

# **Advancing Conservation and Use of Natural Resources**



**SANREM CRSP  
2003 - 2004 Annual Report**

# Advancing Conservation and Use of Natural Resources

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Annual Report  
2003 - 2004

Kristen R. Miller  
Editor

Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
1422 Experiment Station Road  
Watkinsville, GA 30677 USA

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Cover Photograph by Jan Flora

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# SANREM CRSP

## 2003 - 2004 Annual Report

### Introduction

This Annual Report marks the conclusion of SANREM's second Phase (1998-2004). Fittingly, the report is full of great accomplishments under the rubrics of integration, problem solving, institution strengthening, up scaling and ensuring the impact of research beyond the life of the project.

The year was enthusiastically devoted to synthesizing information and making it available to stakeholders. All projects organized and conducted synthesis conferences, often in different formats depending on the stakeholders that SANREM researchers wanted to reach. SANREM SE Asia launched the first synthesis conference on January 13-14, 2004 ("Land Use Change in Tropical Watersheds", Manila, Philippines). SANREM Andes organized its conference in Cotacachi, Ecuador ("Sustainability of Landscapes and Livelihoods in the Andes," January 15-17). SANREM's West Africa's conference was one month later (February 24-26) and titled "Institutional Innovations and Technological Development for a Decentralized and Sustainable NRM". The DSS project, for its part, organized a workshop in Nairobi, Kenya integrating data, research results and analysis at farm- sub-national and national level (May 4, 2004). SANREM SE Asia also organized in May a meeting in Lantapan with local and provincial government officials, producers' groups, the Tigbantay Wahig, HPI, and other stakeholders.

Individual projects also contributed to consolidating and synthesizing information. For instance, the Andes researchers under the lead-

ership of R. Rhoades put together a ToolBook-based multimedia CD with data, documents, maps, photographs pertaining to Cotacachi, as well as a GIS-based Atlas of Cotacachi Canton. Rola, Sumbalan and Suminguit produced a document titled "Realities of watershed management in the Philippines: the Manupali Watershed Experience." Deutsch et al. concluded a monograph of community-based water monitoring based on the Philippines and Ecuador projects. Buck et al. completed a state of the art assessment on natural and social science research worldwide on the management of land use systems to support biodiversity conservation. Badini completed soil characterization, botanical and pasture biomass analyses in Madiama, Mali in order to ascertain the contribution of rotational grazing to soil carbon sequestration and pasture biomass production. Nazarea and Rhoades organized a state of the art workshop on agrobiodiversity conservation issues (April 30-May 1). Crane concluded research on local knowledge of soils and soil fertility maintenance in Mali, and Rodriguez and Southgate completed research on farmers' willingness to accept compensation in return for changing or abandoning agricultural activities in upper watersheds in the Quito watershed, Ecuador.

In all projects, detailed data on soils, slopes and gradients, land use, weather, stream channels and stream flow, water quality and quantity were completed and integrated into GIS layers. From these layers, SANREM researchers produced interpretive maps specifically tailored to meet the needs of natural resource decision

makers around site-specific constraints. In Ecuador, for instance, the interest was on increasing productivity through soil fertility management and improved use of irrigation, and so maps were produced to identify fertile soils, locate water sources for increased irrigation, and characterize sources of water contamination. In Kenya, the interest was on ascertaining the potential impact of implementing the government's policy of massive reforestation in watersheds in the country. Maps and supporting analysis were produced to document the economic and soil sediment impact of land uses that would be displaced as a result of reforestation. Sub-basins were identified for priority reforestation. In the Philippines, GIS layers of land use and livestock and human population densities within sub-watersheds were prepared. The information was used to determine the environmental and economic costs and benefits related to the utilization of livestock manure to intensify agricultural production.

Research results and analysis were presented to decision-makers and host country researchers. Datasets for a climate change study in Mali and Senegal were made available to AGRHYMET. The ToolBook CD and the Cotacachi Canton Atlas were delivered to local government officials, UNORCAC, the Ministry of the Environment, the Institute of Hydrology and local NGOs in Ecuador. By collaborating with the Philippines Watershed Management Coalition, SANREM SE Asia team members were able to participate in the drafting of position papers that were presented to the Secretary of the Department of Natural Resources and the President of the Philippines.

We made sure that the effect of SANREM would continue beyond the life of the project. The ME produced a training manual for upper primary and secondary school teachers to encourage them to incorporate NRM principles

into lesson plans. A Manual for Training on Policy Analysis for Watershed Management was produced in the Philippines at the request of officials of the Department of the Interior and Local Government. Several GIS training workshops for local government planners were organized in Lantapan, as well as a 8-week 1-hour radio broadcast program titled School on Air, where technological information was provided to farmers by ICRAF, HPI and SANREM personnel.

To ensure the "portability" of the SANREM experience, our researchers distilled research results into multiple channels with a remarkable productivity. Three book manuscripts have been submitted to CABI by, respectively, the Andes, SE Asia and West Africa projects and will be printed and distributed later in the year. In the period 1998-2004, SANREM produced 86 refereed journal articles, 84 book chapters, 18 books, 53 policy briefs, 74 research reports, 57 working papers, 105 conference presentations, and 18 tool documentation papers.

SANREM funds sponsored 33 Ph.D.s and 16 MS/MA theses.

All and all, this Annual Report brings news of a very productive year and 6 year period.

Carlos A. Perez  
Director  
SANREM CRSP

# SANREM Andes





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## **Coordination and Management of SANREM-Andes**

**Principal  
Investigator**  
Robert Rhoades

### **ABSTRACT**

During the final year of SANREM Phase II, this workplan ensured coordination and fiscal management of the Andean program by providing timely administrative and financial support to PIs and host country collaborators. The project efficiently linked with the Management Entity by filing timely reports and supplying information as requested by USAID or the ME. After several years of decentralized databases in Cotacachi, Catholic University-Quito, and UGA, the interdisciplinary database was centralized and distributed to all partners, including local partners in the Canton Cotacachi. A full-time Ecuadorian coordinator (Ing Xavier Zapata) has maintained excellent oversight of the program through its primary base in Cotacachi but also from Catholic University-Quito. The activity has continued to link with the global mountain initiative by providing excellent models, methods, and data for informing scientists and decision-makers about mountain-specific planning. SANREM-Andes participated in a developing grant proposals with CIAT's "communities and watersheds" network. In addition, in January, 2004, a conference on "Sustaining Livelihoods and Landscapes in the Andes" was held in which over 100 national and international individuals, including Ecuadorian regional and national decision-makers, participated.

### **OBJECTIVE 1**

Provide timely administrative and coordination support to Principal Investigators

and collaborators in the Andes; link with Management Entity and other regional projects.

### **Achievements**

IBR (The Institute for Behavioral Research, University of Georgia) responded efficiently and professionally to multiple and last minute requests for detailed budgetary reporting. The year was especially challenging given the frequent changes in budget decisions and need to frequently re-write budgets. IBR worked effectively with accounting support offices at Auburn, Iowa State, Ohio State and UGA (The University of Georgia) to move funds speedily through the pipeline. The facilities in Ecuador were upgraded and experienced high occupancy rates in Year 6 with as many as 6 researchers at a time staying in the apartment and office. Online services were maintained as well as new computing facilities (Auburn) installed along with a fax and printer. The SANREM vehicle (owned by UNORCAC-United Peasant Organization of Cotacachi) was upgraded and maintained during a final year of intensive use. The vehicle was turned back to UNOCAC permanently at the end of the project on May 31, 2004.

### **OBJECTIVE 2**

Manage an organized central database and facilitate exchange among SANREM researchers as well as among other partners in the Andean region.

## **Achievements**

The SANREM-Andes listserv was updated and directly shared with all PIs and collaborators. All project data have been delivered and entered into the database. Monsarrath Mejia of Catholic University-Quito has integrated all information in a comprehensive Atlas of Cotacachi. The Toolbook CD has been completed and a beta-version developed for final discussion among participants. The Toolbook CD will be included in the SANREM-Andes final book publication to be published by the end of 2004.

## **OBJECTIVE 3**

Link the SANREM Andean project with the global interagency initiative for Chapter 13, Agenda 21 (Sustainable Mountain Development). In addition, the PM will link SANREM-Andes to CIAT's 'communities and watershed' network, UBC-Canada's Himal-Andes watershed network, and the CGIAR Global Challenge competition for a system-wide program on "food and water".

## **Achievements**

The international SANREM-Andes Synthesis Conference "Sustaining Landscapes and Livelihoods in the Andes" was held on January 15-17, 2004 in Cotacachi, Ecuador. In addition to international and national participants, many high level government decision makers from the ministries of agriculture and environment were in attendance. During May, 2004, a final meeting of the Cotacachi Natural Resources Management Plan was held and all SANREM data distributed to interested parties (beta version of the Toolbook, copy of Cotacachi Atlas, and CD of research data). R. Rhoades and V. Nazarea participated in the British Academy of Sciences meeting (the travel was not financed by SANREM) and presented on their Cotacachi research. The presentation was well received and will be published as a chapter in a book on indigenous knowledge edited by Dr. Paul Sillitoe.

## **Advances in Capacity Building**

Six Ecuadorians linked with partner organizations were trained individually in the Toolbook application, data collection and storage methods, use of GIS (Geographical Information Systems)/GPS

(Global Positioning Systems), 3-dimensional models, and basic field research.

## **Advances in Scaling Up**

The SANREM-Andes experience was scaled up to scientists, practitioners, and decision makers interested in natural resource management questions. The initiatives in which SANREM participated through scholarly presentation, networking, or information sharing include Chapter 13, Agenda 21, the CGIAR Mountain Initiative, CONDESAN (Consortium for the Sustainable Development of the Andean Ecoregion), and the Communities and Watersheds program at CIAT. International agencies, such as IPGRI, have adopted SANREM-Andes ideas, methods, and approaches on in situ conservation. Andes publications have been reviewed by a number of prestigious journals, all with positive outcomes.

## **Major Outputs**

### **Non-Degree Training**

#### **Workshop**

*Community history workshop* was attended by 175 person(s).

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## **Innovative Approaches to Agrobiodiversity Enhancement, Repatriation, and Policy in the Andes**

### **ABSTRACT**

Repatriation (returning to the place of origin) of gene bank accessions is gaining momentum internationally. Efforts at repatriation are fueled by increasing scientific recognition of the limitations of ex situ conservation as well as political advocacy revolving around intellectual property rights and ancestral claims. In Cotacachi, enhancement of agrobiodiversity through the repatriation of traditional Andean crops is currently being pursued by UNORCAC, several NGOs, INIAP (the national gene bank), and local communities, with various stakes and degrees of engagement. SANREM-Andes biodiversity thrust that has emphasized memory banking and in situ conservation has raised awareness about the importance of renewing traditional crops and management practices within the broader context of cultural revitalization. The recent rush to repatriate germplasm, however, needs to be tempered by research into the cultural and legal context of repatriation. Building on a foundation of knowledge and experience gained from five years of SANREM research on biodiversity conservation in Asia and Latin America, this Year 6 project investigated disjunctures in how repatriation and genetic diversity is understood by local people, scientists, political advocates, and policy makers. Moreover, it opened dialogue across different world views in the management of this critical and fragile resource. Through experiential learning on both sides, our project facilitates more effective commu-

nication as well as a complementation of knowledge and skills that will lead to more sustainable conservation of plant genetic resources within Cotacachi and beyond. Better understanding also contributes to a smoother process of institutionalization of these initiatives. At the end of Year 6, an international conference on in situ conservation and repatriation was hosted at the University of Georgia in Athens.

### **OBJECTIVE 1**

Research the past, present, and potential place of traditional Andean crops in the Cotacachi landscape with special emphasis on intergenerational connection, ethnic identity, and gender roles, along with food sufficiency and food sovereignty.

### **Achievements**

During the year, UGA Ph.D. student Juana Camacho spent July/August in Cotacachi conducting research on gender roles and food sovereignty in Cotacachi. This research was presented at the SANREM final meeting in Cotacachi, Jan., 2004. The three masters students completed their fieldwork and are presently writing up the results. All presented in the SANREM-Andes conference. A visit was made to the Finca de Futuros Ancestrales in July, 2003, when a survey of participants' viewpoints was implemented. The data have been analyzed and written up by Shiloh Moates. The plots have all been harvested and seeds for future plantings have been distributed. Information on the

**Principal Investigator**  
Virginia Nazarea

**Co-Principal Investigator**  
Magdalena Fueres

Rafael Guitarra

Cesar Tapia

Jamie Estrella

Proyecto Ally  
Tarpuy

Manolo Morales

Miguel Holle

Maria Scurrah

Henry Shands

50 accessions has been sent to INIAP. A tasting and cooking experiment was carried out on the various accessions. The project is now following the fates of the landraces grown out in the finca as they pass through post-harvest aspects of the food system.

## **OBJECTIVE 2**

Facilitate dialogue and collaboration between participating communities and national, regional, and international "players" in Cotacachi agrobiodiversity conservation and disseminate lessons learned from SANREM's research. Through dialogue and experiential learning, pave the way for institutionalization of more effective means of repatriation and in situ conservation.

### **Achievements**

The night-time storytelling activity was successfully completed. Given that the area has become a center of repatriation activities due to a large PL480 project in the region, the visits of national scientists are a regular occurrence. The "reverse" field trip to the national gene bank did not take place in Year 6 but is planned for a post-project phase funded by non-USAID sources. Training of UNORCAC field assistants in in situ research is complete.

## **OBJECTIVE 3**

Based on the Cotacachi experience, generate useful policy guidelines on biodiversity conservation and sustainable repatriation that is, at the same time, culturally compatible and equitably beneficial. These policy guidelines will identify what conditions need to be in place for repatriation and in situ conservation to be successful.

### **Achievements**

The conference on biodiversity conservation, enhancement and repatriation has proposed to the UGA State of the Art competition was not funded. However, the interest was so high on the UGA campus that numerous departments, centers, and institutes provided funds. The conference was held on April 30-May 1 with great success. Key individuals representing law, policy, and agrobiodiversity research and activism participated. They represent indigenous peoples, professors, genebank managers, research administrators, policy makers and activists. A proceedings of the conference is to be

developed and will be submitted to a major press for publication. A documentary film "Conservation with a Small C" (approximately 10 minutes) has been completed in English and Spanish bilingual formats.

### **Advances in Research**

The main advance was to bring solid research systematization to a field that is largely based on untested assumptions and methods. Despite the rush to repatriation, little is known on how to do it effectively and sustainably. An article was written on the cultural significance of Andean grains and tubers. A Ph.D. dissertation on "Gender, Resistance, and Food Sovereignty in the Andes" (by a Colombian national) and three masters theses on sustainable development related to genetic resources were also completed.

### **Advances in Capacity Building**

Representatives from interested NGOs and INIAP (and other government agencies) were trained in memory banking and in situ conservation methods. While there is much projected activity next year by NGOs, it is obvious that the consequences and procedures for successfully reintroducing material are not clear. SANREM can provide systematic research to guide the process. Gene bank managers from Quito and Lima will be sensitized to local perspectives and constraints, thus building a pan-Andean base for the productive collaboration of scientific and local communities in biodiversity conservation. Three theses and one Ph.D. are still in progress but will be completed this year. In Cotacachi community-wide interest in in-situ conservation is currently high.

### **Advances in Scaling Up**

Development of a book on repatriation based on the international conference (Athens, April-May, 2004) that will involve scientists, gene bank managers, legal experts, and policy makers is in process. Distribution of publication to international centers, national programs, NGOs, and local communities will follow. The Cotacachi Declaration can also serve as an Andean model for definition of responsibilities and benefits in the context of the Andean Pact.

The documentary film "Conservation with a Small C" will have global dissemination. Presentation at the British Academy of Sciences (not funded by SANREM) brings SANREM research to international academic circles.

### **Advances in Policy Impacts**

Based on this research, guidelines were developed for the conservation, enhancement, and repatriation of germplasm in a culturally-contextualized, equitable, and sustainable manner. These guidelines were utilized in a policy dialogue with key policy makers in Ecuador. This dialogue involved representatives of all levels--local communities, indigenous organizations like Jambi Mascaric and UNORCAC, government agencies like INIAP, and international centers like CIP and IPGRI.

The outcome of the dialogue and recommendations based on the repatriation conference can conceivably impact policies at various levels, including increased awareness of the importance of linking in situ gene banking with repatriation efforts in a more informed manner.

### **Advances in Environment and Natural Resource Management**

Andean crops have been and continue to be repatriated to Cotacachi. The lessons learned from agrobiodiversity research in Cotacachi are being adopted by other projects.

### **Major Outputs**

#### **Conference Paper**

Camacho, J. 2004. *Alimentación y Cultura en Cotacachi*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

Camacho, J. and A. Henne. 2004. *Plants, Place, and Resistance in New York City and Colombia's Pacific Coast*. Paper presented at conference entitled Seeds of Resistance/Seeds of Hope. Ethnoecology/Biodiversity Laboratory, University of Georgia, Athens, GA. April 30 - May 1, 2004.

Fueres, M. and R. Flores. 2004. *Returning Andean Crops to Promote ecotourism*. Paper presented at conference entitled Seeds of Resistance/Seeds of Hope. Ethnoecology/Biodiversity Laboratory, University of Georgia, Athens, GA. April 30 - May 1, 2004.

