adoption current technology. This was most likely the result of increased population pressure on the land rather than changes resulting from the adoption of smallholder dairy technology.

The SWAT model was calibrated for 1979-88 using the current land use technology. Model parameters such as curve number (abstraction coefficient), available water capacity, and soil evaporation compensation factor were adjusted interactively to get reasonable match between observed and simulated mean monthly stream flow at the three stream gages. Stream flow and sediment loads were simulated using the calibrated parameters for the validation period and results were compared. Some calibrated model parameters were used with full adoption and traditional land use technology so that the results can be compared and the effect of changing land use on water and sediment yield can be assessed. The same calibration and validation periods using future and old land use scenarios. Statistics were calculated for the simulations with the three scenarios and the results were compared.

Observed flow and predicted flow from two upstream gauges indicated that the methods used gave satisfactory results. There was 27 percent increase in water yield from the basin over the 1980 to 2010 period. Accumulated sediment load was estimated to be almost 6 percent higher from the period of 1980 to full adoption in 2010. Unfortunately, we could not validate the soil loss predicted and must view these values as relative impacts on the system. It appears that population density has peaked and increased population pressure on the land will marginally impact the soil resource as long as government policy does not allow development of the national forest in the upper reaches of the watershed.

Impacts

Previous research done by TAES and the USDA Soil Conservation Service provided assessment methods for evaluation of various conservation practices with models operating at the watershed level. These have been used for planning and priority setting as well as evaluating results of various conservation practices adopted over many years. The same kind of capacity will be provided to decision-makers in developing countries through the development, demonstration and adoption of these methods as part of the integrated suite of models making up the GDSS.

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Development of Economic and Biophysical Models

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Introduction

Using impact assessments in developing countries as test platforms, the GDSS extends existing or develops new biophysical models that mimic the function of the crop or livestock species. The models predict the interaction of key variables in crop and crop-livestock systems for use as input to other economic and environmental models in the Texas A&M portfolio. Such systems typically include germplasm, management practices, natural resources, purchased inputs and pest management.

A streamlined approach to developing country level agricultural sector models is being developed. A stochastic component has been added to the Mali ASM to model farmers decisions on risk aversion. Existing models, such as FLIPSIM, are being adapted for household or farm level economic analyses to reflect the impact of new technology or policy options. Economic, biophysical, and geo-referenced models are being integrated to predict the adaptability of new technology to other locations.

Objectives

- Develop and demonstrate the utility of biophysical models to estimate performance of crop and livestock species under developing country conditions.
- Develop or adapt and demonstrate the utility of economic models to estimate the impact of introduction of new technology or policy affecting the food, agriculture and natural resource agendas for developing countries.

Methods or Approach

Biophysical models are being developed and used to estimate the performance of crops or livestock in situations where experimental data is limited or absent, or where extrapolation of the use of new technology to geographically equivalent locations is being made. These models, along with GIS based information on natural resources and other factors related to production of food and fiber, are being developed for use in estimating performance given by the introduction of new technology or policy. Examples of biophysical models include the Erosion Productivity Impact Calculator (EPIC) – which deals with effects of farming practices on yield, erosion, and chemical runoff (among others), PHYGROW – a multi species plant growth/runoff model designed to address animal stocking rates, and NUTBAL – which characterizes the impact of changes in environment, nutrient intake, genetics, and feed inputs on animal products production.

The Agricultural Sector Model (ASM), providing interaction among commodities and otherwise reflecting the total agricultural sector in a given country, is a necessary component of the suite of models being developed by Texas A&M. Methods to streamline the development of these models to facilitate multinational impact assessment are being developed. Economic models, in addition to the agricultural sector models, include rural household and farm models derived from the Farm Level Income and Policy Simulation Model (FLIPSIM), that simulate the economic performance of individual farms in response to changes in policy or technology. The models predict change in probability of economic survival, changes in debt, and capital and liquidity in response to introduction of new technology or policy. Other household level models used in previous studies provide outputs that include an index of vulnerability, net food surplus, index of mobility, equilibrium values for resource allocation, and household production to maximize profit and minimize cost.

Biophysical and economic models are interactive each providing inputs and receiving outputs from the other in an iterative process that is providing a

holistic approach to assessing the impact of technology or policy options to improve food security through the sustainable use of natural resources.

Results and Discussion

Objective 1 Biophysical Models

Improving Livestock Yield Variation Output of PHYGROW: A new module was added to PHYGROW that allows the translation of dynamics of forage value indices derived from modeled dietary selection into annual livestock production values needed in stochastic analyses within ASM and FLIPSIM economic models (see prior section). An embedded PERL script module allows the user to define the upper and lower limits of response of weaning weight and offspring crop of each specified species based on interviews with focus groups. These groups define what the mean response would be for a given kind of animal and management environment as well as the expected minimum and maximum response. PHYGROW output of forage value is linked with these focus group responses to derive variable production responses that are needed for the farm and sector level models. We are currently designing a mechanism to add in mortality and milk yield variability with a friendlier interface now that the technique has been stabilized.

EPIC Crop Simulation Model Gets Face Lift: To improve the user friendliness of the EPIC crop simulation model, a new visual basic design was added to the system along with a new database structure that allows easier management of the data. The weather generator module used by EPIC, SWAT and PHYGROW has been improved to avoid abrupt data transitions between months and a new weather cycle adjustment technique is nearing completion to help deal with issues of climate change within the suite of biophysical models.