Nazarea, V. 2004. *Marginalities of the Mind, or the Anthropology of Quirkiness*. Paper presented at conference entitled Seeds of Resistance/Seeds of Hope. Ethnoecology/Biodiversity Laboratory, University of Georgia, Athens, GA. April 30 - May 1, 2004.

### **Degree Training**

Juana Camacho, Ph.D., 2001 - 2005

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## **Organizational Innovations for Sustainability**

### **ABSTRACT**

The capacity of indigenous organizations to address issues of natural resources management in the context of decentralization and globalization is key for long-term sustainability in Ecuador. Internal organizational mechanisms must be in place to assure accountability, participation, and effective use of limited resources. Organizational capacity means that the organization has the ability to articulate the goals of the community well enough to appropriately use (or reject) outside technical assistance and other resources. Cotacachi's indigenous secondary-level organization, UNORCAC, is adept at forming connections with groups from outside the geographic area (i.e. creating bridging social capital), particularly with international non-governmental development organizations (NGOs). Effective negotiation with other stakeholders requires organizational capacity and strong networks. Ironically, conflict over access and control of natural resources has grown: between communities, between the municipality and the secondary-level indigenous organization, with large landowners. But, building local and external coalitions for democratic resource management can reconcile conflicting claims. Taking into account the changing national and international context, we have assessed the present organizational capacity of UNORCAC to serve as a major actor for sustainable natural resource management in the municipio, using our 1998 study as a benchmark. We have determined how bridging and bonding social capital contribute to

UNORCAC's capacity for institutional strengthening of the community-based organizations (particularly the 43 rural communities affiliated with UNORCAC), coalition building with other groups inside and outside the municipio, and policy impact.

### **OBJECTIVE 1**

Determine the changes in UNORCAC's institutional capacity for management and its bridging and bonding social capital.

### **Achievements**

An assessment of the changes in UNORCAC's institutional capacity for management of natural resource issues through its use of bridging and bonding social capital was carried out by using already collected data as well as observations of UNORCAC's operations. Key informant interviews and focus group interviews were carried out with local leaders, members of "Committee executive" of UNORCAC, technicians who work with UNORCAC, leaders and members of the communities that constitute UNORCAC, leaders and members of "Watershed Committees" for the Pitzambitze River and Cuychic Cocha River as well as surveys with local farmers. A report summarizing changes in UNORCAC's organizational capacity over the past half decade, as it affects its ability to make natural resource management decisions is being finalized to be submitted on May 31, 2004.

**Principal Investigator**  
Jan Flora

**Co-Principal Investigator**  
Cornelia Flora

Mary Garcia  
Bravo

Florencia  
Campana

Fernando Larrea

The report also analyzes the relationship between UNORCAC and some of its member communities, based on data gathered jointly by Heifer-Ecuador and individuals from the communities themselves. The data has been analyzed, and synthesized in diagrams and graphics of results classified by “indicator, variable, subtheme and theme”.

Heifer continued to participate in meetings, workshops, and activities related to advocacy coalitions led by UNORCAC.

## **OBJECTIVE 2**

Analyze how bridging and bonding social capital can be used in the course of the design of the Municipal Natural Resource Plan

### **Achievements**

Because the effort to develop a Natural Resource Plan for the Canton was not fully realized, this objective was subsumed into the development of a Toolkit CD, that is the joint effort of the various SANREM-Andes projects. The institutional group designed the Institutional section of the Toolkit.

## **OBJECTIVE 3**

Determine the best practices for strengthening organizations of those who are only recently included in decision making processes regarding NRM so that sustainability -- social, ecological, and economic -- can be achieved.

### **Achievements**

The Toolkit includes a documentation of best practices. The comparison of the Peruvian and Ecuadorian cases was developed and presented at the Synthesis Conference in January, but additional funds were received for Grupo Yanapai to do an assessment of its experiences with advocacy coalitions and develop a plan for the future. The final report on this assessment provides the additional information on the Peruvian case to feed further elaboration of the comparison between the two countries.

The Grupo Yanapai worked with a facilitator to develop a plan for assessing its experience as a learning organization using the RAAKS (Rapid

Appraisal of Agricultural Knowledge and Information Systems) approach and the Advocacy Coalition Framework (ACF), and, most importantly, for determining future directions of Grupo Yanapai. The facilitator is also to guide the group through a visioning/strategic planning process.

Workshops, focus groups, and interviews with people from two communities in the Central Highlands of Peru and other resource persons were conducted for the purpose of documenting and interpreting how and if the advocacy coalition framework has strengthened community capacity in the communities of Quilcas and Rangra. The final report is being finalized to be presented by May 31, 2004.

### **Advances in Research**

This research will build on our previous work on advocacy coalitions and institutional capacity. The three papers presented at the SANREM-Andes Synthesis Conference in January 2004 will, among other things, assess how collective natural resource management decisions have influenced the institutional capacity and the bridging and bonding social capital of an indigenous secondary organization (Ecuador) and of an indigenous community (Peru). These papers are titled, "Rules of Evidence, Advocacy Coalitions, and Natural Resource Management" (Jan and Cornelia Flora) and "Agroecology experiences and natural resources management in the Andean region of the Cotacachi Canton" (Fernando Larrea).

### **Advances in Capacity Building**

Florencia Campana and Mary García of Heifer-Ecuador enrolled in an 8-week intensive English course at the University of Delaware in 2004. This will be an enormous boost to their effectiveness as researchers and grant-writers, since it will enhance their English reading comprehension and will equip them to communicate more readily with mono-lingual English-speakers who represent American or British foundations and other institutions. It will also be helpful to them in their applied work, particularly in broadening ability to interact with funding organizations on behalf of Heifer-Ecuador and in collaboration with indigenous groups whom they advise.

In Peru, an interview community leaders conducted with the regional director of OXFAM America (as part of the advocacy coalition methodology) led to a grant to the Peasant Community of Quilcas from the Global Green Grant Foundation for training in collective property rights and recovery of natural resources, with collaboration of the Grupo Yanapai. In October 2003, 175 peasants and peasant leaders were trained from the communities of Quilcas, Rangra, Saño, Chicche. A representative of the mining company also participated in this training. Although this was not specifically a SANREM activity, it was a direct outgrowth of the advocacy coalition action-research.

### **Advances in Scaling Up**

The techniques and methodologies are being shared with CIAT via the Toolbook CD, to the National Agrarian University-La Molina in Peru, as well as to collaborators in the Global Livestock CRSP in Mexico, Ecuador, and Bolivia. Two workshops on the advocacy coalition methodology were conducted with development professionals in Peru as part of intensive classes for community, agricultural, and rural development professionals pursuing Masters in Agricultural Innovation for Rural Development at the National Agrarian University-La Molina.

The Co-PIs also gave a presentation on “Advocacy Coalitions and Rural Development in the Andes Region” to the Vern Larson Colloquium Series of the Office of International Programs, Kansas State University, Manhattan, KS in March 2004.

### **Advances in Policy Impacts**

As a result of the participatory advocacy coalitions research, communities in Peru have taken actions that may eventually affect local and regional policy. The Quilcas community led a regional coalition aimed to curbing the environmental abuses of small mining companies on community grasslands. This action may lead to changes in the process whereby mining permits are granted, that may allow a greater role for communities whose land is being used. This development is a direct result of the application of the Advocacy Coalition Framework, which fostered contacts and alliances that thrust the community of Quilcas into a regional leadership

role in CONACAMI, the Coordinating Body of Communities Affected by Mining. The timing is propitious since certain decisions and functions are being decentralized from the national government to regional governments.

In Ecuador, policy impact is slow in coming, but it is likely to occur through the strengthening of UNORCAC’s linkages to local, regional, and national governments. UNORCAC initiated a dialogue with the Minister for the Environment on the management of the Cotacachi-Cayapas Bioserve, that has been partly informed by the advocacy coalition research and methodology. However, the potential results of these actions remain constrained by the Ministry’s weakness and/or inability to deliberate or to mediate an agreement about which local entity(ies) that should manage the Reserve.

The national and international institutions we have collaborated with will be interested in the findings related how to facilitate the effective participation of groups that had been previously left out of processes and deliberations concerning natural resource management planning. The Toolbook CD and the forthcoming SANREM-Andes Synthesis Monograph will be useful tools for informing Ecuadorian, US, and international audiences.

### **Advances in Environment and Natural Resource Management**

This project is one of several component in SANREM-Andes’s integrated thrust aimed at improving natural resource management in Cotacachi, Ecuador. The advocacy coalition framework and other methodologies used in this project facilitate the involvement of marginalized groups, including the largely indigenous rural communities of Cotacachi.

SANREM-Andes has contributed to improving the capacity of UNORCAC to negotiate with other actors around natural resource management issues. The increased sophistication with which UNORCAC forms strategic alliances can be seen in the case of the discussion around decentralized management of the Cotacachi-Cayapas Bio-Reserve. When cantons and municipalities emerged as the

organizing entities around which decentralized management would occur, UNORCAC made links with the adjacent municipality of Uruquí in an attempt to block the municipality of Cotacachi (which is allied with a mestizo faction) from taking undue advantage of lucrative tourist concessions in the bio-reserve without investing in the environmental conservation of the reserve. Unfortunately, it was unable to negotiate an end to the impasse that has plagued the attempt to establish a decentralized natural resource management.

In Peru, there have been advances, particularly as regards natural resource management. A study that quantified the natural resources lost as a result of the talcum mine in the highland portion of the peasant community of Quilcas, financed by the Global Green Grants Foundation, was concluded. The study indicated that more than 180 hectares of grassland had been destroyed by the mining operation. During Year 6 and previously numerous attempts were made to open dialogue with the mining company, but when they did send a representative the person did not have authority to negotiate on behalf of the company. The fact that the Community of Quilcas is the regional representative to CONACAMI and the convener of CORECAMI, the regional affiliate of CONACAMI means that the institutional base for future negotiations with mining companies is in place.

## **Publications**

### **Book Chapters**

Flora, C. 2003. *Democracy: Balancing Market, State, and Civil Society*. Pp. 88-100 In Bell, M. and F. Hendricks (eds). *Walking Toward Justice: Democratization in Rural Life*. Bristol, UK. JAI/Elsevier.

Flora, C. and M. Bendini. 2003. *Globalización en Cadenas de Valor Agroalimentaria: Relaciones Entre el Mercado, el Estado y la Sociedad Civil*. In Bendini, M., S. Cavalcanti, M. Murmis y P. Tsakoumagkos (eds.) *El Campo en La Sociologia Actual: Una Perspectiva Latinoamericana*. Buenos Aires: Editorial La Colmena.

## **Other Major Outputs**

### **Conference Paper**

Flora, C., Rames, Hurtado and Morales. 2004. *Capital Social, Empoderamiento y Medioambiente Social*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

### **Degree Training**

Edith Fernandez-Baca, M.A., 1999 - 2004

### **Non-Degree Training**

#### **Workshop**

*Intensive English language study* was attended by 2 person(s) and lasted 40 day(s).

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## **Water Resources Management and Education in Andean Watersheds**

### **ABSTRACT**

The focus of the AU water-monitoring project was broadened beyond health and sanitation to Natural Resource Management (NRM) planning. AU personnel conducted three trips to Ecuador during this period and several meetings were conducted with local leaders to work with NRM planning of the intersectoral committee of the Asamblea Cantonal. Some Year 6 activities were integrated with the work of other researchers and NGO partners to 1) improve data management and presentation, 2) advance Community-based Water Monitoring (CBWM), 3) strengthen institutional and research links, and 4) initiate scaling up/out activities.

### **OBJECTIVE 1**

Analyze and present existing data (outputs from water monitoring in Phase II) to stakeholders of the project. A major target will be use of the data for the annual meetings of the Cantonal and UNORCAC asambleas, and other policy-setting institutions.

### **Achievements**

As planned a new computer was placed at the SANREM Cotacachi office, and the new version of the Ecuador Water Watch relational database was installed and tested. Training was provided to the UNORCAC water coordinator on use of the database for data entry, data editing and production of graphics and reports. A presentation entitled "Initial

Interpretations of Chemical and Bacteriological Data Resulting From Community based Water Monitoring (CBWM) in Three Streams in Cotacachi", was made by Sergio Ruiz-Cordova, in January 2004 to the Asamblea Cantonal, UNORCAC and other stakeholders attending the SANREM-Andes Conference. A second presentation entitled "Taking More Care of Our Water: Institutional Experiences and Perspectives for a better of community based water resources management in Cotacachi", was made by Auburn Team member, Dr. Rosemary Fernholz. The Global Water Watch website is active now and includes Ecuador Water Watch. Feasibility of web-based data management is an ongoing activity.

### **OBJECTIVE 2**

Establish and provide full support to pilot CBWM groups.

### **Achievements**

Fifteen participants attended a certification workshop for bacteria and physico-chemical monitoring representing three new community organizations from the provinces of Cotapaxi (UNOCANC and UOPICJJ) and Pichincha (UNOPAC), in addition to Imbabura (UNORCAC). CBWM has also extended to new locations in the Pichincha province. Assistance was extended to a CBWM project in Intag in partnership with DECOIN, a local environmental protection organization working in Intag com-

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munities. Each organization is monitoring more than five sites, with plans to expand to 20 sites. Technical assistance, supplies, quality assurance, and data management are being provided on a continuing basis to each organization. A locally built 3-D model of UNORCAC project watersheds was used for environmental education, thus the proposed EnviroScape watershed model was not needed.

### **OBJECTIVE 3**

Institutional and research links will be strengthened.

#### **Achievements**

Formal linkages were established with a new main partner organization. This is an extremely important accomplishment for sustainability of CBWM in Ecuador. Heifer-Ecuador was approached by the AU team because of long and close relations between Auburn University and Heifer International. Discussions were held, terms of agreement were decided, and a memorandum of agreement was signed. A basic certification workshop was conducted, monitoring activities initiated and three new community-monitoring groups established under this new partnership. Heifer-Ecuador has had close relations with UNORCAC for the past several years, and will now broaden this relationship to include support and coordination for CBWM. A memorandum of agreement with DECOIN has been proposed and is being reviewed. In the meantime cooperation with DECOIN in CBWM has begun. Cooperation has occurred with the UGA soils/water project to measure stream flow and rainfall. An AU social scientist, Dr. Rosemary Fernholz, visited Ecuador project sites to initiate research relative to resolution of water conflicts. Interviews with key actors have been conducted and recorded and more are planned. Two meetings were held with the director of the National Council for Water Resources, especially to inquire about experiences with water conflicts.

### **OBJECTIVE 4**

Scaling out/up activities will be initiated.

#### **Achievements**

Three NGOs, Heifer International, Christian Children's Fund/Ecuador and DECOIN, and one governmental organization, ECORAE, expressed interest in CBWM projects. Visits were made to project sites of the NGOs, and possible follow-up activities were discussed. Four meetings were held with the GO at which a memorandum of understanding was signed. A memorandum of agreement was signed with Heifer Ecuador, and training and monitoring activities were immediately implemented in two new provinces (Pichincha and Cotopaxi) and continued in Imbabura. Technical assistance was extended to DECOIN for CBWM activities in Intag region of Imbabura. Meetings were held with PROPEDINE (World Bank supported) and Plan International to investigate possibilities for cooperation in CBWM in Ecuador.

#### **Advances in Research**

Fifteen new monitors (a total of 101 certified monitors in Ecuador) representing one existing and three new CBWM groups were trained. Sixty-three sites were monitored for physical-chemical parameters yielding 183 records and 37 sites were sampled for coliform bacteria rendering 147 bacterial records. These records were created and entered into the local UNORCAC database as well as the GWW database at Auburn University during Year 6. These records increased the cumulative total to 805 chemistry records from 142 monitoring sites and 1228 bacteriological records from 226 sites since CBWM started in Ecuador.

#### **Advances in Capacity Building**

Four new CBWM groups were established to further community-based participatory research. One basic certification workshop was conducted for 15 participants including members of three new organizations. The UNORCAC water coordinator received training on data management and GWW database and was a key supporter in the training and follow up of monitoring activities in the new locations. Issues important to sustainability of the groups were addressed. A principal actor in this activity, together with the AU team, is the new partner, Heifer-Ecuador. Key local participants from UNORCAC and Heifer-Ecuador were trained on aspects of data management.

## **Advances in Scaling Up**

Three NGOs, Heifer International, Christian Children's Fund/Ecuador and DECOIN, and one governmental organization, ECORAE, expressed interest in CBWM projects. Visits were made to project sites of the NGOs, and follow-up activities were discussed. Numerous meetings were held with the GO at which a memorandum of understanding was signed. A memorandum of agreement was signed with Heifer Ecuador, and training and monitoring activities were immediately implemented in two new provinces (Pichincha and Cotopaxi) as well as in Imbabura. CBWM activities were introduced to two second-degree organizations in the Cotopaxi province and eight monitoring sites were tested for water chemistry. Two organizations in the Pichincha province were also introduced to CBWM and started testing at 18 monitoring sites. Technical assistance was extended to DECOIN for CBWM activities in Intag region of Imbabura. Meetings were held with PROPEDINE (World Bank supported) and Plan International to investigate possibilities for cooperation in CBWM in Ecuador.

## **Advances in Policy Impacts**

Links were established with the Asamblea Cantonal, especially through Jomar Cevallos who is well aware of the CBWM project with UNORCAC, Carlos Zorrilla, former president of the Intersectorial Canton Committee for Natural Resources and Executive Director of DECOIN, and the current president of the Committee, Anibal Robalino. SANREM researchers were in frequent contact with these individuals. A decision was taken by the Asamblea Cantonal in September 2003 to address problems of water resources as the highest priority among Cantonal issues. New fees for water consumption were approved by the Asamblea Cantonal considering the need of a routine analysis of drinking water in all the systems. Links to the Mayor's office were established through frequent direct talks with the mayor, and cooperation with Arq. Rosalinda Gavilanes, the City of Cotacachi water commissioner. A presentation entitled "Initial Interpretations of Chemical and Bacteriological Data Resulting From Community Based Water Monitoring (CBWM) in Three Streams in Cotacachi" was made in January 2004 to the Cantonal Asamblea, the body responsible for devel-

oping natural resources policy for the local government.

## **Advances in Environment and Natural Resource Management**

Data were collected and some steps were taken to integrate the CBWM with a natural resources management plan for Cotacachi. Data were provided in digital format to the municipal water commissioner, to the cantonal assembly and to UNORCAC to be used as baseline for future proposals to improve drinking water systems as well as streams and springs. SANREM collaborated with PUCE (Pontificia Universidad Catolica del Ecuador)-Quito to do an assessment of the Cambugan water system that provides drinking water to six communities. Water quality data also supported a proposal for improving the water system facilities and improving the water quality of this system that benefits more than 1200 people from 300 families. Another proposal was submitted to assess in more detail three irrigation systems that provide the water to 12 communities.

## **Publications**

### **Book Chapters**

Ruiz-Córdova, S., B. Duncan, W. Deutsch and N. Gómez. 2004. *Community-Based Water Monitoring In Cotacachi, Imbabura, Ecuador*. Community-Based Water Monitoring Monograph.

## **Other Major Outputs**

### **Conference Paper**

Fernholz, R. 2004. *Tomando Mas Cuidado de Nuestra Agua*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

Ruiz-Córdova, S. 2004. *Interpretaciones Iniciales de Datos Químicos y Bacteriológicos Resultado de Monitoreo de Agua con Participación Comunitaria en Tres Ríos del Area de Cotacachi, Imbabura, Ecuador*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

### **Tools**

Deutsch, W., B. Duncan and S. Ruiz Córdova.

2003. *Manual de Certificación Básica, Monitoreo Bacteriológico de Agua*. Guía Para Ejecutar Proyectos Participativos de Monitoreo de Agua en Comunidades de La Región Andina. Auburn University. Auburn, AL.

Deutsch, W., B. Duncan and S. Ruiz Córdova. 2003. *Manual de Certificación Básica, Monitoreo Físico-Químico de Agua*. Guía Para Ejecutar Proyectos Participativos de Monitoreo de Agua en Comunidades de La Región Andina. Auburn University. Auburn, AL.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
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## **Linking Science, Planning, and Policy in the Andes: The Cotacachi Natural Resources Management Plan**

**Principal Investigator**  
Robert Rhoades

### **ABSTRACT**

In Year 6, SANREM-Andes research findings were brought to bear on the complex planning process facing the multiple stakeholders of Cotacachi Canton. The canton is in the process of developing a natural resource management plan which is linked to a new legal structure for governing and using natural resources. SANREM researchers interacted with the canton-wide Natural Resource Management Committee which is developing the plan. By providing data on water, soils, biodiversity, and landuse change the committee was able to take advantage of scientific information for the first time in its existence. Particularly useful was the Cotacachi Canton Atlas developed by Monsarrath Mejia of Catholic University-Quito. The rich data on water were also of great interest to the planning committee.

maps, photos, charts, tables), the Toolbook multimedia presentation (with embedded specific information), and several CDs of individual projects with all the projects' information. All of this information has been delivered to the people of Cotacachi, including decision makers in positions of power (e.g., Municipality of Cotacachi, UNORCAC, Cantonal Assembly, Ministries, Institute of Hydrology, etc.). News stories have been written in national and regional papers in Ecuador highlighting the accomplishments of the SANREM-Andes project.

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Committee on  
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(Carlos Zorilla)

### **OBJECTIVE 1**

Integrate and synthesize SANREM-Andes interdisciplinary research data, findings, and methods into a knowledge base under the joint guidance of the Cotacachi Canton Natural Resource Committee.

### **OBJECTIVE 2**

Utilize the knowledge base and participatory planning involving diverse stakeholders from all critical sectors to facilitate the design, writing, and publishing of a bilingual NRM plan for the Canton.

### **Achievements**

SANREM researchers from various projects met regularly with the Natural Resources Management committee of the Cantonal Assembly. The committee is made up of elected or appointed representatives: mayor, President of Canton Assembly, City Commission on tourism, UNORCAC, Neighborhood Federation, rural Andean and Intag parishes, local government committee on health, education, and modernization, professional organization/chambers of production, Ministry of Environment, NGOS, and any other person selected by the Committee. Obviously with so many var-

### **Achievements**

After 5 years of interdisciplinary research, the PIs of SANREM-Andes joined together over the past 12 months to present their rich data in an integrated framework and centralized node. The products of this databank on Cotacachi include: the Canton Atlas (with graphic

ied agendas, the points of view and data requirements varied. The approach of the SANREM team was to meet with focus groups (often by invitation of the committee) to present specific information (e.g., on water and soils) which then served as a basis for discussion. SANREM outputs (e.g., Cantonal Atlas, Toolbook presentation) helped local stakeholders better understand the dynamics of natural resource use in the Cotacachi region. The approach of SANREM was not to "tell" the committee what to do, but rather to serve as a research backstopping on critical issues. The committee discussed several options for a NRM plan based on protocols provided by SANREM (e.g., example of Sonoran Desert Plan for Tucson, Arizona). The SANREM-Andes Synthesis Conference held in Cotacachi in January, 2004, which was attended by many committee members and local decision makers, presented an excellent overview of the region. During the conference, roundtables were held in the evening on water, biodiversity and other themes for discussion and planning.

### **OBJECTIVE 3**

Draw on SANREM-Andes research to analyze key policies, laws, and conventions related to the water, land, and biodiversity components of the NRM plan.

#### **Achievements**

The study of institutions of Cotacachi has been largely under the Iowa State project activity (AND\_3) related to advocacy coalitions and social capital. However, in addition, this synthesis project examined the particular issues surrounding the natural resource planning process of the Canton. Research by an indigenous woman on the concessions agreements with the National Institute of Hydrology in Ibarra demonstrated that conflict over water is increasing. The laws governing water are rarely heeded, especially the clause about indigenous rights. Water rights tend to be concentrated with historical owners (e.g., former haciendas) with little being release to the indigenous communities. The landuse change analysis of 40 years has been completed and written up in a final report. Significant changes are related to growth of the floriculture industry, urban zones, and eucalyptus plantations. Except in one zone, there is not an

advance of the agricultural frontier in the high zone. The institutional analysis demonstrated that there is a great deal of conflict over land rights and titling. In this regard, the local government is at odds with the local indigenous organization and the Ministry of Environment. Understanding this complexity of stakeholder conflict is important in developing the Canton Natural Resource Management Plan and its "Cantonal Ordenanza".

### **OBJECTIVE 4**

Jointly with the Canton Assembly, document the process of developing a Natural Resource Management plan in contexts of social conflict over resources and disseminate the experience through outreach documents and scientific papers.

#### **Achievements**

SANREM-Andes completed 16 community histories and distributed them to the communities for final approval. During the final conference, the histories were presented in a ceremony to those community leaders in attendance. Much of the video footage shot by the SANREM project in Cotacachi was edited and developed into a series of short films on the area (e.g., development of the Maqueta of Cotacachi, ceremonies and rituals of Cotacachi, etc.). The project still has a great of specific data and visual media that needs to be finalized into a documentary film. At the close of the project, we are placing this information on a website called "Virtual Cotacachi".

### **OBJECTIVE 5**

Organize an international synthesis conference ("Toward Sustainable Environments and Mountain Communities") jointly with the Canton Assembly to discuss and compare participatory, decentralized natural resource planning experiences in Latin America.

#### **Achievements**

The capstone conference for SANREM-Andes "Sustainability of Landscapes and Livelihoods in the Andes: Reflections, Status, and Advances for the Integration of Science and Cultural Values in Cotacachi" was held January 15-17 in Cotacachi, Ecuador. Over 100 individual participated in the

conference. The conference program centered on three key themes--soil, water, and biodiversity. Research professor from four American universities (Auburn, UGA, Ohio State, and Iowa State) and their teams made presentations. The program opened on January 15 in the Casa de Las Culturas in Cotacachi with opening remarks by the President of UNORCAC and the Mayor of Cotacachi. Dignitaries from USAID and the ministries then made comments on the importance of research for natural resource management. The program consisted of 6 sessions: 1. General overview of Cotacachi; 2. Influence of Soil and Water in the Landscape of Cotacachi; 3. Biodiversity and Agrobiodiversity in Cotacachi; 4. Ethnoecology of Cotacachi; 5. Institutions and Planning for Natural Resources; 6. Conclusions and Recommendations. By accounts of all that participated, it was a successful conference.

### **Advances in Research**

Advances in research include: 1. A 40-year landuse change maps and analysis; 2. transformations and trajectories developed for each landuse category; 2. Community histories of 16 communities completed and distributed; 3. Content analysis of water and land policies completed; 4. In-depth study of Cambugan water system and Chumavi completed; 5. 3-D model (Maqueta) and future visioning exercise completed in Cotacachi. All final papers for the final SANREM-Andes book have been received and are being edited.

### **Advances in Capacity Building**

SANREM research presented in international fora, utilized by local NRM planners, accepted and used by NGOs and other projects for their own agendas in development. Capacity building in the final year was connected mainly with the diffusion of data and findings of the project. All participants in SANREM received individual training in Toolbook use, use of GPS units, and other aspects of research.

### **Advances in Scaling Up**

SANREM-Andes research has been utilized by UNORCAC to gain funding for a number of new projects on agrobiodiversity (USDA/IPGRI/INIAP with PL480 funds) and food security (European

Union). SANREM data, photos, and other information appear all over the Canton in posters and information sheets disseminated by other projects. The large World Bank project scheduled to begin this year in the Ambi Watershed has access to SANREM-Andes research and will incorporate it into their work. SANREM-trained assistants are now employed by these projects.

### **Advances in Policy Impacts**

SANREM-Andes research has been critical in helping Cotacachi Canton achieve its goal of becoming a Green Canton. The canton has received several international awards (Dubai Prize, UNESCO award for conflict resolution). SANREM-Andes has been an integral part of this process. SANREM water research has been critical in forming water groups and re-defining local regulations. At a global level, the impact has been on Chapter 13, Agenda 21 initiatives (mountain sustainability) as an example of how sustainability science can be effective within context of strong cultural identification.

### **Advances in Environment and Natural Resource Management**

Due to SANREM-Andes research, a rich database (including publications) is available for the NRM plan and development of legal structures for the Canton. This information is being used widely by international agencies as well as local groups seeking funding. The approximate number of people who have benefited is 40,000 over an area of 21,000 hectares.

### **Major Outputs**

#### **Conference Paper**

Rhoades, R. 2004. *When Seeds are Scarce: Globalization and the Responses of Three Cultures*. Paper presented at conference entitled Seeds of Resistance/Seeds of Hope. Ethnoecology/Biodiversity Laboratory, University of Georgia, Athens, GA. April 30 - May 1, 2004.

Rhoades, R. and S. Moates. 2004. *La Finca de Futuros Ancestrales*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes

Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

Rhoades, R. and X. Zapata. 2004. *Analisis Multitemporal de Cambio del Uso del Suelo en la Region Andian del Canton Cotacachi Entre Los Años 1963 y 2000*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

### **Degree Training**

Karla Vasquez, Ph.D., 2002 - 2003

Shiloh Moates, Ph.D., 2003 - 2006

Brian Campbell, Ph.D., 2000 - 2004

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## Soil, Water, and Land Use Interactions in Cotacachi Canton, Ecuador

Principal  
Investigator  
William Miller

Co-Principal  
Investigator  
Franz Zehetner

### ABSTRACT

Soil properties, elevation, and land use data collected during Phase II of the project were integrated into a GIS database and combined with new data in order to provide a deliverable set of spatial and temporal input for a natural resource management plan. Hydrologic modeling produced water yield data over time within the Cotacachi region as a further addition to the database. The model predictions were verified through field calibration.

### OBJECTIVE 1

Assist in water quality sampling and analysis (with B. Duncan, Auburn Univ.) for sediment, nutrients, pesticides, and trace metals.

### Achievements

In collaboration with Xavier Zapata Rios, existing water quality data, collected over the years through Auburn's community-based water monitoring program, were incorporated into a GIS to analyze temporal and spatial distribution of water pollution in the studied landscape. The three major streams in the SANREM-Andes study site (Yanayacu, Pichambiche, and Pichavi) showed similar trends, with pristine water close to the springs and increasing bacterial contamination with distance from the springs. In an effort to identify sources of contamination, the three streams were closely surveyed in the field from the springs to the watershed outlets into the Rio Ambi. Fecal contami-

nation from grazing animals was clearly identified as the major contributor to impaired water quality in upstream areas, whereas discharge of (untreated) sewage further deteriorates water quality as the streams flow through the urban centers Quiroga and Cotacachi. Faced with an important and urgent bacterial problem in the area (children in the surrounding communities frequently contract water-related stomach diseases), the efforts of this objective were directed towards raising awareness and giving recommendations for the control of fecal contamination and the mitigation of associated health problems.

### OBJECTIVE 2

Integrate and synthesize soils, land use, and topographic data collected during Phase II into a hydrologic model, which predicts water quantity in various altitudinal zones covering several Andean sub-catchments.

### Achievements

The studied watersheds were delineated, and relevant topographic, soil, and land cover data were compiled and integrated into a GIS. Using the WGEN model (Richardson and Wright, 1984), a 30-year weather dataset was randomly generated based on an existing 30-year dataset for the area, and average and extreme weather patterns were analyzed. Evapotranspiration and soil water balance were estimated with the DSSAT model (Jones et al., 1998) for different altitudi-

nal zones of the study area. The data were incorporated into the HEC-HMS model (Hydrologic Engineering Center – Hydrologic Modeling System) to predict stream discharge at various locations (elevations) for different weather scenarios.

Jones, J.W., G.Y. Tsuji, G. Hoogenboom, L.A. Hunt, P.K. Thornton, P.W. Wilkens, D.T. Imamura, W.T. Bowen, and U. Singh. 1998. *Decision support system for agrotechnology transfer: DSSAT v3*. In: G.Y. Tsuji et al. (eds.), *Understanding Options for Agricultural Production*. Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 157-177.

Richardson, C.W., and D.A. Wright. 1984. *WGEN: A Model for Generating Daily Weather Variables*. USDA-ARS, ARS-8, Washington, DC.

### **OBJECTIVE 3**

Calibrate and adjust the hydrologic model using hydrographs developed from precipitation and stream discharge data collected during Phase II and continuously monitored throughout the rainy season of Year 6.

### **Achievements**

Dry-season water availability was extensively surveyed in the area under study. For the three principal streams, baseflow was measured at various points (elevations) in the main channel as well as in inflowing creeks and outflowing irrigation canals. Additionally, the dry-season flow of all other (minor) springs in the area was determined to obtain a total of available water. Since in the area under study, the heaviest rainfall events generally occur during the night, we installed six automated rain gauges and stream stage sensors to capture these important events with a high temporal resolution. The rain gauges were installed between elevations of 4000 and 2450 m above sea level, covering the entire SANREM-Andes study site. One of the water depth sensors was installed in the Cuicocha crater lake to obtain better insight into the role of this water body in the hydrology of the area. The other sensors have been continuously monitoring stage height at different points in the major streams of the area. Storm hydrographs of heavy rainfall events registered by these sensors were constructed

and used to calibrate the hydrologic model of Objective 2.

### **OBJECTIVE 4**

Design, prepare, and present interpretive maps/databases incorporating biophysical data related to agriculture, environmental issues, and water quality/quantity at various scales of interest to stakeholders and decision-makers in the study area.

### **Achievements**

A variety of GIS layers were prepared (e.g., watershed boundaries, rainfall distribution, stream network, slope gradients, soil fertility, erodibility, land use, water quantity/quality, etc.), and interpretive maps were designed to address questions such as the sources of water contamination or the location of fertile soils and water sources for irrigated agriculture.

### **Advances in Research**

Stream baseflow and storm hydrographs (rainfall – stream discharge relationships) were determined for the studied watersheds. A 30-year weather dataset for the area was statistically analyzed, and precipitation patterns for average as well as dry and wet years were identified. Data on climate, topography, soils, and land use were incorporated into the HEC-HMS model (Hydrologic Engineering Center – Hydrologic Modeling System) to predict water quantity / availability in various altitudinal zones for several climate scenarios.