Least Cost Mediation Module Added to NUTBAL PRO: To help address optimization of biologically efficient and least cost analysis for mediation of nutrient deficiencies of livestock, a simplex algorithm was added to the NUTBAL PRO nutritional balance analyzer to help determine optimum mixes of feeds for both confinement and pastoral settings. Price sensitivity analysis as well as consideration of waste, processing, handling, storage and transport costs can be factored along with biological value to determine optimum solutions to alleviating short falls in nutrients supplied to livestock.

NOAA RFE Weather Data Download Site Established: After reaching agreement with the EROS Data Center, a new weather data support application was developed that allows users of the various biophysical models to log on to the web and go to http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi and specify the longitude/latitude of a site in the 17 FEWS countries in Africa, including our West and East African pilot countries. The program reads the EROS data from two FTP sites, formats the data into model ready comma separated value files and computes the daily solar radiation values to make the files complete. Daily weather data is available form January 1, 1998 to within 24 hours of the date accesses as it is updated each night via an automated bot. The site was jointly developed with the Global Livestock CRSP team developing the Livestock Early Warning System in East Africa. Plans are underway to capture legacy data and provide the same function in ACT. Systems studies are underway to determine how best to convert the 1981 to present 10-day METEOSAT rainfall data of Africa to daily data using the improved WxGEN weather generator developed for use in the biophysical models.

Use of Point-Based Biophysical Models Co-Krigged With NOAA RFE/NDVI Data to Extrapolate Regional Biophysical Responses: A test was performed with the new GS+ co-krigging software to determine how point-based biophysical models (PHYGROW in this case) could be used to reduce computational time and improve extrapolation of biophysical responses across large regions. Collaborators in the GL-CRSP LEWS project classified rangeland communities in East Africa and GPS locations provided for those representative "modal plant communities". Satellite-based weather data from our newly created web site was linked with each geo-referenced plant community over a 2-year simulation period and input in the PHYGROW model to produce estimates of forage standing crop by species.

The region was stratified into three primary, long-term NDVI cluster zones. Model output of total standing crop of forage available to cattle at each stratified point was then linked with the corresponding grid value of the NOAA RFE rainfall estimate and a statistical relationship was derived. There was good correspondence between NOAA RFE 30-day accumulated rainfall and modeled standing forage preferred by cattle. This statistical relationship was then used to extrapolate probable levels of forage in grids not sampled with the biophysical models in each NDVI stratification. We were encouraged at the results but realized the need for more points to adequate extrapolate point based biophysical model output using co-kriging. A minimum of 30 points is needed per stratification to adequately extrapolate point-based analyses for rangeland forage production. This technique will be further explored in both the Mali and Kenya pilot studies with the ultimate goal of integrating the spatial technique in our modeling and ACT tools.

Biophysical and Environmental Impact Analysis of Sorghum Technology in Mali: The EPIC model linked

with the ACT area weighted yield feature allowed simulation of 6 major crops in Mali and 5 major management practices across over 191 simulation zones. These area weighted responses allowed prediction of yields according to political boundaries and aggregated to the appropriate level of response in the ASM sector analysis as well as selected representative farms. The mean and annual yield values were derived for supporting the "States of Nature" (stochastic) analysis in ASM and the stochastic response in the representative farm analysis.

Area weighted mean responses of water yield and erosion were also determined with this system. Environmental impact runoff was minimal for most of the provincial regions in Mali when new sorghum germplasm and crop management practices were assessed. However, in all cases across all districts and all scenarios, the technology adoption scenarios reported reductions in erosion when compared to the baseline scenario ranging from very small in Segou district (1-3 percent) to substantial reductions in Kayes district (30-43. The reduction in the Kayes district is almost totally attributable to the changing technology not the adjustment in area or mixes. Both groundnuts and sorghum had substantial reduction in erosion rates when moving from the baseline scenario and technology to each of the improved technology options. For example erosion on groundnut areas dropped from an estimate of 10.5 MT/Ha to 9.0 MT/Ha while sorghum dropped from 8.9 MT/Ha to 4.0 MT/Ha. For the most part, this reduction in erosion in both crops is attributed to the faster development of canopy cover and the increased development of biomass exhibited by the improved varieties and higher fertility levels (in the case of sorghum). This improved canopy and biomass provides added ground cover during the rainy season when the erosion accrues. Moving erosion in the opposite direction was a 30 percent increase in the groundnut area with the improved technology scenarios. However, this by itself would increase weighted area erosion estimates as groundnuts have the highest erosion estimated of all the crops simulated in the area (e.g. 10 percent MT/Ha for groundnuts versus 8.9 MT/Ha for sorghum in the base run). However, the net results of the various interactions were a reduction in the area erosion rates.

Other districts like Koulikoro and Sikasso report erosion reductions in the 10 percent to 15 percent ranges. In Koulikoro there was no significant change in cropland area among crops for the three technology scenarios. This implies that all of the reduction of erosion is attributed to the variety and cultural practices used with the new technologies.

In Sikasso the ASM estimated a 50 percent reduction in cotton area for the full adoption scenario. Cotton has the highest erosion rate of all crops in the region; therefore, the movement out of cotton would be reflected in a decrease in total erosion for the region. However, cotton accounts for less than 2 percent of the cropland base in the Sikasso region. Movement in equilibrium acreage in other crops like maize, sorghum, and millet accounts for the small movement from 13 percent to 11 percent reduction that occurs in erosion in the Full Adoption scenario.

In summary the simulations report no significant changes in the water runoff but significant reduction in erosion when the technologies under consideration are adopted. In some areas there are significant changes in cropland areas and crop mixes. Even though this shift in areas will affect the economics of the district, the environmental impact of the cropping area changes and mixes are negligible. However, the adoption of the new technologies does affect the total area erosion and, therefore, provide a measurable environmental benefit in all areas. This benefit is attributable to the crop-growing characteristic associated with the new technologies.

Objective 2 Economic Models

To assess regional and national impacts to societal welfare from adoption of variety, fertility and tillage/water retention improvements for sorghum and millet production, an agricultural sector model (ASM) was constructed for Mali. Last year a static version of the Mali ASM was developed that computes mean level economic impacts of the technological improvements at the subnational regional, national and global scales. This year the model was extended to include yield risk and to examine the aggregate economic welfare impacts and distribution among consumers, producers, farmer and family home consumption, and foreign surpluses of changes in risk aversion costs by producers associated with crop yield variations stemming from variable rainfall conditions (i.e. states of nature).

The stochastic version of the Mali ASM provides insight into the relationship between individual farmer behavior and aggregate welfare. It represents a methodological contribution to the analysis of economic impacts from technology advance under risk and uncertainty. In Mali, actions to advert risk that may appear profitable to an individual farm firm may not be profitable to the aggregate sector (i.e. society) after market adjustments have occurred. Because of farm sector and foreign economic welfare losses due to increasing risk aversion behavior, total social economic welfare may be decreased even though variability in producers=, consumers=, foreign and global economic welfare decreases. Consequently, under uncertainty there is a trade-off between mean level of total economic welfare and its variability in Mali, as producers become more risk averse in their behavior.

Development, transfer and adoption of new output increasing and cost reducing technology in primary production of commodities with highly inelastic demands and/or slowly growing demands such as for sorghum and pearl millet are likely to benefit domestic consumers in towns and cities and disadvantage rural producers and their families in the aggregate. Commodities with more elastic demand and/or rapidly growing demand offer potential for increased benefits to both producers and their families and urban consumers from output increasing and cost reducing technology. Knowledge of demand changes that may be expected during periods of technology adoption by producers is necessary to assess total economic impacts of the technology and the distribution of economic benefits among groups in the society.

The Mali ASM was used to launch the Mali FIVIMS Pilot Study for application of the GDSS for use by decision-makers. This was done to provide an improved precision in assessing the impact of technology or policy options. The ASM forecasted results of various generic intervention options assuming projected population growth to the year 2015. Projections of the cost and availability of food with the increased population were made. The consequences of various interventions was assessed by model outputs which showed the productivity increases needed to maintain the current price of food in Mali. Other options such as changes in import and market policy and the intensification and extensification of agricultural operations were also explored. The results provided the basis for debate in the major planning workshop held in Bamako in December 1999 with key decision-makers in the government to plan the more detailed studies now underway on food security options.

Representative farms in Mali had high probability of economic success (i.e. earning 12.6 percent or more on equity) by early adoption of the improved sorghum varieties and fertility/tillage/water retention technologies. Real net worth of the Cinzana farm in the Segou Region of Mali with 400 to 600 mm. of annual rainfall experienced a 66 percent increase from early adoption of the technologies. For the Koutiala farm in the Segou Region with 600 to 800 mm. of annual rainfall and the Kadiolo farm in the Sikkasso Region with 800 to 1200 mm. of annual rainfall, the increase in real net worth was only 4 percent to 6 percent from early adoption of the technologies. Non adoption of the technologies would be particularly disadvantageous for the Cinzana farm as the probability that the farm would earn a return on equity of 12.6 percent or more declined from 64 percent to 24 percent if other farms adopted the improved technologies but the representative farm did not. The impact of nonadoption was negligible on the Koutiala and Kadiolo farms, as the probability was 100 percent that each farm would earn a return of 12.6 percent or more on equity with or without adoption of the new sorghum technologies. Both the expected net incomes and the variance of expected net incomes for each of the representative farms in Mali were forecast to increase from the adoption of the new sorghum technologies.

Impacts

The precision and utility of biophysical and economic models was substantially enhanced, providing decision-makers with improved methods to assess the impact of technology and policy options related to food security and sustainable use of natural resources. Especially important has been the further development of stochastic elements in both classes of models to assist in decision-making on risk aversion. This represents a significant advance over current deterministic models, which show only mean outcomes.

The addition of modern and more reliable input data on weather and other environmental variables through linkages with NOAA and NASA sources provides enhanced statistical validity to the GDSS and improved methods for assessing and predicting consequences of adoption of new technology.

The progress towards linking biophysical and economic models into a holistic approach to impact assessment is a breakthrough at the conceptual level. It allows decision-makers to deal with the food security and environmental issues of top priority in developing countries with new methods and increased precision. The impact is not only related to better decisions, but to avoiding the cost of poor decisions.

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GIS and Spatially Explicit Analysis

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Introduction

Almanac Characterization Tool (ACT) is being developed to provide interconnecting linkages or information flows through which detailed simulation models can be effectively interfaced with spatial data and the outputs delivered to less detailed simulations (other models in the GDSS). The Spatial Characterization Tool provides a method for working with GIS engines such as Arc Info and Arc View. It serves as both an output visualization tool and an internal database input organizer. This provides a GIS application tools that access gridded environmental data, point data and vector based information. The tool provides a suite of querying capabilities aimed at the characterization of agricultural and agroecological environments. SCT/ACT are part of the suite of interactive models and generates input to sector and farm level models.