### **Advances in Capacity Building**

Local community leaders were involved in the climate and stream flow monitoring and thus learned low-tech approaches for the measurement of rainfall, stream discharge, and water flow in irrigation canals. The president of the local water authority received extensive training in climate and stream flow monitoring as well as mapping of water sources using GPS technology, and is now able to supervise such activities. The results of the dry-season water monitoring (dry-season water availability in the area, location of water sources, feasibility evaluation of potential expansions of irrigation systems) were presented and discussed during the SANREM-Andes conference in January. Selected

themes from the bio-physical resource database (e.g., soil fertility, erodibility, land use change, water quantity/quality, etc.) were graphically presented to local stakeholders and decision makers.

### **Advances in Scaling Up**

The stream discharge monitoring was expanded from the pilot Yanayacu watershed to the entire study area of SANREM Andes. Field scale modeling results (evapotranspiration, soil water balance) were scaled up and used as input for hydrologic modeling at the watershed scale. The methods used in this activity to map water sources and measure water flow in streams and irrigation canals have been adopted by key members of the local water authority and employed within other research and development projects in the area, e.g. the study of water quantity in irrigation systems and of the construction of potable water systems in mountain communities. The hydrologic monitoring with the automated equipment installed and calibrated as part of this activity will be continued by UNORCAC, the local indigenous organization, in collaboration with Nicolas Gomez, a key member of the local water authority, and Xavier Zapata Rios, who has served as on-site coordinator for SANREM-Andes during Year 6.

### **Advances in Policy Impacts**

Three articles tailored to a non-technical audience were prepared in Spanish language and are currently being revised for Dr. Rhoades's book on SANREM research in the Ecuadorian Andes. They address soil fertility, water availability, and irrigation, and include model predictions, interpretations and recommendations. Key data from the bio-physical resource database (e.g., soil fertility parameters, water quality, etc.) and modeling scenarios were graphically presented and included along with interpretations and recommendations in the SANREM-Andes toolbook CD, which is intended, among others, for policy makers at the community and municipal levels.

### **Advances in Environment and Natural Resource Management**

The automated stream gauging and hydrologic modeling conducted as part of this activity is pioneer work in the Ecuadorian Andes, where little

information is available about the hydrology. In Cotacachi, local decision makers are aware of the necessity to better understand the complex hydrologic processes in the region in order to manage their water resources in a sustainable way. While it is too early to observe the effects of this activity on the environment, long-term benefits beyond SANREM presence are expected as a result of improved water resources management in the area.

## **Publications**

### **Book Chapters**

Zehetner, F., and W. Miller. 2004. In Press. *Towards Sustainable Crop Production in Andean Communities, Ecuador: An Assessment of the Soils' Nutrient Status*. In Rhoades, R. (ed.) SANREM-Andes Phase II Synthesis Monograph.

Zehetner, F., and W. Miller. 2004. In Press. *Shaping an Andean landscape: Volcanism and Topography, Climate and Hydrology, Soils and Agriculture in the Cotacachi Area, Northern Ecuador*. In Rhoades, R. (ed.) SANREM-Andes Phase II Synthesis Monograph.

Zehetner, F., W. Miller, and X. Zapata Rios. 2004. In Press. *Plant – Water Relations in an Andean Landscape: Modeling the Effect of Irrigation on Upland Crop Production*. In Rhoades, R. (ed.) SANREM-Andes Phase II Synthesis Monograph.

## **Other Major Outputs**

### **Conference Paper**

Zehetner, F. and W. Miller. 2004. *Fertilidad de Los Suelos y Productividad de los Cultivos en la Zona Andina de Cotacachi*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

Zehetner, F. and W. Miller. 2004. *Describiendo el Paisaje Geología, Clima, Suelos y Hidrología en el Área de Cotacachi*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

## **Degree Training**

Franz Zehetner, Ph.D., 2000 - 2003

## **Non-Degree Training**

### **On the job training**

*Stream gauging, maintenance of rain gauges and stream gauges, data download and processing of hydrologic data* was attended by 5 person(s) and lasted 270 day(s).

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## Watershed Development in Ecuador: Economic Analysis and Policy Dialogue

Principal  
Investigator  
Douglas Southgate

Co-Principal  
Investigator  
Fabian Rodriguez

### ABSTRACT

Demonstration of the value of watershed management and assessment of the capture of this value has been undertaken in two places. One is Cotacachi, where previous research indicates that households' willingness-to-pay for water supplies that clean and reliable exceeds existing water tariffs. The other setting for research has been the drainage basin containing Ecuador's national capital, where poor watershed management may lead to inter-basin water transfers requiring a capital expenditure of more than \$1.5 billion. Although dissemination of research findings was limited during Year 6, we anticipate that our study will show that watershed conservation combined with intra-basin transfers (which would depend on policy changes) would be the cheapest way to supply Quito with water.

### OBJECTIVE 1

To demonstrate the economic value of improved watershed management in Cotacachi and to identify changes in pricing and other policies required for improved local capture of this value.

### Achievements

Household surveying began in Cotacachi on 15 March 2004 - in cooperation with SANREM-Andes's local counterpart, the Union de Indigenas y Campesinos de Cotacachi (UNORCAC), which supplied enumerators. By April 15th, representatives of 200 households had been interviewed, and tabulation of all data was

completed by the middle of May. This sample will be combined with the 80-household sample that co-PI Rodriguez interviewed for his doctorate, which was completed in June 2003. Findings contained in Rodriguez' dissertation were also reported at the July 2003 Annual Meeting the Latin American Association of Environmental and Resource Economists, which took place in Cartagena, as well as in the research brief that was placed on the SANREM website in November 2003. The same findings served as the basis for a presentation at the SANREM Synthesis Conference in January 2004, which was held in Cotacachi; this presentation will be included in the conference proceedings, which are being published in Ecuador. Finally, data collected from the combined sample of 280 households are currently being used in linear-programming (LP) and contingent-valuation (CV) analyses of water values. This research will be reported in a manuscript to be submitted to a refereed journal by September 2004.

### OBJECTIVE 2

To demonstrate the economic value of improved watershed management in the drainage basin where Quito is located and to identify changes in pricing and other policies required for improved capture of this value within the drainage basin. Closely related to the three core hypotheses is a series of research questions.

## **Achievements**

Consultation with environmental groups, Quito's municipal water company, and other stakeholders led us to the conclusion that the best setting for an economic analysis addressing conflicts over water resource development would be a pair of communities in the eastern part of the watershed - Cangahua and Oyacachi. Surveying of 200 households in the former community occurred during the second half of March 2004, with a questionnaire very similar to the instrument used in Cotacachi. Analysis of the data collected in Cangahua was completed in late April. The most significant finding is that households' willingness-to-accept (WTA) compensation in return for changing or abandoning agricultural activities in upper watersheds is sizable, relative to the value of commodities produced thanks to these activities as well as to household income. WTA estimates were presented at a seminar organized on May, 7, 2004 by Fundacion Antisana, the host-country counterpart for this activity, where Rodriguez currently works. A journal manuscript about the reasons for sizable WTA and implications for watershed conservation initiatives will be submitted by September 2004. Due to Oyacachi's remote location and deficient telecommunications links, surveying of 40 families (out of approximately 100 that live there) was not completed until early May. Data collected there will be tabulated and merged with the Cangahua set by the end of May.

## **Advances in Research**

Contingent valuation (CV) has been used on a number of occasions to estimate the willingness-to-pay (WTP) of rural households in poor countries for water supplies that are cleaner, more reliable, or both. Much rarer have been CV studies that address the same households' willingness-to-accept (WTA) compensation to cut back on use of fragile resources, as would be the case to improve water supplies at lower elevations for example. The high WTA levels we are observing in the Cangahua/Oyacachi site reflect two things about impoverished populations in fragile environments. First, their incomes are highly variable, subject to market and environmental shocks. Second, their ability to cope with income variability is limited by institutional rigidities and policy-induced distortions of various sorts. Under these circumstances,

access to resources is a critical part of a rural household's livelihood strategy, and therefore given up only if sizable compensation is offered. Observations along these lines about the size of WTA as well as implications for conservation initiatives will be useful to development practitioners as well as interesting to the academic community.

## **Advances in Capacity Building**

In addition to resulting from Rodriguez's daily interaction with colleagues at Fundacion Antisana, capacity building has taken place thanks to (1) a seminar that Southgate (the PI) gave in USAID on 10 December 2003, which was attended by representatives of various environmental groups; (2) Rodriguez's talk at the SANREM regional workshop, on January, 15, 2004; and (3) presentations by both individuals during the seminar on May, 7, 2004 organized by Fundacion Antisana.

## **Advances in Scaling Up**

The success with which this activity has scaled up from SANREM-Andes' site in Cotacachi is indicated by the dialogue over the economics of watershed management that now exists among: (1) Southgate; (2) Rodriguez and his colleagues at Fundacion Antisana; (3) Quito's municipal government and the water company, EMAAP-Q; (4) environmental organizations; (5) local communities; and (6) USAID, the Inter-American Development Bank, and other development agencies. One indicator of this dialogue is the memorandum of agreement that is currently being negotiated between Ohio State University (OSU), where Southgate is a professor, and EMAAP-Q, through the good offices of Fundacion Antisana.

## **Advances in Policy Impacts**

The memorandum between OSU and EMAAP-Q is a good indicator that this activity, which started during the second half of 2003, will have impacts long after the end of Year 6 on public policy governing the development of water resources near Quito and in other parts of Ecuador. Specific evidence of the size of WTA is of great importance for the design of conservation initiatives.

## **Advances in Environment and Natural Resource Management**

Along with demonstrating that tariffs understate rural households' WTP for water (and therefore the value of watershed conservation), this project the very high value of natural resource access to rural households. Conservation initiatives need to take this value into account.

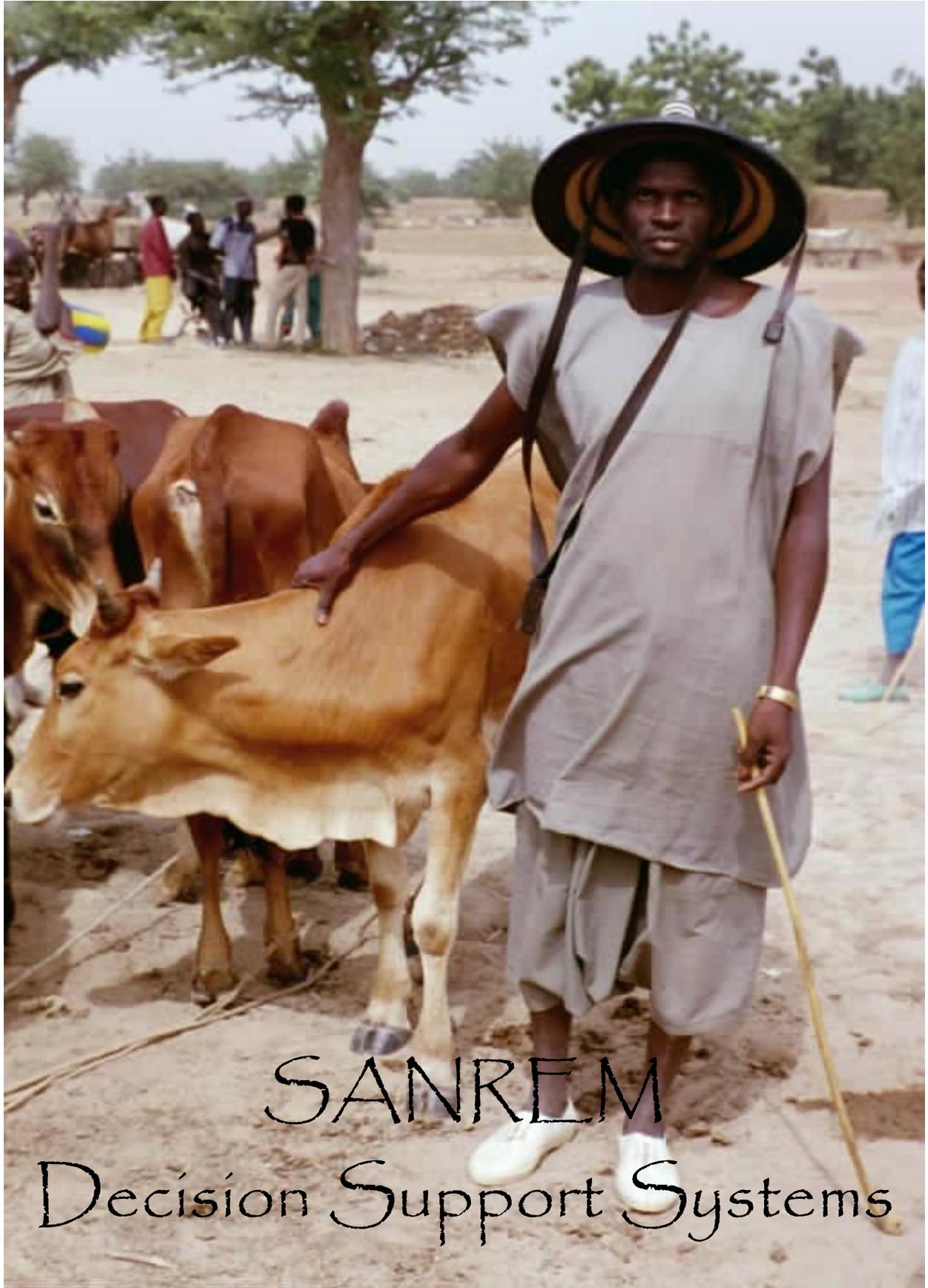
### **Major Outputs**

#### **Conference Paper**

Rodriguez, F. 2004. *Decisiones Locales Para el Manejo de Cuencas*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.

Rodriguez, F. and D. Southgate. 2003. *Local Resolution of Watershed Management Trade-Offs: The Case of Cotacachi, Ecuador*. Paper presented at Primer Congreso Latinoamericano de Economistas Ambientales y de Recursos Naturales. Cartagena de Indias. July 9-11, 2003.

Rodriguez, F. and D. Southgate. 2004. *The Value of Water and the Benefits of Watershed Management - The Case of Cotacachi, Ecuador*. Paper presented at Conference on Sustaining Landscapes and Livelihoods in the Andes. SANREM Andes Research Synthesis Conference. Cotacachi, Ecuador. January 2004.



SANREM  
Decision Support Systems



# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
DSS\_1**

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## **Management, Synthesis, and Integration of the Decision Support System Methods and Products**

**Principal  
Investigator**  
Neville Clarke

### **ABSTRACT**

This activity documents the provision of technical and scientific leadership for the DSS project. It involves developing and maintaining linkages across the activities in year six and the synthesis of the results of the total six-year effort of the DSS across all activities. It helps ensure a coherent description of the methods and their applications. The activity provides administrative and fiscal management of the DSS project and ensures ongoing communication with the ME and sponsors.

### **OBJECTIVE 1**

Facilitate and provide technical and scientific leadership for the interrelationships between the other activities under the DSS.

### **Achievements**

A training workshop for 14 Malian scientists and analysts was completed providing level one capacity for use of the DSS. The Rift Valley study in Kenya was the subject of a 40 person workshop in August 2003 aimed at final coordination of results and analysis with Kenya partners and reporting results and creating new awareness for the DSS with senior decision makers. A final workshop was held in Nairobi on May 4, 2004 to present the results of Year 6 studies to a group of 23 colleagues and senior officials of the Government of Kenya and to regional international research and development

organizations headquartered in Nairobi. The Kenya Agricultural Research Institute (KARI) established an institutional home for the decision support system staffed by scientists trained at Texas A&M. Linkages are being explored with ILRI in a three way collaboration to add animal disease and production capability on a regional basis and to use the methodology in the US for homeland security applications. KARI will request funds from several of its donors, with DSS help, to provide ongoing application of the system. A web-based approach is in place to provide to direct potential users to the relevant models and databases and the related publications that bring the overall six-year results into an overall context.

### **OBJECTIVE 2**

Provide administrative and fiscal management of the project.

### **Achievements**

The stated objectives of this project have been achieved, although some changes in the training aspect were made to reflect the redirection of efforts from West to East Africa. This was due to the fact that CILSS failed to acquire funding to use the DSS in their strategic planning, as planned. The reports called for in the publication plan for the project have been completed and documents placed on the Texas A&M Center for Natural Resource Information Technology website. This has also been linked to the SANREM and FAO websites and the models and data-

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Jerry Stuth

Tanveer Butt

Jay Angerer

Jeffrey Vitale

Robert Kaitho

Bruce McCarl

Paul Dyke

Alpha Kergna

bases resulting from the project over the course of SANREM Phase II have been made available to developing country partners.

### **Advances in Research**

This activity aimed to ensure the integration of products among the various components of the project and the establishment of linkages occur with users and with other collaborators.

### **Advances in Capacity Building**

Through integration of research products across the project into more coherent packages, the overall utility of the DSS by our national and international partners is greatly enhanced. This helps ensure the viability of the project through an informed set of analysts capable to use the system and decision makers interested in using the products of future analyses. Workshops, completed in Year 6 provided capacity for national partners and decision makers to make use of the DSS on completion of SANREM Phase II.

### **Advances in Scaling Up**

The inherent structure of the DSS development is oriented around scaling upward and outward and developing ways of linking economic analysis along politically defined boundaries with biophysical analysis defined along geographically explicit regions that transcend political boundaries. Farm, sub-national, and national levels of scale are integrated in the Rift Valley Study that was the subject of the August 2003 workshop in Nairobi. Climate change studies compared multi-national and trans-regional predictions of effects with various options and methods for mitigation. The fundamental capabilities of the DSS have been proposed to USDA and DHS (Department of Homeland Security).

### **Advances in Policy Impacts**

The statement of intent by KARI to institutionalize the DSS and use it as a tool for ongoing policy analysis, and the linkages with decision makers in the new government of Kenya offer encouraging evidence that there will be ongoing use of the DSS at the end of SANREM Phase II. This is helping to meet its intended use as a tool for policy and decision makers at varying levels of scale. Year 6 studies of climate change effects across Africa and

explicit watershed studies on NRM management provided policy makers with explicit information on options to sustainably increase food production in the future. Throughout SANREM Phase II, this project has maintained ongoing engagement with policy and decision makers in planning and evaluation of results. This has enhanced the acceptance and future utility of the research outcomes.

### **Advances in Environment and Natural Resource Management**

The overall goal of this project is to provide decision makers with tools that allow them to make more informed decisions on policy and technology alternatives in matters affecting livelihood, environment and NRM. The aggregate DSS products provide decision makers in East and West Africa with new analytic models, whose application addresses key issues relative to sustainable production and food security. The studies in Year 6 have drawn together the outcomes from the previous five years into a set of findings and principles that have global implications.

### **Major Outputs**

#### **Degree Training**

Tanveer Butt, Ph.D., 2000 - 2003  
Jay Angerer, Ph.D., 2000 - 2004  
Kristen Zander, M.S., 2000 - 2004

#### **Non-Degree Training Workshop**

*Modeling* was attended by 22 person(s) and lasted 1 day(s).

*Use of DSS* was attended by 14 person(s) and lasted 2 day(s).

*Final coordination of results and analysis; DSS awareness* was attended by 40 person(s) and lasted 2 day(s).

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## Assessment of Factors Affecting Short and Long Term Agricultural Productivity and Sustainable Use of Natural Resources

Principal  
Investigator  
Jeffrey Vitale

### ABSTRACT

Applying a newly developed web-based method for simplifying the application of the decision support system, our modeling results showed that yield productivity for both baseline and new technologies will be much better maintained in the Rift Valley than in Sikasso. Yields for the major food crops in the Rift Valley, maize and wheat, will decline annually by 0.12 and 0.18 percent over the next 50 years; in Sikasso, maize and sorghum yields will decline much faster at rates of 0.24 and 0.29 percent. Even though the potential for erosion is greater in the Rift Valley, with its higher rainfall and steeper slopes, soil profiles are much deeper and of significantly higher quality and are better able to regenerate losses in their upper layer than the thinner and less fertile lateritic soils found in Sikasso. Organic matter losses were found to be the most significant long-term environmental consequence affecting farmers in both the Rift Valley and Sikasso, but the effects were much more severe in Sikasso. Outside of the Rift Valley and Sikasso study sites showed qualitatively similar losses of productivity over the long-term. Sorghum and millet yields would decline annually by about 0.31 and 0.36 percent in Kenya and about the same, 0.29 and 0.35 percent, in Mali. When the environmental analysis was scaled-up to the national level, cluster analysis found that from a strategic perspective Kenya's food production is less vulnerable than Mali's. The areas most

prone to environmental degradation account for only about 15 percent of the total food production in Kenya, as compared to a much higher percentage, 28 percent, in Mali. In response to requests from our East and West Africa collaborators, the web-based user interface applied to these studies was constructed to allow policy makers easier access to the DSS. Results of our crop and environmental simulations were summarized into a series of meta-equations that were subsequently coded into a web-based application: (<http://cnrit.tamu.edu/africacrops>).

Co-Principal  
Investigator  
Jay Angerer  
Jerry Stuth  
Alpha Kergna  
Robert Kaitho

### OBJECTIVE 1

Extend the product of DSS Year 5 by developing further syntheses of the models and databases in the DSS for Kenya and Mali maintaining the overall spatially explicit framework. Previously developed meta-functions to describe results of biophysical analyses will be extended to more comprehensively access and use the existing DSS data. This will (a) allow more rapid and broader assessment of the relative importance of various constraints to meeting current and future food security demands and (b) provide a readily accessible approach to assessing the relative merits of alternative policies and technologies that could be applied to overcome these constraints to meet future demands that lead to reducing poverty and improving food security while making prudent use of natural resources.

## **Achievements**

Through our workshops in Mali and Kenya, a set of key biophysical factors and environmental indicators related to increasing farm incomes and enhancing food security were identified. These included the quantity of organic matter (i.e. carbon) in the soil, the supply of available macronutrients (NPK) for the plant through applied/in-situ sources, water and nitrate runoff, soil erosion, germplasm, and climatic factors (see DSS\_3). Given the importance of soil organic matter, the crop model results were updated for both Mali and Kenya using a new version of EPIC called EPIC 3060 that contains an enhanced carbon-tracking module. Dynamics of decomposition and pooling of soil humus and other carbon related attributes is more effectively represented in EPIC 3060.

The meta-equation analysis that was begun in SANREM Phase II (Years 4 and 5) was restructured and enhanced through the development of a broader set of meta-equations that individually tracks the time varying responses of the key biophysical factors (as identified by our Malian and Kenyan counterparts) and crop yields. After considering various regression techniques, ordinary least-squares (OLS) using second and third order polynomials provided the best fit for the meta-equations. Soil-specific variables were best handled using separate equations for each soil type. The results of the meta-equations were considered to be good for both the Mali and Kenya cases. The crop yield meta-equations were able to explain, on average, 65 percent (R-squared = 0.65) of the crop yields using rainfall, applied fertilization, temperature, and soil specific properties. Additional meta-equations were developed for changes in soil organic matter, soil nitrate levels, soil erosion, crop available water, and nitrate runoff. These equations generally had excellent explanatory power, with R-squared values that ranged from .7 (nitrate runoff) to .95 (changes in soil organic matter). To provide policy makers with a comprehensive view of the long-term environmental consequences, the meta-equations were used to assess the combined, long-term effects of soil erosion, loss in soil organic matter, and nitrate runoff on future farm profits. A technique known as Cumulative Degradation Analysis (CDA) was used to quantify the average annual loss in farm profits

attributable to these three environmental factors (loss in organic matter, erosion, and nitrate runoff).

Results were generated throughout Mali and Kenya using the range of farming systems that were found during the rapid and intensive surveys in SANREM II and further refined during recent training workshops in Mali and Kenya. For example, in Kenya it was found that the major food crops (maize and wheat) would be most adversely affected over the long-term by cumulative losses in soil organic matter. This would result in an average annual loss of about \$35 per hectare for maize farmers and about \$25 per hectare for wheat farmers. Given the wide range of agro-ecological zones and production systems, GIS mappings and associated HTML Imagemaps provided the best method for displaying the results of the meta-equations and CDA, allowing users to assess the spatial variability within the DSS User Interface (see Objective 2). In Kenya, the areas with the highest levels of long-term degradation are those located around the lower slopes of Mount Kenya and the Aberdarees Mountains. In the cross-cutting analysis, the long-term degradation costs have been presented in a table that includes both the East and West African sites. The results indicate that the long-term degradation costs for the cotton-based farming systems in Mali would be, on average, about three times that (\$145 per hectare) of either wheat (\$58 per hectare) or maize (\$63 per hectare) based farming systems of the Kenyan Rift Valley.

## **OBJECTIVE 2**

Develop a simple and versatile interface between the current DSS models and databases and the needs of analysts in developing countries that apply the system.

## **Achievements**

A simple planning interface to the DSS was developed for both Mali and Kenya to assess the outcomes of specific scenarios that (1) identify the most critical constraints to food security in the short and long term and (2) assess the consequences of various policy and new technology options on food security. An analytical engine was developed using a variety of JAVA enhanced scripts that assesses the constraints imposed on crop productivity and food

security by each of the key biophysical factors analyzed in Objective 1. JAVA was selected so that the DSS planning tool could be used in web-based environments to maximize the potential user base; moreover the HTML format is considered as easily accessed by users with limited computer skills and allows users to access the interface in a convenient and intuitive point-and-click manner.

Our final design of the DSS User Interface is primarily focused on the crop meta-equations and their associated equations that detail how each of the critical biophysical factors change over time (see Objective 1). This approach allows users to assess crop productivity for baseline and new technologies in the short and long-term at user-selected sites in Mali and Kenya (the legacy databases, including our biophysical and survey data, are referenced to the CNRIT website where interested users are able to acquire the data). Users navigate through the interface guided by a variety of menus. The initial menu guides users to their country of interest, Mali or Kenya, which then takes the user to a new screen that contains an HTML Imagemap of their selected country. This Imagemap contains the spatially explicit representation that was used in the TAMU spatial framework and allows users to access results at the highest resolution used in our analysis (i.e. the simulation zone.) Users are prompted to select their region of interest through a “mouse-click,” which then carries them through successive menus that allow them to view (graphically and in tabular format): (1) crop yields in the short and long-term; (2) impacts of new germplasm on crop yields in the short and long-term, (3) impacts of higher fertilization on crop yields in the short and long-term, (4) changes in biophysical factors and environmental indicators over the long-term (organic matter, erosion, nitrate runoff, and soil nitrate levels), and (5) rainfall. To provide greater flexibility, users are able to save the tables into text files for their own offline uses. In addition to developing the interface, multivariate regression models were developed to explain long-term yield declines in terms of spatially dependent factors such as climate, geography, and soils. Results for the major food crops showed that slope, soil depth, mean rainfall, and clay content were significant factors (at 90% confidence) with

R-squared values ranging between .51 (maize) and .73 (sorghum.) In Kenya it was found that many high rainfall areas were able to withstand soil erosion due to their deeper profiles and a greater ability to regenerate organic matter, particularly with the new maize and wheat varieties. Yields for the major food crops in the Rift Valley, maize and wheat, would decline annually by 0.12 and 0.18 percent over the next 50 years. In Sikasso, the relatively high amount of rainfall that falls during the early growing season makes this region much more susceptible to yield losses from erosion, particularly since the lateritic soils have much less ability to regenerate and maintain an adequate upper topsoil layer. In Sikasso, hence, maize and sorghum yields would decline at higher annual rates, 0.24 and 0.29 percent, than the Rift Valley. In the drier areas of Kenya outside of the Rift Valley the results were similar to the areas in Mali outside of Sikasso. In both cases the loss in soil organic matter contributed most significantly to the decline in yield productivity. Sorghum and millet yields would fall annually by about 0.31 and 0.36 percent in Kenya and about the same, 0.29 and 0.35 percent, in Mali. The website is located at <http://cnrit.tamu.edu/africacrops>.

### **OBJECTIVE 3**

Conduct a preliminary assessment of requirements for extending this concept to a cross-regional analysis capability to linking West and East Africa models and databases.

### **Achievements**

As stated under (Objective 1, the meta-analysis was developed in a general enough manner to allow results to be extrapolated to regions outside of our case-study areas in Mali and Kenya. The meta-equations, in particular, have purposely been structured so that they do not contain any “hard-coded” references to our sites in Mali or Kenya, allowing for parallel transfers to any point where the required data is available. During the recent Symposium held in Nairobi in May 2004, we were able to acquire, through individual engagements with our East African counterparts, their insights into the practical considerations of extending the analysis into a neighboring country such as Uganda, Tanzania, Ethiopia, or Rwanda. Their

concerns for extrapolating results were similar to our earlier experiences in extrapolating crop yields: sites must be limited to areas that share a reasonable level of geographical similarity and for which the data is available. The bulk of our Year 6 efforts in the area of regional extrapolation were reflected in the two climate change studies (see DSS 3). Interested DSS users can access the CNRIT website to view our regional extrapolation research from: (1) the earlier studies that extrapolated crop yields from out Kenyan and Malian study sites into neighboring countries in East and West Africa, (2) small holder dairy technology in Kenya extrapolated to Uganda and Tanzania, and (2) the recent climate change studies that provide results for neighboring countries of Uganda and Senegal in East and West Africa, respectively.

### **Advances in Research**

The meta-equations further strengthened the links among the various elements of the SANREM DSS, and have enhanced the DSS capacity to allow users to explore the environmental consequences of policy and technology options. Through providing users access to the meta-equations through the DSS User Interface, a more complete description of the key factors that are linked to maintaining agricultural productivity over the short and long terms is obtained. This provides a more approachable portal for the complex set of analyses that were developed by SANREM DSS in SANREM Phase II. Through its web-based design, there is potential to reach a user base that extends beyond our East and West African collaborators and the close-out of the SANREM program.

### **Advances in Capacity Building**

In Kenya, a four-person team has been established at the Kenya Agricultural Research Institute. This follows from the August 2003 Workshop in Kenya, where a select group of KARI scientists went through intensive training on the methods and applications of the DSS. One of the objectives of this four-person team is to continue with the meta-equation analysis and to institute new studies to suit the changing needs of KARI. This team will also serve as a conduit within KARI to disseminate the DSS User Interface in an effort to expose a greater number of scientists to the capabilities of the DSS.

In Mali, our collaborators and workshop trainees will be able to access the results of the Mali meta-equation research via the web-based DSS User Interface. The Mali workshop conducted in Year 6 laid the foundations for assessing the interface and how trainees could utilize it in their research. Two interdisciplinary teams of researchers, who work for key policy and technology institutions in Mali and Kenya, were jointly trained on the DSS. These teams were designed to assist the host country institutions in conceptualizing and formulating analyses on strategies to enhance food security through more effective use of agricultural technology and better management of the natural resource base using the DSS. The August 2003 workshops in East and West Africa have advanced SANREM DSS's commitment to augment the human capacity of our collaborating institutions through further intensive training on the methods and applications of the DSS. On-going training efforts are aimed at transferring the simple DSS user interface, which will better facilitate the institutionalization of the more complex suite of DSS tools and data developed in the earlier years of the SANREM DSS project.

### **Advances in Scaling Up**

The issue of scaling is an explicit part of the SANREM DSS. Analysts using the DSS have the capacity to assess the impacts of policy alternatives on food security and other criteria at varying levels of scale that include the farm, provincial, and national levels. The advances made in Year 6 through the development of the meta-equations allow for more accurate extrapolations and scaling through increased generalization of our biophysical modeling output. The natural extension of this research is to utilize spatial techniques and methods to extrapolate these results and findings from site-specific research to other locations using the concept of geographic equivalence. The development of the DSS User Interface provides the first step in addressing scaling issues by policy analysts through providing more convenient access to the DSS.

### **Advances in Policy Impacts**

The DSS User Interface was designed as a simple tool to assist policy analysts in exploring the impacts of various technology options on crop productivity and food security in a systematic and inte-

grated manner. The East and West Africa case studies that were conducted in SANREM Phase II form the basis of the policy options included in the DSS User Interface, as they were the ones selected as most relevant by our KARI and IER counterparts. Through the 2003 East and West Africa workshops and 2004 Symposium in Nairobi, the process of transferring the DSS and its supporting user interface was advanced to increase the ownership of the DSS on behalf of our East and West African collaborating institutions. The East and West Africa research efforts have been linked in a cross-cutting matrix that assesses and synthesizes how policies compare across East and West Africa.

*depletion on farm profits: Case studies from Kenya and Mali.* Submitted to Agricultural Systems.

## **Advances in Environment and Natural Resource Management**

The DSS User Interface provides policy analysts with a balanced and linked picture of various economic, environmental, and biophysical criteria. The project's recent enhancement of the meta-equation analysis provides a clearer and more detailed view of the key factors linked to enhancing food security through maintaining yield productivity over time. This provides opportunities to assess various policy alternatives and the corresponding trade-offs between enhancing food security and prudent use of the natural resource base, in the short and long terms, across a broadly defined and scalable pathway of impacts. With the DSS packaged into this user-friendly environment, policy analysts have access to more complete and integrated analyses that includes the capacity to evaluate cross-cutting issues (that have emerged from the East and West Africa studies) in the improvement of food security.

## **Major Outputs**

### **Working Paper**

Vitale, J. and D. Bessler. 2004. *Price discovery in and around the Sahel: A Malian case study.* Submitted to World Development.

Vitale, J., J. Angerer and J. Stuth. 2004. *Crop and livestock intensification issues in Southern Mali: A GIS based integrated modeling approach.* Submitted to Agricultural Economics.

*Vitale, J., P. Dyke and J. Angerer. 2004. The long term effects of soil erosion and organic matter*

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
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**May 2004  
Annual Report  
DSS\_3**

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## **Synthesis of Climate Change Impact Across Africa**

### **ABSTRACT**

Following concern about climate change impacts on food security in developing countries, the DSS was used to assess food security implications of climate change in Kenya, Mali, Uganda, and Senegal. The study used climate change projections for these countries made by two of the Global Circulation Models (GCM) for the year 2030. The GCM projections show that these countries may face a hotter and drier future conditions in general, thereby leading to a loss in agricultural production with adverse economic and food security implications. The challenge will be to develop a new set of germplasm that is more suitable for the changing conditions and establish improved farming practices to accompany the change in germplasm. Implications were also noted on potential shifts in human populations from the current regions of high productivity to rangeland areas where conditions are expected to improve.