The SCT and ACT are being developed for use as a first step in GDSS analyses to scope the problem and define inputs to other models. They also function to link and facilitate iterative interactions between models in the suite and finally to interpret the spatial projections of outputs from one level of scale to another. The ACT is being further developed, expanded, and used as part of the total interactive GDSS. The ACT also serves as a repository for data bases and analyses completed during the course of case studies.

Expanded use of the ACT is central to the ability to extrapolate research and demonstrate results to other locations. It will provide a capacity to develop input to other economic and biophysical models as well as extend and display outputs of these models to other scenarios. It will provide a framework for storage and management of both raw and foundation data for ongoing analysis and a focal point for interacting various models in the Texas A&M suite.

Objectives

- Develop and demonstrate the utility of a geo-referenced framework for models, information systems and analytic procedures using the Spatial Characterization Tool (SCT) and the Almanac Characterization Tool (ACT).
- Expand the ACT to a multi-regional scale providing methods to make projections of the utility of research products to other geographically similar areas.
- Continue to expand the capacity, content, and utility of the ACTs for Sub-Saharan Africa.

Methods or Approach

Further development of the SCT and ACT and related software will be done through the use of case studies on new technology or policy options with integration of this and other elements of the Texas A&M portfolio. Advances in state of the art methods of analysis and display of information will be incorporated into the SCT and ACT as will an expanded capability for statistical treatment of input and output data. ACT will be linked with remotely sensed imagery from modern satellites in the overall GDSS activity.

Results and Discussion

Release of the Mali Almanac Characterization Tool (ACT) for Mali: The Mali ACT v 1.0 will be delivered in Bamako in July 2000 (ACT 2.03). The database includes the climate, soils, vegetation, etc. data gathered from various sources for Mali as well as the climate surfaces, soils, simulation zones, and simulated yields for Mali, Burkina Faso, and Senegal. The ACT software allows for user-friendly access to these spatial data as well as visualization and querying capability. In addition, the bulk of the training manual has been translated into French though both the English and French versions are included.

Scaleable Biophysical Modeling for Economic and Environmental Analysis: Research under this activity contributed to the results reported under GLO 99-23, objective 1. As noted in that section of the report, two methods were developed to link model outputs based on biophysical models and environmental models. These reflected information on field, watersheds, and river basins derived from census and other sources acquired within and defined by political boundaries. In West Africa, the ACT was used to delineate climatic clusters and soil groups to create spatially explicit simulation zones. Georeferenced historical weather data was assigned to each polygon along with modal soil type to create an environment for biophysical models to simulate yields of major crops and varying levels of management inputs. These yields were then aggregated by administrative boundaries to the desired level (province, national, regional) where they served as input to the Agricultural Sector Model.

Also noted above, in East Africa, a second stratification method was used that involved creation of agroecological zones within regions capable of supporting small holder dairying. The resulting stratification allowed on-ground surveys of a selected group of households where a median (representative) farm was selected for intensive interviews to determine critical land area/use, management inputs and crop/livestock responses. Biophysical models (EPIC for crops, PHYGROW for forage, NUTBAL for livestock intake/milk) were then applied to each representative farm to generate stochastic yield variation for the FLIPSIM farm model. Aggregated yields weighted by area of each agroecological zone within administrative boundaries was then provided to ASM for provincial and national agricultural sector economic analysis.

Development of preliminary spatial sampling frame for Sikasso Region, Mali. In anticipation of GDSS activities in Sikasso region, a Sikasso specific spatial sampling frame is being developed. This spatial sampling frame uses the broad simulation zones created in the previous three-country study. It will include the addition of a crop use intensity database from EROS, a higher resolution soils database, a human population density database, and an estimate of distance to either a road or 'market' (defined here as a town or populated place). This sampling frame supports a more detailed environmental analysis of the Sikasso region accounting for various land use intensity estimates. The stage was also set to support analytical efforts to diagnose and understand technological "adoption rates" across the region. This preliminary spatial stratification contributes to optimization of data collection from on-farm and rapid rural assessment sources. Working with our Malian colleagues, refinements will be made to the initial sampling frame as focus groups and local knowledge amplify and refine the systematic analysis of the region.

Tools and Utilities to enhance spatial data management: Using the GDSS suite of models creates a database management challenge. The link between the biophysical models and the economic models requires further manipulation to the biophysical model results. Average yields are calculated using an area-weighted yield from each simulation zone. Special utilities have been under development that facilitate the specific calculation of area weighted means. Additional benefits from this development will increase the capacity of the ACT to provide the calculated area of any select zone, whether a political unit or the results of a site comparison. The area-weighted capability is specifically useful to convert the output of a simulation model into the input to an economic model.

An additional utility under development involves the development of visualization tools for time series data to manage sets of simulation "scenarios" that will serve to help diagnose conditions over time. Initial tool development has focused on the management and visualization of the yearly-simulated yields.

A third utility involves the importation of point observations directly into the ACT. Data collected from point observations using hand-held GPS receivers will now be automatically incorporated into the database of the ACT. An attribute editor will allow modification of any data in the ACT as well as the linking of data tables to georeferenced attributes (for example, a census report on district production can be linked to the spatial database containing the district boundaries).

Linking Satellite Data with Biophysical Models: See GLO 99-23, for information on linkage to EROS Data Center and daily weather for FEWS countries in SSA. Design is under way for incorporation of these data – or a summary of these data – in to the ACT. The daily data provided by EROS support the simulation models and over time, will provide insight into the spatial variability of meteorological phenomena.