### **OBJECTIVE 1**

Complete the suite of IAG impact studies synthesizing data from Uganda and Senegal along methodological lines developed in earlier IAG climate change impact studies in Mali, Kenya, and U.S.A.

### **Achievements**

Climate change projections made by Canadian Global Circulation Model (CGCM) and Hadley Global Circulation Models (HADCM) were compiled for use

in the SWAN database for Kenya and Senegal. The Kenyan study also included the impact on livestock. In order to provide biophysical models with the projected changes in climate, the WXGEN weather generator coefficients for the region were splined using the AUSPLIN technique and an automated procedure was developed to modify the generator coefficients to reflect the projected changes in rainfall and temperature for a georeferenced point. This allowed climate change scenarios to be spatially-explicit, thus allowing biophysical simulations for each of the climate change scenarios to be conducted at the geographic scale dictated by the ASM model (agroecological zones in Kenya and districts in Senegal). Databases were developed for crop varieties and forage species parameters that would be impacted by climate change. This allows for a more robust examination of the impacts as plants are impacted differently by climate change. The Kenyan climate change yield responses were imbedded into the IAG economic model.

### **OBJECTIVE 2**

Synthesize climate change impact results across five countries to identify agro-ecological factors of high vulnerability and identify effective adaptations to reduce vulnerability.

### **Achievements**

Climate change impact assessments done for African countries show that they are vulnerable to climate change. Their vul-

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nerability is based on two factors including the limited availability of mitigative options and harsher climate change projections.

For potential mitigative strategies, we considered crop mix alterations, trade adaptations, improved technology adoption, and heat resistant varieties. We found that these adaptations did reduce climate change impact. At the same time, there are other mitigative strategies that are simply not available to producers in the African countries we studied. For example, one of the adaptations found effective in the US was changes in dates of planting and harvesting operations. However, this option was not available in countries like Mali and Senegal where scheduling of farming operations are dictated by rainfall. Similarly, higher input application as a mitigative strategy may not be financially feasible for smallholders in these countries.

The second climate change vulnerability factor for these African countries is that the climate change projections for African countries are harsh; the future is projected to be hotter and drier. For example, 19 out of 20 climate change projections made for various agricultural areas in Mali by two GCMs show a decrease in rainfall and an increase in temperature. In contrast, the US study suggests that agriculture may benefit from a mild warming (for example, cold northern state may have more frost free days) and an increase in precipitation in various US agricultural areas.

Key policy recommendations stemming from climate change impacts on the African countries we studied point to the importance of: 1) investing in heat-resistant varieties; 2) opening trade for improving food security conditions in a post-climate change era; 3) improving extension services for promoting the use of improved technology; and 4) developing the physical transport infrastructure to handle larger volume of grain shipments from outside the country and across surplus and deficit regions within the country .

### **OBJECTIVE 3**

Develop options for mitigation and their consequences for national and international decision-makers in anticipation of climate change.

### **Achievements**

The results of climate change impact study show that production of cereals may decline by 13 percent in Kenyan and 10 percent in Senegal. Consequently, prices and import of cereals may increase. In Kenya, cereal imports may increase by 20 percent with a 77 percent increase in cereal prices. On rangelands, forage yields show an overall decline of 14 percent. In Senegal, imports rise by 15 percent with a 47 percent increase in cereal prices. Such changes reflect the weakening domestic food security conditions as the dependence on imports may be increasing. We also considered a number of adaptations to mitigate climate change impacts. We found that developing heat resistant varieties, opening up imports, and promoting the adoption of improved cultivars may help reduce adverse climate change impacts.

Results from the Kenyan study, as well as from Year 4 study in Mali, show that a wider adoption of existing improved cultivars would be important in improving the worsening food security conditions. Investing resources for the wider adoption of improved cultivars is, therefore, advisable. We also find that the adoption of heat resistant varieties have a high pay-off for mitigating the climate change impact. As developing heat resistant varieties take a considerably long time (10 to 15 years), it is important to focus efforts towards this end early on. Technology adoption also provides important gains in terms of reducing the negative impact of climate change both in East and West Africa. We found that adoption of improved technology reduces the risk of hunger due to climate change from 62 percent to 43 percent in Mali and from 63 percent to 47 percent in Kenya. In rangeland, we considered improvements in forage technology that might be needed to maintain current level of forage yields. The value of overall mitigating strategies in Mali was close to \$1.7 billion, while in Kenya it was \$2 billion.

To disseminate the results of DSS climate change studies, a Symposium was held in Nairobi, Kenya on May 4, 2004. The symposium participants included Kenyan government officials, national agricultural researchers, and representatives of regional research institutions and various donor agencies.

To consolidate the findings from the DSS applications of climate change impacts (for Kenya research), a research paper has been submitted to (and has been accepted by) the Journal of Climate Change.

### **Advances in Research**

Data Sets: under the climate change activity, climate change projections for the entire globe have been compiled and linked with GIS. This allows the capability not only to obtain GCM projection for any country/region of the world but also to map by country/region for ease of analysis.

Networks created: results of the study have been presented to Kenyan policy makers as well as to various donor agencies working in Kenya. This was achieved through a Symposium held in Nairobi, Kenya in May, 2004. The methods and results were appreciated by the symposium participants and helped IAG to form new network for research and implementation of recommendations of the climate change studies.

New research methodologies and analytical tools developed: in order to provide biophysical models with the projected changes in climate, the WXGEN weather generator coefficients for the region were splined using the AUSPLIN technique and an automated procedure was developed to modify the generator coefficients to reflect the projected changes in rainfall and temperature for a georeferenced point. This allowed climate change scenarios to be spatially-explicit, thus enabling biophysical model simulations for each of the climate change scenarios to be conducted at the geographic scale dictated by the ASM model (agroecological zones in Kenya and districts). A paper on the methodology has been submitted for presentation to the African Association of Remote Sensing of the Environment conference in Nairobi Kenya in October, 2004.

Cross-cutting / cross-regional analysis: the database generated from the climate change studies in Kenya and Mali is important for cross-cutting / cross-regional analysis. The two areas have similarities as well as marked differences, which provide a basis for identifying features that make a region vulnera-

ble or resilient to climate change. A separate study on this is available on CNRIT web site.

### **Advances in Capacity Building**

The databases on the CNRIT web site provide an easy access to results of economic and biophysical models. These databases are an important source of decision making and future planning by African countries. Results of the study, as well as the study methodologies, are being published to make them available for educational use and decision making (see DSS 5).

### **Advances in Scaling Up**

The comparison of results of predicted climate change in four African nations - both East and West Africa - involving a highly diverse set of geographical and cultural conditions demonstrates the utility of the DSS to scaling from local to multinational levels. The general conclusions from diverse assessments provide useful insights into strategic planning for donors and for regional and multinational organizations dealing with climate change.

### **Advances in Policy Impacts**

The decision makers were informed of the vulnerability of African countries to climate change, particularly the increase in risk of hunger due to a fall in cereal production. Decision makers' attention was drawn to the possibility of increased cereal import requiring adequate financial resources to meet the import needs as well the physical infrastructure to handle larger volume of imports. A paper is being published (for Mali research) in the Journal of Climate Change, informing a wider audience that includes researchers and policy makers on the impacts of climate change on food security and the potential mitigating adaptations that can help developing countries to cope with such impacts. The CNRIT study on climate change impacts is scheduled to be presented at the SANREM Accomplishment Dissemination workshop in June 2004.

### **Advances in Environment and Natural Resource Management**

The study is an estimate of how climate change would impact farmlands and grazinglands in year 2030. Our studies show a loss in overall farmland productivity as reflected in a loss of crop yield. The losses ranged from less than 5 percent to over 30 percent. Rangelands generally had decreased productions throughout Kenya and improvements in forage technology or mitigation of rangeland degradation will be needed to maintain current yields. We find that livelihood might get even more constrained in Central, Nyanza and Eastern regions of Kenya, and most regions in Mali as climate conditions for both countries are predicted to become drier and hotter.

By providing these estimates and mitigative options to policy makers, adaptive strategies may be enacted to the benefit of rural and urban populations in developing countries.

*Climate Change Impact Studies*. Submitted to African Association of Remote Sensing of the Environment Conference. Nairobi, Kenya. October 18-21, 2004.

## **Publications**

### **Book Chapters**

Schneider, U. and B. McCarl. 2003. *Greenhouse Gas Mitigation Through Energy Crops in the U.S. with Implications for Asian-Pacific Countries*. In Chang, C., D. Shaw and R. Mendelsohn (eds.) *Global Warming and the Asian Pacific*. Edward Elgar Publishing, UK.

### **Journal Articles**

Butt, T., M. Kim, B. McCarl, J. Angerer, P. Dyke, R. Kaitho and J. Stuth. 2004. In Press. *Climate change impact assessment - A synthesis of economic and biophysical impacts*. *Journal of Climate Change*.

McCarl, B., T. Butt and M. Kim. 2004. In Press. *The cost of carbon sequestration*. *The Journal of Applied Agricultural Economics*.

Schneider, U. and B. McCarl. 2003. *Economic potential of biomass based fuels for greenhouse gas emission mitigation*. *Environmental and Resource Economics*. 24(4): 291-312.

## **Other Major Outputs**

### **Conference Paper**

Angerer, J., P. Dyke, J. Stuth, and T. Butt. 2004. *Use of Splined Weather Generator Coefficients to Derive Spatially Explicit Climate Data for Use in*

# SANREM CRSP

Sustainable Agriculture and Natural Resource Management  
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## Impacts of Emerging Reforestation Policy and Agro-Forestry Technology on the Environment and Food Security in the Upper Tana River Basin of Kenya

Principal Investigator  
Robert Kaitho

### ABSTRACT

The Upper Tana River Basin and the string of dams below Masinga Dam is strategically one of the most critical resource areas of Kenya, providing water and hydroelectric power for 65 percent of the needs of the Nation. Unregulated deforestation and expansion of cultivation practices onto marginal soils in this critical river basin has resulted in significant reservoir siltation, reduced ecosystem function of the reservoir and more erratic downstream flows. Using a participatory process, collaborating technical policy analysts working for key government institutions in Kenya identified the need to assess the impact of meeting the national goal of reforestation of 30 percent of deforested lands with the infusion of new agro-forestry technologies and land tenure laws considering population expansion to 2015. Using a rapid rural appraisal methodology, it was determined that reforestation below 1850 m would be difficult to achieve. Reforestation impacts on hydrology of the system in elevation increments of 2000 m, 1950 m, 1900 m and 1850 m revealed that reforestation would represent a 30 percent to 55 percent increase in reforested area in the Upper Tana River catchments. Full implementation of reforestation to 1850 m would result in a 7 percent decrease in sediment loading in the Masinga Dam reservoir. Runoff yields would be similar to baseline conditions but peak annual flows would increase approximately 3

percent with less inter-annual variability, resulting in greater stability of water levels in the reservoir. Replacement of tea plantations by reforestation did not result in hydrologic benefits. Deforestation would allow the government to pursue reduction of lake water levels to stabilize fluctuation in vegetation, thicken the epilimnion with greater nutrient mixing, and greater downstream delivery of more stable water flows and coastal nutrient loading. Priority subbasins were identified for reforestation based on costs of dam sediment management relative to sediment yields to allow decision makers to sequence reforestation efforts. Recommendations on government actions were made for greater enforcement of illegal logging and illicit drug plantations, community based tree nursery and reforestation activities, improved land tenure laws, greater efforts in soil conservation of croplands, patterning reforestation to preserve biodiversity and strategy promotion of tea plantations in key elevational areas.

Co-Principal Investigator  
Jerry Stuth

Jay Angerer

Paul Dyke

Raghavan Srinivasan

Jeffrey Vitale

Tanveer Butt

### OBJECTIVE 1

Develop a comprehensive suite of GIS data coupled with biophysical and economic tools and associated databases that can be used for future planning needs of the Upper Tana River Basin.

### Achievements

A comprehensive set of spatial data on

elevation, soils, land use, weather (ground and CHARM), stream channels, stream flow, and reservoir capacity was acquired and assembled in a gridded manner and assigned to hydrologic units to parameterize the SWAT basin hydrology model of the Upper Tana River. Information on crop budgets by major land use category was assembled based on rapid rural appraisal and secondary data. After parameterizing the SWAT model, with these input data the model was calibrated against flow gauges in five locations in the watershed. Coefficient of Efficiency computations revealed that the correspondence between baseline flow data recorded at each flow station from 1985 to 1995 provided acceptable model performance to superimpose a series of reforestation scenarios and discuss potential environmental and economic impacts.

## **OBJECTIVE 2**

Determine the environmental impacts of deforestation processes and unregulated extensification of farming practices that have occurred during the period from 1975 to 2000 in the Upper Tana River Basin on small holders and watershed integrity.

### **Achievements**

Most of the land use change in the Tana River basin has occurred in the last 15 years as it relates to deforestation based on the forest cover data for the early years prior to the construction of the Masinga Dam that is the first reservoir downstream from the Upper Tana River Basin. This dam controls a bulk of the water flowing into the Tana downstream. Sedimentation has accelerated during this 15 year period due to a combination of expanded farming and deforestation. There are three major catchments in the Upper Tana River basin, Tana being the largest, Thika the smallest of the three, and Thiba the basin with the most sedimentation loss per unit land area. We estimated that approximately 55 percent of the forest land area has been cut over since the formation of the dam, corresponding 1850 m elevation. Over 47 million tons of sediment has flowed into the Masinga Dam since 1985 but overall runoff has not changed to any appreciable degree with an accumulated inflow of 72 million m<sup>3</sup>. Peak deposition occurred in April and November, .87 million tons and .68 million tons, respectively. These periods corresponded with peak rainfall peri-

ods, exhibiting much greater loading in the high rainfall years than in the low rainfall years. The baseline analysis served as a basis of establishing an incremental reforestation policy that was pursued under Objective 3 of this workplan.

## **OBJECTIVE 3**

Determine the impact of reforestation policy and emerging agro-forestry technology in the Upper Tana River Basin at varying levels of adoption on environmental consequences and economic/food security welfare of small holders in the watershed and the agricultural sector to meet national goals of 30% reforestation in the Basin, considering population change to 2015.

### **Achievements**

Once the SWAT model parameterization was stable against the 1985-1995 flow gauge data for all five recording stations and our rapid rural appraisal was completed, the government agencies involved in the study felt that an elevation approach would be appropriate to determining reforestation patterns in the Upper Tana River. Given that most of the farmers below 1850 m were well established for over 25 years and the land above 1850 m constituted marginal farming areas with grazing, recent squatters and illegal logging activities, this elevation would represent the maximum extent of expansion of the forested areas over the current baseline forest that is mostly above 2000 m. To avoid excessive computational demands, we established four expansion elevation goals of 2000 m, 1950 m, 1900 m, and 1850 m. Over 1250 km<sup>2</sup> would have to be reforested to achieve lowest elevation zone of 1850 m.

The major land uses displaced by reforestation would be grazing lands (41 percent), tea (19 percent), maize (16 percent), coffee (14 percent) and woodlots (5 percent). Our initial analysis revealed that reforestation of the tea plantations was not advantageous in terms of reduced sedimentation and economic benefits. However, displacement of the other land uses resulted in a reduction of 7 percent sediment loading per year. Peak annual inflow of water would change from -0.5 percent to +2.4 percent per year with less variance when fully reforested down to 1850 m. The 1950 m level resulted in an elevated loss of sediment and increased runoff

due to displacement of existing tea plantations, indicating that the current policy of encouraging tea enterprises is compatible with downstream hydrologic benefits. Of the 60 sub-basins, we recommended that those in the Thiba catchment be given priority for reforestation, followed by the Tana catchment. Based on costs of dredging and displacement of cropping, there were several sub-basins where it would no net benefit to displacement of the current users of the land. The current proposal is to lower the level of water in the Masinga reservoir to help reduce fluctuations in shoreline vegetation and improve ecosystem function of the epilimnion with greater nutrient mixing and cooler temperatures. The reduced depth of the reservoir would be better supported with a reforestation program given the reduced sedimentation in the inlet areas of the reservoir and the slightly elevated flows but less variance in those flows of water into the Masinga Dam ecosystem. These results were presented to key agencies, such as the forestry department, environmental groups, power generators and policy makers, and were well received. They felt that the analytical framework developed by this component would serve them well into the future as they explore new policies and technologies.

#### **OBJECTIVE 4**

Assemble a simple meta-modeling environment derived from legacy databases to allow policy makers to explore a range of technology/policy interventions within the limits of the analyses conducted for the Upper Tana River Basin.

#### **Achievements**

A comprehensive series of crop meta model equations have been upgraded using the new EPIC 3050 model that has improved soil carbon functions. A wide array of crop germplasms and cropping practices were established with these new carbon, nitrogen and yield functions for each agroecological zone of the country, including the Upper Tana River basin. A website has been created where the user can click on a map, then select the crop and view long term yield changes that occur as soil carbon levels or nitrogen levels change over time. This tool can be found at <http://cnrit.tamu.edu/africacrops>.

#### **Advances in Research**

The Collaborative Historical African Rainfall Model (CHARM) data from 1961 to 1997 was integrated with the Weather Generator (WxGEN) and World Meteorological Organization (WMO) data to create a georeferenced and gridded (11 x 11 km) data set that utilizes an event-correction algorithm to better match the behavior of rainfall collected by the Meteorological Satellite Rainfall Estimator (METEOSAT-RFE). The CHARM data is based on historical data from WMO and image processing that allows estimation of rainfall and temperature back to 1961 from a wide variety of data and remote sensing sources. The data was smoothed to 10-day intervals but the application of event correction with rainfall generators based on statistically valid WMO data sets allows the adjustment of the recorded data to behaviors more normal for the variation in rainfall event sizes in the region. This breakthrough in delivery of long term rainfall data for Africa will allow exploration of a wide variety of biophysical processes including crop yields, rangeland production, animal production and hydrological processes at multiple scales. The fully parameterized SWAT model of the Upper Tana River offers an excellent tool for agencies to explore new policy options. The study of the Upper Tana River Basin constitutes the first major intervention analysis of reforestation for the region.

#### **Advances in Capacity Building**

Close coordination with the prior trainees has enabled the identification of data needs, the collection of critical information, and an improved working relationship with government agencies that hold the critical data. A team of experts in KARI and the Ministry of Planning and Ministry of the Environment working with water agencies in Kenya's government will serve as a cadre of specialists able to meet meeting the analytical needs for the formulation of reforestation policy of Kenya.

A Symposium was held at the International Livestock Research Institute (ILRI) campus in Nairobi Kenya in May 2004. The Impact Assessment group presented results and led discussions on the environmental and economic options and consequences of climate change, including

reforestations of the upper Tana river catchment and improved soil management in Kenya. Over 28 participants attended the symposium, drawn from international institutions: International Centre for Research in Agroforestry (ICRAF), Forum for Agricultural Research in Africa (FARA), ILRI and Drought Monitoring Centre, Nairobi; government institutions : Forestry Department, Ministry of Agriculture, Ministry of Planning and National Development; government parastatals: KARI, National Environment Management Authority, Tana and Athi rivers Development Authority, Department for Resource Surveys and Remote Sensing, University of Nairobi, Kenya Meteorological Department and non-governmental organizations and natural resources lobby groups. The Symposium participants were senior management, policy and decision makers within their institutions.

### **Advances in Scaling Up**

The generalized grid approach applied in this research program has provided a clear mechanism for applying the concept of gridded weather data system, linked with virtual representations of landscapes within grids in biophysical models, to capture the effects of land use change on hydrological processes. The methodology will aid the performance of aggregate or disaggregate analyses, scaling up from the farm to the basin scale. It can be obtained by any country interested in linking gridded satellite weather data and hydrology models to reflect how land use change will affect the environmental characteristics of a region and explore the economic trade-offs of different policies. The weather data can be acquired from <http://cnrit.tamu.edu/charm> or <http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi>. The Global Livestock CRSP is depending on the weather data to support its Livestock Early Warning System and the newly emerging Livestock Information Network and Knowledge System.

### **Advances in Policy Impacts**

Using the concept of image map HTML interfaces to biophysical meta-equations linked to economic and environmental models allows policy makers and their technical advisors to explore different levels and patterns of reforestation in the Upper Tana

River Basin to better understand the environmental and economic consequences of their decisions. The research on reforestation impacts on the hydrology of the Upper Tana River and the interactions generated during the end-of-project workshop, have catalyzed discussions among various agencies involved in forestry, environment and power generation to define next steps for implementing reforestation policy. Policy makers expressed their intention to introduce legislation to facilitate actions for the promotion of reforestation in the region.

### **Advances in Environment and Natural Resource Management**

The analysis on the effects of reforestation on the hydrology of the Upper Tana River basin has impacted a region that generates 65 percent of all the power for the country and provides a substantial amount of downstream drinking and irrigation water. Over 1250 km<sup>2</sup> of land will be promoted for reforestation, reducing sediment loading by 7 percent per year and improving the ecosystem function of the Masinga Dam reservoir. Government policy of retaining or expanding tea plantations in the mid elevation zones has both positive downstream hydrologic effects and upstream economic benefits.

### **Major Outputs**

#### **Working Paper**

Byenkya, G., J. Stuth, J. Angerer, C. Sudhe and J. Kigongo. 2004. *Impact of undesirable plant communities on carrying capacity of a tropical savanna landscape*. Submitted to the Journal of Range Management.

Vitale, J., J. Jacobs, J. Angerer, R. Kaitho, J. Stuth and R. Srinivasan. 2004. *An integrated economic and hydrologic modeling approach to resolving externalities: A case study of the Tana River Basin*. Submitted to Journal of Agricultural, Ecosystems, and the Environment.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
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**May 2004  
Annual Report  
DSS\_5**

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## **Institutionalization of The Decision Support System**

### **ABSTRACT**

This effort was directed at ensuring that the DSS is available, useful, and usable in the institutions of the host and other developing countries that are targets of this research and development. Other activities in Year 6 simplified the interface between user analysts and the DSS and to demonstrate the utility of the system through analysis on user-driven applications. In this activity, specific engagements were undertaken to institutionalize the DSS in KARI for East Africa and at AGRHYMET and related countries in West Africa. Successful institutionalization includes providing access to databases and models, developing knowledge and skills of analysts, and helping ensure institutional commitment to continuing use of the DSS. Developing country partners in Mali and Kenya gained skills in applying the DSS through research using the methods and workshops were held in both countries to further develop this capacity. Models and related databases developed and used in West Africa were provided to IER in Mali and AGRHYMET in CILSS for future application. Models and databases were provided to the Kenya Agricultural Research Institute where an administrative unit was established to house scientists trained at Texas A&M for application of the DSS to analysis directed to priority setting for research and governmental investments. A final Symposium was conducted in Kenya to demonstrate the use of the DSS in several NRM applications including studies of climate change and evaluation

of reforestation on watershed health to interest future potential users of the methodology and its application.

### **OBJECTIVE 1**

Extend DSS capacity through installation of legacy databases and models at AGRHYMET for West Africa and conduct regional capacity building for CILSS and its member countries.

### **Achievements**

A pilot study to evaluate the impact of the FAO Special Programme on Food Security (SPFS) was completed in Mali where estimates of village level increases in production were conducted at the regional and national level. These results showed substantial positive impact of the program. The results were presented to FAO (United Nations Food and Agriculture Organization) Director General Jacques Diouf in October 2003 during his visit to TAMU (Texas A&M University). He was very interested and asked that we conduct a similar analysis for the program in Burkina Faso which is nearing completion. This could lead to a broader application of the DSS to evaluate the SPFS. CILSS (Comite Permanent Inter-Etats de Lutte contra la Secheresse au Sahel) has not developed funding to institutionalize the DSS at the regional level in West Africa after SANREM II. Thus, the regional workshop originally planned was not held. However, the databases and know how were made available to AGRHYMET (West Africa Regional Training Center for Training and

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Application in Agriculture, Meteorology and Hydrology) as called for in the Year 6 plan.

The databases for the climate change study in Mali and Senegal, as well as the sector models, were also completed and made available to AGHYMET as scheduled. Simplified approaches to using the models have been provided. In February 2002, we conducted a regional workshop for analysts and researchers under CILSS sponsorship to demonstrate the use of the DSS to representatives of the member nations of CILSS. In August 2003 we conducted a training workshop for 14 Malian scientists and analysts, including DSS collaborators as well as analysts working in the various ministries. These individuals now have capacity to use the DSS at stage 1 level of proficiency – which is to apply them using the simplified interfaces for standard impact analyses of options for research and policy. Application of the DSS has been made in a series of studies in the Sikasso region in Year 5, providing relevant results for decision makers and demonstrating to them the utility of the system. Policy makers within the government have participated in setting the agenda for the studies done using the DSS in Mali – and through these experiences have familiarity with the methods.

## **OBJECTIVE 2**

Extend DSS capacity in Kenya (East Africa) through the installation of legacy databases and models in the Kenya Agricultural Research Institute and continue regional capacity building as part of research collaboration for KARI staff and members of the Ministries of the Government of Kenya, and relevant NGOs in the region.

### **Achievements**

A reporting and capacity building workshop was held at KARI in August 2003 where the results of the Rift Valley Study conducted in Year 5 and completed in Year 6 were presented and discussed. The workshop was attended by approximately 40 people – staff of KARI, representatives of the key ministries, and several NGOs. Further engagement was had with the Kenyan staff given long term training at TAMU last year. They were active collaborators on the Year 6 work in Kenya and will be an important part of the cadre of expertise that will make

future use of the DSS. Based on the positive reaction to the results of the Rift Valley study and previous work, senior administrators, including the Director General of KARI, made commitments to the future use of the DSS as an analytic tool by senior decision makers in the GOK and as an internal research planning tool in KARI.

A new administrative unit has been established in KARI and individuals assigned to it to implement the further development and use of the DSS. A new memorandum of agreement was developed between KARI and TAMU for further development and use of the DSS after completion of SANREM Phase II. This calls for KARI to acquire donor funds to institutionalize the DSS and for TAMU to back-stop them and continue to provide technical support. This will be enabled by real-time internet based video, voice, and data communications system between East Africa and Texas A&M that has been installed and is now working at nearby ILRI (International Livestock Research Institute). Discussions are underway with the staff and Director General of ILRI for them to join with KARI and TAMU in a three-way relationship involving combining animal disease and production models from ILRI with the DSS to provide an important new dimension to the DSS. The package of models and databases relevant to East Africa was made available to the new KARI element at end of Year 6. Much of this was in the form in a web-based format using the new linkage noted above. A Symposium on results of current Tana River and Climate Change studies was held in Nairobi in May 2004 to provide further opportunity for capacity building with both KARI staff and government decision makers. The new KARI commitment will be a highly relevant development for SANREM's DSS applications.

## **OBJECTIVE 3**

Conduct a cross regional assessment and synthesis of the methods and results from DSS studies in East and West Africa, including a collaborator-client workshop, to compare and contrast the products of the two sites and to derive a general statement of applications and limitations of the method for general application in the SSA.

## **Achievements**

There are a number of inherent geographic and sociocultural factors that differentiate East and West Africa and that impact future sustainability of natural resources and food security. We studied these variables for both the current time frame and for projections out to the years 2015 and 2030. Differences in climatic patterns and projections of water availability play major roles. Differences in land tenure substantially affect farming practices and long term stewardship. Community held lands in West African communities are not managed with the same care as privately held lands in the East. Cropping systems are variable within countries and across countries depending on natural resources and climate. Access to markets – for both imports and exports – affects not only food security, but overall economic activity in different ways in these two countries. The greater diversity of climate, elevation, soils and other natural resources variables in Kenya offers a greater diversity of current and future options for meeting the goals of the World Food Summit regarding food security. This activity is closely linked to DSS-2 (Factors Affecting Short and Long Term Productivity), wherein comparisons between East and West Africa were developed in Year 6. The effects of trends in organic matter, macronutrients, water availability, and nitrogen runoff on productivity and food security were compared between Mali and Kenya. The more fertile soils and climatic diversity in Kenya offers more options for dealing with food security in the future than in most of Mali. Similarly, the studies of climate change under DSS-3, where comparisons were made between Senegal, Mali, Uganda, and Kenya, provided a cross cutting comparison of both the predicted impact and forecasted mitigation resulting from adoption of new germplasm and farming methods. The impacts of climate change will be substantial across Africa and other tropical areas. The ability to mitigate these effects may be greater in East than West Africa. The effects of weather variability will be substantial in both regions.

## **OBJECTIVE 4**

Potential expansion of activity through support from the USAID-WEST Africa Regional Program (WARP).

## **Achievements**

This was a provisional objective in the initial work plan. It depended on the successful development of a CILSS proposal to WARP to continue the future capacity building in the region for use of the DSS. Given the failure of CILSS to acquire these funds during SANREM Year 6, the investment in capacity building in the CILSS institutions is being limited to that needed to provide minimum capacity to use the DSS and to ensure that relevant databases developed in West Africa during the course of SANREM II are delivered to AGRHYMET, which is the institution designated by CILSS to continue to develop and use the DSS methodology in the future. This leaves the possibility of future engagement with CILSS should new resources become available. As noted elsewhere, a regional workshop with representatives of the CILSS nations was conducted in February 2002, and a second training workshop was conducted in Mali in August 2003 to build capacity to use the DSS.

## **Advances in Research**

This activity was directed to institutionalization of the DSS. The major research products of this project in Year 6 were developed by other workplan in the DSS project. The collaboration of Kenyan scientists in these activities enhanced their ability to use the DSS models in the future. The cross-site synthesis extended the evaluation of lessons learned from East and West African studies carried out during SANREM Phase II.

## **Advances in Capacity Building**

In the other workplans of the DSS project, methods were developed and applied to further simplify the use of the DSS as a total system or of its constituent models for specific studies. The major accomplishments are the establishment of a new unit in KARI, with staff assigned to set the DSS in place for use as a planning and evaluation method for KARI and relevant ministries, along with the possible linkage with ILRI in a three way endeavor to further develop and use the DSS after completion of SANREM Phase II. This will be a very significant contribution to successful future use of the DSS system in East Africa.

### **Advances in Scaling Up**

The cross-site synthesis of applications between East and West Africa, coupled with the results of research conducted under DSS-2, adds a scaling up dimension to the DSS, as its application on a transnational basis was explored. This accrues to the overall development of models and databases that allow for scaling up and out from farm and village levels to subnational and national levels in studies done in Mali and Kenya. Workshops and symposia conducted in East and West Africa and the linkage with AGRHYMET have provided broad access to the tools and databases of the DHS. The nesting of capacity in KARI and AGRHYMET and the potential linkages with regional organizations in East Africa offer good possibilities for future use of the system in these areas. The general lessons learned make the overall concepts available and useful on a global scale, where linkages are provided to FAO's WAICENT.

### **Advances in Policy Impacts**

The progress toward developing an institutionalization commitment in KARI for the future use of the DSS both in the Institute and by the government of Kenya is very important to ensuring that the system is used by policy makers for planning and evaluation of policy and technology options. The incorporation of relevant databases and models at both KARI and AGRHYMET and the practical experience of scientists and analysts in East and West Africa contribute to the likelihood that the DSS will continue to be used by policy makers who must address the WFS (World Food Security) goals of decreasing hunger and poverty through the sustainable use of natural resources. The specific application of the DSS to relevant issue-based studies in both East and West Africa has provided decision-makers with quantitative estimates of the consequences of options they are considering to achieve these goals.

### **Advances in Environment and Natural Resource Management**

Successful incorporation of the DSS in developing country institutions helps ensure its ultimate utility. In terms of the overall project, the DSS provides a capacity for comprehensive integrated assessment of the consequences of alternative policy and tech-

nology options. This broader view helps ensure that policy decisions are informed by a better understanding of their consequences on the lives of people in both rural and urban settings. The integrated nature of the DSS provides a framework for promoting the sustainable use of natural resources in the context of efforts to enhance food security.



# SANREM Global Impacts and Information Exchange





# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
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GLO\_11**

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## Communications and Outreach

### ABSTRACT

This activity provides a diversity of communications and information exchange channels that address a wide range of audiences on issues of sustainable agriculture (SA) and natural resource management (NRM), including SANREM's research findings and outputs. Efforts have focused on facilitating both access to information, tools, resources, and materials produced by SANREM and other programs and agencies, as well as to networking and exchange among researchers, educators, and practitioners interested in SA and NRM. An Ecoagriculture listserv has been managed that enables greater interaction among scientific, development, and advocacy circles. A variety of communication and educational materials have been produced and disseminated. Availability of relevant information and downloadable documents has been greatly increased through continuous updating of the various sectors of the website (Announcements, Related Links, What We Are Reading, etc). A training manual for primary and secondary educators in SANREM host countries has been developed to help disseminate SANREM's research to school-age learners while helping teachers to introduce concepts of natural resource management into their classroom lessons.

### OBJECTIVE 1

Collect and provide access to and facilitate synthesis of knowledge generated by SANREM regional and global projects.

### Achievements

Three Research Briefs have been completed, drawing from SANREM's research in Ecuador. They focus on a) households' willingness to pay for improving water resources, b) potential vulnerabilities of Andean volcanic soils, and 3) applications of modeling tools to improve soil fertility management and crop productivity. Complete sets of SANREM's Research Briefs (17 in total) have been disseminated to interested parties during Synthesis Workshops in Ecuador and the Philippines. Synopses of the Synthesis Workshops held in Ecuador, Philippines, and Mali were featured on the SANREM website, enabling viewers to access workshop programs, paper abstracts, power point presentations, and workshop recommendations for future research directions.

Two Research Impact stories have been produced, highlighting a) a participatory 3D watershed model produced by the SANREM-Andes team, and b) the attribution of a prestigious environmental award by the government of the Philippines to the province of Bukidnon, site of SANREM's research and capacity building efforts during the last 10 years. A complete and updated list of SANREM publications and documents is available for viewing on the SANREM website, and many of these publications are downloadable.