Impacts

The ACT has been used, along with the EPIC model, to build the bridge between analysis done within boundaries defined by biophysical parameters and analyses done using primary and secondary economic data which is reported by administratively defined boundaries. This provides a new way of developing biophysical model inputs to economic models and for extrapolating the potential use of new technology beyond areas where experimental data exist. The concept of geographic equivalence for

these extrapolations provides a new tool for ex ante assessment of the impact of research results.

Delivering the ACT to Malian collaborators provides a substantial planning and assessment tool as an early product for the GDSS. It provides ready access to spatially correlated data on natural resources, demographics, agriculture and other factors affecting adoption of technology and can be used by analysts after relatively limited training in its application. It is a significant component to the overall GDSS deliverables.

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Interactive and Participatory Delivery System

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Introduction

Research results on individual components of the GDSS are presented under other activities. Integration of these into the global decision support system and ensuring that this system is both useful and usable to partners and users in the developing world is a key component in the overall strategy. All of the activities under the GDSS are interactive as the total system is developed and evaluated. This activity describes the interactive component of the total GDSS that focuses on national partnerships both with NARS and with government decision-makers. These partners are engaged on a continuing basis in the development of the GDSS from the conceptual planning through research, evaluation, and ultimately adoption of the methods by both the research communities in developing countries and key government agencies and their leadership. A part of the overall strategy for the GDSS has been to link this research with needs of such decision-makers to meet their commitments to various international conventions, which have recognized priority and opportunity for external funding. An interactive and participatory process is necessary to ensure this type of involvement.

There are several parts of this process which are fundamental to the success of the strategy. Our national and regional partners have given capacity building. Participation in the development of the models, long-term training and short-term workshops in the region are examples of how this is being done. Packaging of models and databases to make them more usable by other than the inventors is another key component. Participation in case studies that involve further development, evaluation, and modification of models in collaboration with national partners not only builds capacity, but incorporates the experiences and expertise at the national level.

Objectives

- Extend and expand the integrated package of decision support tools through the cooperation with partners by using specific case studies at various levels of government as platforms for development of methodologies.
- Provide effective delivery of new methodologies to customers and assure their ability to use them.

Methods or Approach

Early engagement of key government decision-makers at the Ministerial level to understand their needs for analytic methodologies is undertaken to gain both insight and commitment. Similar contacts with counterparts in national research programs are done to define both existing capacities and interest. Early development of an overall strategy, done in collaboration with both decision-makers and researchers in the developing country to establish priority and focus of research on development of methods. Engagement of the international community of potential donors at the outset is also undertaken. In these studies, the commitments of developing countries to international conventions such as the World Food Summit and the Convention to Combat Desertification were considered in planning the development of methods for impact assessment. It was assumed that the probability of utility of the results would be enhanced if they were connected to areas with high visibility, priority, and possibility for funding. Collaboration with national research partners is integral to the field research. Expert panels are used to help focus the studies and to evaluate results and early outputs. Workshops are held at frequent intervals during the development process to develop input and ownership from decision-makers and their analysts outside the research community. Selected long-term training is conducted for key indi-

viduals, where funding permits. A major joint proposal with FAO is being developed to provide for expanded capacity building, packaging of models and data and establishment of a network for related systems that has an institutional focal point within FAO.

Results and Discussion

Collaboration with the Secretariat for the Food Insecurity and Vulnerability Information Mapping System: A letter of intent has been signed between the Director of the FIVIMS Secretariat and Texas A&M for collaboration on pilot studies to evaluate the use of the GDSS in enhancing the analytic capacity of national level decision-makers as they plan for actions needed to achieve the goals of the World Food Summit. Pilot studies in Mali and Kenya has been initiated. A major planning workshop was held in Bamako December 7-9, 1999 to launch the pilot study. Preliminary analyses using the ASM were conducted in preparation for this workshop and results reported under GLO 99-23.

Collaboration with National Research Institutions and National Government Decision-Makers: The pilot studies for FIVIMS-GTOS are providing access to senior national level decision-makers who are participating in the definition of the development of the GDSS. Through this involvement and training of key personnel in the government and research institutions, the opportunity for successful transfer and use of these methods will be enhanced. Specific linkages with the governments of Mali and Kenya have been made. Extension of these to adjacent SSA countries is anticipated through linkages with regional organizations.

Collaboration with FAO Worldwide Agriculture Information Center (WAICENT): A letter of intent has been signed with WAICENT for an ongoing collaboration to support the FIVIMS pilot studies in Mali and Kenya as well as for collaborative research on development of methods for networking models and data bases for a modernized WAICENT function. This includes developing more effective linkages with the WAICENT Knowledge Information System (KIMS) for use in developing national level FIVIMS. The information exchange and linkages established here will be tied to the SANREM Global Information System. WAICENT is providing partial support to augment SANREM funds in developing the GDSS.

Collaboration with INSAH and AGRHYMET (CILSS) for Regional Application of the GDSS: A memorandum of understanding has been signed between INSAH and Texas A&M for both the development and regionalization of the GDSS. Under the GDSS, INSAH was a cosponsor of the Mali Pilot Study Workshop and will collaborate on these studies INSAH is facilitating linkages with national programs in the Sahelian countries. The USAID Africa Bureau is providing four year funding of a consortium of US universities, including Texas A&M, to work with INSAH, AGRHYMET, and other regional organizations. This directly augments SANREM funding. The GDSS component of this involves the application of its methodology to specific case studies to be defined by regional and national decision-makers.

Planning Workshop for Mali FIVIMS Pilot Study: A planning workshop, hosted by the Institute du Sahel (INSAH), was held in Bamako December 7-9, 1999 to initiate the Mali FIVIMS Pilot Study and agree on the approach and plan of action to be used (i.e. Workshop report, vol. II, at http://cnrit.tamu.edu/workshop/ and I. There were approximately 40 participants, including key government decision-makers, national researchers and staff of government agencies that will use the methods, donors, FAO, and Texas A&M University under the USAID SANREM CRSP. The overall purpose of the workshop was to plan for further development and evaluation of the Texas A&M models and methods to improve the assessment of status and estimate the economic and environmental impact of options to enhance food security. Its product was a refinement of the plan of action for a pilot study in Mali to develop methods and their practical use in assessing the status of food security now and in the future and the impact of new technology or policy options on food security.

Specific objectives of the workshop were 1) Increased understanding and insight into the needs of several agencies of the Government of Mali for analysis of the impact of alternative policy options and use of technology to enhance food security and ensure protection of natural resources and environment 2) Presentation of methods and results from previous Texas A&M research in Mali and FAO data and management information systems for use in food security assessment and analysis 3) Discussion by workshop participants to enhance understanding and to identify potential applications of the assessment methodology 4) Enrichment of the design of the pilot studies and agreement on the roles and contributions of national and regional collaborators.

The Mali FIVIMS Pilot Study Planning Workshop was a highly useful engagement that produced awareness and buy-in among all collaborators and decision-makers in Mali and the region and the valuable inputs on the plan of action for the pilot study.

The workshop provided insight and guidance from decision-makers and generated understanding and relevant discussions by technicians. The workshop provided excellent feedback about general needs for use of models with recognition of their necessity. The product of the workshop was the final

plan of action for a pilot study in Mali. Models will be modified to enhance their utility and will be adapted to meet the priorities of the GOM (e.g., food security and desertification) by:

1. The engagement of a technical advisory committee on Mali agriculture
2. The expanded collaboration with scientific colleagues in IER
3. Contacts and tentative agreements to collaborate with CILSS organizations
4. Evaluation in analysis of "real-world" food security related planning scenarios i.e. the opportunities for broadening the engagement on food security to include human nutrition.

An important recognition of the utility of models was the decision made by Malian decision-makers to form a National Task Force on Models for Food Security to help guide and develop ownership of the products of the IER-FAO-Texas A&M effort toward improving food security. The establishment of a National Task Force on Models for Food Security will assure integrated planning and action on the use of models such as the Texas A&M suite in enhanced decision-making on food security and on meeting the mandates of the World Food Summit and the Convention to Combat Desertification.

This workshop was a starting point of a process that led to institutional utility and survival by ongoing participation of national partners in the research and development, workshops and mentoring, and training of key operators.

The process of deliberation with our national partners has continued since the December workshop with two additional substantive engagements in February and May and intervening correspondence by e-mail and telephone. The Malian Technical Advisory Committee has discussed the results of the December workshop and provided a report on their findings. A new area of research is in development on Factors Affecting the Adoption of New Technology. These activities have identified a set of issues and opportunities that will form the basis of in-depth work sessions, which will be undertaken at a second workshop IER-INSAH-Texas A&M to be held July 4-6, 2000 in Bamako, Mali.

Capacity Building: Dr. Robert Kaitho of the Kenya Agricultural Research Institute and our collaborator in previous research to develop the GDSS spent three months at the campus of Texas A&M in the Spring of 2000 where he developed skills in using both biophysical and economic models from the GDSS.

Impacts

Memoranda of Understanding involving commitments to collaboration and support have been made with FAO and national partners in Kenya and Mali. A similar agreement has been signed with the Institut du Sahel (INSAH) to facilitate research and adoption of these models in the CILSS nations. Taken together, these agreements demonstrate a well-developed network of committed collaborators and users of the GDSS, which adds substantially to the probability of adoption of these methods in developing countries.

The effective engagement of decision-makers at high levels of government in the process of developing and evaluating the GDSS fulfills one of the key mandates of SANREM II, which is to ensure that the project engages decision-makers at national, regional, and global levels. Adoption of the parts or all of the GDSS by such decision-makers provides a holistic approach to enhanced decision-making on methods and means to enhance food security through sustainable use of natural resources.

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Collaboration With Regional SANREM Projects at Local Levels

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Introduction

A key component of the overall SANREM II strategy is to ensure that the efforts of the regional projects are clearly focused on decision-makers at various levels from farmers to multinational (regional) decision-makers. The strategy includes linking regional and global projects to develop and use methods by which experimental design can be improved and assessments made of the regional project outcomes in terms of their economic, environmental and societal benefits systems. By participating in appropriate regional programs, Texas A&M benefits by having real-life scenarios to evaluate, thereby providing a platform for the further development of the methodologies in its emerging Global Decision Support System. Note that substantial support for regional projects comes from other activities in the GDSS, such as models developed and parallel efforts using related case studies. See the introductory description of linkages and interrelationships.

Objectives

- Develop and extend methods for impact assessment by collaboration with regional SANREM projects in studies at the watershed and provincial levels, and provide capability to regional projects for their self-assessment of impact.

Methods or Approach

Economic models developed at regional and national levels and farm level models, where available, will be compared to results from the WAP at the cercle, village, and household levels. Outputs of the regional and national ASM will serve as inputs to the WAP local models and vice versa. Plans were developed at the last meeting in February 2000 to include the use of the NIRS fecal profiling method from Texas A&M in the WAP studies to assess and monitor the nutritional status of livestock in their studies. We await their implementation plan.

Results and Discussion

The general ASM for Mali was modified to include minimum nutrient constraint based on home-consumption quantity for each commodity and nutrient component coefficient for the commodity. This requires that agricultural production satisfy minimum nutrient requirement for farmer and family self-consumption

The Mali ASM was modified to include a risk aversion parameter (RAP) in the objective function. The stochastic ASM for Mali takes into account risks associated with product yield variability that results in production income variability. Specifically, the objective function in the Mali ASM was modified to include a term which is the RAP times the standard deviation of production income, which represents a risk cost.

Stochastic ASM was run for the Mali analyses of sorghum and millet technology improvements involving combinations of tillage, variety improvements, fertility, and improved water retention

Results from the stochastic ASM for Mali generally indicated that mean economic benefits to consumers in cities, towns and regional markets decreased, and concurrently the standard deviation of these economic gains decreased as the RAP increased in values ranging from 0.0005 to 2.0, i.e. as producers become more risk averse

Similarly home-consumption expenditures generally decreased, as producers become more risk aware; and producer returns to land, labor, management and risk increased as producers became more risk aware. Consumer benefits in cities

and towns decreased proportionally more than farmer and rural family benefit increased. Consequently, total social welfare (i.e. total economic benefits to the Malian society) decreased by 10.04 billion fcfa (or 1.2 percent) as producers become more risk averse

Data were collected to partition Mopti region into delta and non-delta sub areas for SANREM project analyses, to permit farm or household level analyses of economic viability and survival of farms and villages as alternative policies for conflict resolution are identified and implemented

Impact

The economic model for Mali and the Mopti region provide the WAP project with quantitative methods and results for assessment of the impact of alternative policies and technology at local levels in the Mopti region. When WAP models and data are further developed, the goals of this activity will be addressed.

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Acronyms

ACMAD	African Center for Meteorological Applications and Development
ACT	Almanac Characterization Tool
ADMP	Assessment of Decision-Maker Priorities
AID	United States Agency for International Development
AGRHYMET	West Africa Regional Center for Training and Application in Agriculture, Meteorology and Hydrology (a CILLS Organization)
AGRHYMET-CILSS	Centre Régional de Formation et d'Application en Agrometerologie et Hydrologie Opérationnelle
AND	SANREM-Andes
ARTEMIS	Africa Real-Time Environmental Monitoring Information System
ASB	Alternatives to Slash-and -Burn
ASM	Agricultural Sector Model
ATSAL	Agroforestry Tree Seed Association of Lantapan, The Philippines
AU	Auburn University
AWS	Automatic Weather Stations
BIDANI	Barangay Integrated Development Approach for Nutrition Improvement, a unit of CMU
BIFAD	Board for International Food and Agricultural Development (USAID)
CARE	Cooperative for American Relief Everywhere
CBNRM	Community Based Natural Resource Management
CCD	United Nations Convention to Combat Desertification
CDC	United States Center for Disease Control
CENRO	Community Environment and Natural Resource Office
CGE	Computable General Equilibrium
CGIAR	Consultative Group on International Agriculture Research
CIAT	Centro Internacional de Agricultura Tropical
CILSS	Comité Permanent Interétats de Lutte contra la Sécheresse Dans le Sahel (Interstate Committee on Drought Control in the Sahel)
CIMMYT	International Maize and Wheat Improvement Center
CLIMAG	Climate Prediction in Agriculture
CLUP	Comprehensive Land Use Plan
CME	Common Modeling Environment
CMU	Central Mindanao University, The Philippines
CODELSPA	Defending San Pablo Lake Committee
CONDESAN	Consortium for the Sustainable Development of the Andean Ecoregion
CQ	Central Queensland
CQU	Central Queensland University
CRRA	Regional Agriculture Research Center, Mali
CSD	Commission for Sustainable Development
DA	Department of Agriculture, The Philippines
DENR	Department of Environment and Natural Resources, The Philippines
DILG	Department of the Interior and Local Government
DMNA	Decision-Maker Needs Assessment
DRAER	Regional Ministry for Management and Provision of Farming Tools to Rural People
DRAMR	Regional Ministry for Support to the Rural World
DS	Decision Support
DSS	Decision Support System
DRRC	Regional Office of Regulations and Enforcement
DURW	Durum Wheat
EEP	External Evaluation Panel
ENRO	Environmental and Natural Resource Officer
ENSO	El Niño/Southern Oscillation
EPIC	Erosion Productivity Impact Calculator

ESRI	Environmental System Research Institute
FAA	Department of Fisheries and Allied Aquacultures
FAO	United Nations Food and Agriculture Organization
FEWS	Famine Early Warning System
FIVIMS	Food Insecurity and Vulnerability Information Mapping System
FLIPSIM	Farm Level Income and Policy Simulation Model
FVI	Forage Value Index
GASM	Global Agricultural Sector Model
GDRN5	Natural Resource Management and Decentralization NGO Network
GDSS	Global Decision Support System
GEM	Growth with Equity in Mindanao, a program of USAID-The Philippines
GIEWS	Global Information and Early Warning Information System
GIS	Geographic Information Systems
GLO	SANREM Global Project
GO	Governmental Organization
GOLD	Governance and Local Democracy
GOLD	Governance for Local Democracy, a program of USAID-The Philippines
GOM	Government of Mali
GTOS	Global Terrestrial Observing System
HES	Human and Ecology Security
HLURB	Housing and Land Use Regulatory Board
HPI	Heifer Project International
HRS	Hard Red Spring Wheat
HRSW	Hard Red Spring Wheat
HRWW	Hard Red Winter Wheat
IARC	International Agricultural Research Center
IBSRAM	International Board of Soils Research and Management
ICAAE	International Center for Aquaculture and Aquatic Environments
ICIMOD	International Center for Integrated Mountain Development
ICRAF	International Center for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	Institut d'Economie Rurale (Malian Institute of Rural Economy)
INERA	National Institute for Agricultural Research and Study (Burkina Faso)
IIRR	International Institute for Rural Reconstruction (NGO)
ILRI	International Livestock Research Institute
INSAH	Institut du Sahel (The Sahel Institute)
IPAS	Integrated Protected Area System
IRRI	International Rice Research Institute
ISPPS	Institute for Strategic Policy and Planning Studies, a unit of the College of Public Affairs at UPLB
ISU	Iowa State University
KAP	Knowledge Attitudes and Practices Survey
KARI	Kenya Agricultural Research Institute
KIN	Kitanglad Integrated Non-Governmental Organizations
KNP	Kitanglad Natural Park
LEWS	Livestock Early Warning System
LGU	Local Government Unit
ME	SANREM CRSP Management Entity
METEOSAT	a satellite
MFCAL	Multifunctional Character of Agriculture and Land
MKRNP	Mount Kitanglad Range National Park
MLUP	Municipal Land Use Plan
MOSCAT	Department of Aquaculture and Technology of Misamis Oriental State College of Agriculture and Technology
MOU	Memorandum of Understanding
MW	Manupali Watershed, The Philippines
NAPACOR	National Power Company
NARS	National Agriculture Research System
NASA	National Aeronautics and Space Administration (United States)

NCIP	National Commission on Indigenous Peoples (The Philippines)
NDVI	Normalized Difference Vegetation Index
NGAs	National Government Agencies
NGO	Non-Governmental Organization
NIA	National Irrigation Administration
NOAA	National Oceanographic and Atmospheric Administration (United States)
NPC	National Power Company
NRM	Natural Resource Management
NRMAC	Natural Resource Management Advisory Committee
NRMC	Natural Resource Management Council
NRMDP	Natural Resource Management Development Plan
NRMDP	Natural Resources Management and Development Plan
NRMP	Natural Resource Management Plan
NUTBAL	Nutritional Balance Analyzer Program
NVS	Natural Vegetative Strips
OFDA	The Office of U.S. Foreign Assistance (USAID)
OID	Office of International Development
OIRD	Office of International Research and Development (Virginia Polytechnic and State University)
P/PE	Precipitation/Potential Evapotranspiration
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAMB	Protected Area Management Board
PAR	Participatory Action Research
PARRFI	Philippine Agriculture and Resources Research Foundation, Inc.
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PCC	Pole Coordination Committee
PGRN	Natural Resources Management Project
PHYGROW	Phytomass Growth Simulator
PI	Principal Investigator
PLLA	Participatory Landscape Lifescape Appraisal
PME	Participatory Monitoring and Evaluation
PPDO	Provincial Planning and Development Office, Province of Bukidnon, The Philippines
PPDO	Provincial Planning Development Office
PRA	Participatory Rural Appraisal
PU	Purdue University
PUCE	Pontificia Universidad Católica del Ecuador (Catholic University, Ecuador)
RAP	Research Application Program
RFE	Rainfall Estimates
SAM	Social Analysis Matrix
SANREM SEA	Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program–Southeast Asia
SANREM-CRSP	Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program
SAP	System Alerte Precose (Mali National Food Security Early Warning System)
SCO	Site Coordination Officer
SCO	Site Coordination Office (officer)
SCT	Spatial Characterization Tool
SEA	Southeast Asia
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	Southeast Asian Center for Graduate Studies
SEARCA	SEAMEO Regional Center for Graduate Study and Research in Agriculture
SLO	Secondary level organization
SLUP	Sustainable Land Use Planning
SNRM	Sustainable Natural Resource Management
SO	USAID Strategic Objective
SOFT	Soft Red Winter Wheat
SpO	USAID Special Objective
SUBIR	Sustainable Use of Bio-Resources Project (Ecuador)
SWAT	Soil Water Assessment Tool
SWRRB	Simulator for Water Resources in Rural Basins
TAMU	Texas A&M University
TAT	Thematic Apperception Test
TNA	Training Needs Analysis

TOT	Training of Trainers
TSS	Total Suspended Solids
TW	Tigbantay Wahig Inc. ("Water Watchers")
TWG	Tigbantay Wahig Group
UAF	University of Agriculture and Forestry (Vietnam)
UGA	University of Georgia
UK	The United Kingdom
UN	The United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNORCAC	United Peasant Organization of Cotacachi, the indigenous peasant secondary level organization located in the canton of Cotacachi, Ecuador
UPLB	University of the Philippines at Los Baños
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UW	University of Wisconsin-Madison
VSO	Volunteer Services Organization
WA	West Africa
WAF	SANREM-West Africa
VT	Virginia Polytechnic and State University
WAICENT	World Agriculture Information Center
WANRM	West Africa Natural Resource Management
WAP	West Africa Project
WCM	Western Carolina University
WMO	World Meteorological Organization
WSM	Watershed Model
WSU	Washington State University

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