Dr. Carla Roncoli gave a presentation at Kennesaw State University on Science and Sustainability: the Role of

**Principal Investigator**  
Carla Roncoli

**Co-Principal Investigator**  
Robert Phares

Kristen Miller

Participatory Collaborative Research. Students from four Environmental Studies classes and faculty from Biological and Physical Sciences attended the event. Besides being exposed to SANREM's principles and projects, participants were offered virtual a 'tour' of the SANREM website and introduced to the various resources available there.

## **OBJECTIVE 2**

Facilitate exchange of information and data generated by SANREM research with organizations and individuals interested in sustainable agriculture and natural resource management.

### **Achievements**

Through the Ecoagriculture listserv that SANREM is managing we have been able to reach a variety of institutions and individuals who were not previously linked to SANREM. The listserv facilitates discussions about sustainable agriculture and natural resource management and announces conferences, seminars, and new publications about these topics.

The 'Announcements' page (<http://www.sanrem.uga.edu/tmp/announce.cfm?pageID=39>) has continued to provide timely information on national and international meetings, calls for papers and proposals, jobs in natural resource management or sustainable agriculture, opportunities for internships and fellowships, and valuable resources and reference materials. We have also updated and increased the number of available resources in the 'What We Are Reading' section of our 'Resources' link (<http://www.sanrem.uga.edu/index.cfm?pageID=2>).

We have continued to expand the number and diversity of links to other resources and organizations (via the internet) related to SANREM's foci of sustainable agriculture and natural resource management. Almost 1000 links to organizations that promote SA and NRM can be accessed through the 'Related Links' page (<http://www.sanrem.uga.edu/index.cfm?pageID=32>).

## **OBJECTIVE 3**

Promote understanding and adoption of sustainable agriculture and natural resource management concept and practices, in particular as undertaken by SANREM.

### **Achievements**

Educational and training materials produced by SANREM have been made available through the website. For instance, three Spanish manuals on biodiversity conservation have been produced and distributed, and the Watershed Directed Reading module produced during Year 5 has been updated and further circulated. ICRAF-Southeast Asia has requested (and obtained) permission to distribute the Watershed Directed Reading module to participants in a regional workshop on watershed management.

A training manual for upper primary and secondary school teachers in all SANREM host countries was created with the goals of 1) disseminating information about SANREM's work to school age children, and 2) encouraging teachers to incorporate natural resource management principles into lessons for students. To meet these goals, we 'translated' several SANREM Research Briefs into lesson plans for teachers. The lesson plans were based on activities and concepts specific to the SANREM projects covered in the Briefs, but are general enough that they can 'stand alone' as lessons that discuss NRM principles, independently from SANREM context. The lessons encourage interdisciplinary, learner-centered education through hands-on science inquiry, the scientific process, and use of the outdoors as a classroom; they were not written to meet any specific curricular standards of SANREM host countries. The lessons were validated by feedback from experts in the fields of science and environmental education (the Philippines, Ecuador, Guatemala, Honduras, United States). Most reviewers felt that teachers with little science background and few resources could understand and complete the activities and that the lessons' methodologies were sound. Additional comments from the host-countries pointed out that some of the scientific content was more advanced than students in their country

would receive at the primary and secondary level and some of the language was too technical. Some reviewers gave suggested modifications for how the lessons might work better in their countries, which were incorporated either into the body (lessons) or into the introductory material and/or appendixes of the final version.

The manual contains three Units of lessons focused on Water, Soil, and Culture/Values. Each Unit is comprised of three to five lessons. In addition, a template illustrating the procedure used to create such Units was provided to enable teachers to translate scientific information (i.e., articles) into effective, engaging lesson plans that meet local curricular standards in their countries. Supporting materials were provided, including background information on the basic concepts of NRM and tools for teaching these concepts to children; an explanation of the lesson plan format that we created and used; a brief annotated list of web-based resources on sustainable agriculture, environmental education, and service learning; information on how to incorporate scientific inquiry in the classroom; an example of children's science articles for teachers to translate into lesson plans; examples of existing teaching materials that integrate principles of systems thinking, adaptive management, and constructivism; and a sample agenda for a teacher training workshop designed to equip teachers with the necessary understanding of NRM principles, learner-centered pedagogical approaches, and methodology for creating lessons plans that are science-based and encourage using local resources and the natural environment as an engaging place to learn.

### **Advances in Research**

Increased accessibility of research findings and outputs has stimulated dialogue among SANREM and non-SANREM researchers, facilitating comparative analysis and integration of efforts. Information and recommendations from the three Synthesis Workshops publicized on the website have defined the state-of-the-art and future directions for SA and NRM research in West Africa, Southeast Asia, and the Andes.

### **Advances in Capacity Building**

Researchers in developing countries have benefited

from website access to resource materials and information about publication and funding opportunities that would otherwise be unavailable to them. The reading module and training materials contributed to improving understanding of SA and NRM by educators and practitioners in the U.S. and in the host-countries. The Teacher Manual for upper primary and secondary school teachers has improved awareness of NRM principles and integration of research skills into classroom lessons.

### **Advances in Scaling Up**

Dissemination of the Watershed Directed Reading module during a ICRAF regional workshop and the publication of the Improved Watershed Management article by Perez and Tschinkel on a ODI (United Kingdom) website have considerably widened the outreach of these tools.

### **Advances in Policy Impacts**

The Research Briefs and other communication materials produced by this activity and posted on the SANREM website are designed to address the information needs of professionals and policy makers. The article by Perez and Tschinkel on Improved Watershed Management has been featured on a website specifically oriented to bringing research findings to policy makers in the United Kingdom and internationally.

### **Advances in Environment and Natural Resource Management**

Resources and information provided online can assist decision makers in making more sustainable NRM decisions. The educational and communication materials generated by this activity enable greater understanding and appreciation of sustainability issues, contributing to the development of an environmentally sensitive citizenry.

### **Major Outputs**

#### **Briefs**

Rodriguez, F. and D. Southgate. 2003. *Water Resources Management and Willingness to Pay: The Case of Cotacachi, Ecuador*. SANREM CRSP Research Brief No. 15.

Zehetner, F. and W. Miller. 2004. *Plant-Water Relations in an Andean Landscape: Modeling the Effect of Irrigation on Upland Crop Production*. SANREM CRSP Research Brief. No. 17.

Zehetner, F. and W. Miller. 2004. *Towards Sustainable Crop Production in Andean Communities, Ecuador: An Assessment of the Soils' Nutrient Status*. SANREM CRSP Research Brief. No. 16.

**Tools**

Miller, K. and J. Wilson. 2004. In press. *Creating learner-Centered, Multidisciplinary Lessons from Scientific Articles: A Training Manual for Teachers*. SANREM CRSP ME. Watkinsville, GA.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
GLO\_31**

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## Selecting Priorities and Opportunities in Ecoagriculture

**Principal  
Investigator  
Carla Roncoli**

### **ABSTRACT**

One report has been prepared to assess trends and gaps in ecoagriculture-related research. Ecoagriculture is defined as land use systems that produce both human food and ecosystem services, including habitat for wild biodiversity. The report includes the perspectives of natural resource management, economics, and ecology. The assessment's goal was to define the state of collective knowledge on: 1) agricultural land use systems that increase biodiversity, and 2) the ability of researchers to influence biodiversity conservation in agricultural ecosystems. The report identifies ecoagriculture-related research priorities. Although the report's main thrust is on research, extension and education implications are also identified.

ers were assisted by two Ph.D. students, one in economics and one in ecology. The research team conducted extensive literature reviews. The team evaluated documentation on ecoagriculture-related issues that were available in the main research journals and books (as well as gray literature), covering agriculture, conservation of protected areas and landscape ecology from social and natural science perspectives. In addition, the teams guided their in-depth assessment through face-to-face interviews and virtual meetings with a wide range of researchers and stakeholders throughout the US and abroad. In order to ensure the inclusion of different perspectives and experiences, the research team worked with an interdisciplinary advisory panel. The panel was composed of more than 30 scholars from Cornell University and from other institutions all over the world.

### **OBJECTIVE 1**

Assess the current state of natural and social science research on the management of agricultural land use systems to support biodiversity conservation, and document efforts that show the ability of scientists to combine, interpret and communicate their research results to decision-makers and influence changes in practice or policies that enhance biodiversity conservation.

### **OBJECTIVE 2**

Widely share the results of the research assessments with a broad, international community of researchers and practitioners of, and investors in, ecoagriculture.

### **Achievements**

Team leaders were identified among Cornell University faculty: Louise Buck (Department of Natural Resources); David Lee (Department of Applied Economics), and Tom Gavin (Department of Conservation Biology). The team lead-

### **Achievements**

A draft version of the assessment report was widely circulated in electronic form to gain feedback from researchers and practitioners representing agriculture, conservation of protected areas, landscape ecology, and social and economic sciences. The feedback was used to enhance the overall quality of the report. Channels used for the report's distribution included the ecoagriculture partners net-

work, ASB-GLOBAL; EANTH-L; ASEAN Regional Centre for Biodiversity Conservation (ARCBC); CONDESAN; the Development Gateway, FRAMEgram, and SANREM's website.

### **Advances in Research**

The review provides a state-of-the-art assessment of ecoagriculture research for researchers from different disciplines. The report will likely be a landmark to define ecoagriculture research priorities for years to come.

### **Advances in Scaling Up**

The assessment report will be a key document in a September 2004 world ecoagriculture congress organized by Future Harvest and ICRAF, which will take place in Kenya. The report highlights the vast amount of ecoagriculture knowledge already available, gaps in research, as well as organizations and institutions that are researching or implementing ecoagriculture activities. Due to these conditions, the report will likely become a catalyst for wider partnerships, coordination and mutually supported leverage among stakeholders around strategic ecoagriculture research (and extension) activities throughout the world.

# SANREM

## Southeast Asia





# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
SEA\_1**

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## **Administration and Research Management for SANREM-Southeast Asia**

**Principal  
Investigator**  
Ian Coxhead

### **ABSTRACT**

This activity lends administrative support and coordination to all research and related activities being conducted by SANREM-SEA researchers.

### **OBJECTIVE 1**

To manage and coordinate research and related activities conducted by PIs and work plan holders of the Southeast Asia project.

### **Achievements**

Project management proceeded smoothly, with the exception of difficulties associated with delayed release of Year 6 funds.

### **OBJECTIVE 2**

To provide administrative guidance for the research programs of the Southeast Asia project

### **Achievements**

During this final year efficient financial administration of the project has been made impossible by delays in the approval of budgets by USAID/Washington.

Over the last 18 months we developed four separate budgets - Phase 3, Year 6, First half of Year 6, and finally the second half of Year 6. - These submissions not only took untold hours at UW, but also stretched the limits of the time and patience among the 14 work plan leaders

and the administrators at the four institutions with which we have subagreements. The modification to the agreement between UGA and UW that finally provided the first half of the funding for Year 6, was not fully executed until November 11, 2003 - six months after the beginning of the final project year.

### **OBJECTIVE 3**

To coordinate documentation and communication of SANREM-SEA procedures and results.

### **Achievements**

The SANREM Synthesis Conference held in January 2004 in Manila drew researchers together with senior government officials and their advisors, as well as representatives NGOs and other groups with an interest in sustainable agriculture, natural resource management, and the development of the uplands.

### **OBJECTIVE 4**

To facilitate project monitoring and evaluation

### **Achievements**

Project's final meetings, in Malaybalay and Lantapan, May 17-19, bring together project participants in concluding activities. Accomplishments and impacts of individual work plans are documented in their reports and in the PM's overview.

**Co-Principal  
Investigator**  
John Rowe

## **Major Outputs**

### **Conference Paper**

Paningbatan, E. 2004. *Application of PCARES in Locating the Soil Erosion "Hotspots" in the Manupali River Watershed*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
SEA\_2**

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## **Administration and Coordination of the SANREM CRSP Southeast Asian Program (PCARRD)**

**Principal  
Investigator**  
Romalao  
Aggangan

**Co-Principal  
Investigator**  
Vel Suminguit

### **ABSTRACT**

This activity afforded proper financial management and coordination of the SANREM-SEA (PCARRD) project. Coordination and communication took place between SANREM-SEA PIs and Co-PIs, as well as the SANREM Management Entity (ME).

entitled “Human Dimensions of Family, Farm and Community Forestry International Symposium” which was held at Washington State University-Pullman, from March 29 to April 1, 2004. He also had meetings with Dr. Ian Coxhead and Dr. John Rowe, respectively SANREM-SEA Program Manager and Program Administrator, based at the University of Wisconsin-Madison on April 2-3, 2004 and with the SANREM CRSP Management Entity at the University of Georgia on April 5-6, 2004.

### **OBJECTIVE 1**

To provide timely administrative and coordination support to regional principal investigators and work plan holders.

### **OBJECTIVE 3**

To support scaling and outreach activities at the community, provincial, national and regional levels.

### **Achievements**

1) Dr. John Rowe, SANREM-SEA Program Administrator, based at the University of Wisconsin-Madison, visited the PCARRD-based SANREM-SEA from December 7-11, 2003 for financial and selected workplans’ progress updates. Among the items discussed during the meetings were the smooth closing of the SANREM program in terms of financial utilization, identification of institutions for equipment turnover, and proposed activities for the culmination event of SANREM-SEA.

### **Achievements**

1) Dr. Vel Suminguit and Ms. Dinah Tabbada of the SCO served as chapter presenters to the SEA\_11 sponsored workshop held on April 18-21, 2004 at the Sunrise Holiday Mansions in Tagaytay City, Philippines. The activity was conducted for the production of a resource manual on natural resource management for academic use. Dr. Suminguit presented a chapter on GIS while Ms. Tabbada, a chapter on the dissemination of NRM researches. Dr. R.T. Aggangan, Regional Program Co-Director, and Ms. Ma. R.M. Baltazar, Communication Specialist, served as editors and publication consultant for the manual.

### **OBJECTIVE 2**

To build linkages with other agencies and institutions which are implementing similar programs.

### **Achievements**

1) Dr. Romulo T. Aggangan of SANREM-PCARRD presented a paper on SANREM-SEA experiences in a conference

2) Dr. Vel Suminguit co-authored with Dr. Agnes Rola and Dr. Antonio T. Sumbalan a paper on "Realities of Watershed Management in the Philippines: The Manupali Watershed Experience". The paper was presented to the members of the Technical Advisory Committee (TAC) of the Bukidnon Watershed Protection and Development Council (BWPDC) on May 13, 2004 to provide the TAC/BWPDC fresh insights on how to advance watershed management for the province of Bukidnon.

3) The SCO assisted the implementation of the GIS workplan SEA\_11 Activity 4 "Capacity Building and Technical Support Services" of Dr. Tony Sumbalan and Agnes Rola. Two SCO staff (Vel and Jeffrey) participated the Geospatial Information System trainings held in La Trinidad, Benguet and Cagayan de Oro respectively.

4) SANREM-PCARRD assisted the Philippine Institute for Development Studies (PIDS) workplan entitled "Watershed-based Water Management Approach" in organizing a discussion forum entitled "The Realities of Watershed Management Approach in the Philippines held last May 14, 2004 at the Bulwagang Panday Karunungan, PCARRD, Los Baños, Laguna.

#### **OBJECTIVE 4**

To support program capacity building activities, especially for community-based partners.

#### **Achievements**

1) The 2nd Lantapan Farmers' Technology Forum was held on January 27, 2004 at the Lantapan Municipal Gymnasium. The SANREM SCO, PCARRD-based staff and the Northern Mindanao Consortium for Agriculture Resources Research and Development (NOMCARRD) Director Dr. Rebecca Cagmat coordinated the one-day event. Topics discussed included technologies for integrated pest management, soil nutrient management, agroforestry-based farming systems, soil erosion control, animal management, and financing and marketing. In general, the objective of having higher farmer attendance was achieved, with farmers comprising about 70 percent of forum participants.

2) The SCO-based development communication specialists implemented a School-on-the-Air program, teaching farmers about agrosilvopastoral systems, particularly about proper integration of goats in agroforestry farms. Of 50 farmers who participated, 30 graduated from the program. Some farmers did not graduate because they failed to submit the answers to weekly tests. The participants expressed great enthusiasm for the program.

#### **OBJECTIVE 5**

To organize and coordinate the annual conference, seminar and fora of SANREM CRSP-Southeast Asia partners.

#### **Achievements**

1) Dr. Romulo T. Aggangan, SANREM-SEA Regional Program Co-Director and PCARRD-based staff under the SEA\_2 workplan, Ms. Ma. Rowena M. Baltazar, Mr. Edgar S. Romuar and Mr. JE'Berlin E. Bautista, served as working committee chairs/members for the conduct of the SANREM International Research Conference on Sustainable Agriculture and Natural Resources Management held from January 12-15, 2004 at the Sulo Hotel, Quezon City, Philippines. The conference's overall coordinators were Dr. Gerald Shively and Dr. Ma. Victoria O. Espaldon, principal investigators for SEA\_24 and SEA\_11, respectively. Among the presenters included SANREM SCO's Dr. Vel J. Suminguit, Site Coordinator, and Ms. Dinah Q. Tabbada, IEC Specialist.

2) The SCO served as the main organizer and coordinator of the SANREM CRSP/SEA culminating activities, which were held from May 17-19 at the following different venues: Kaamulan Folk Arts Theatre for the Provincial Level policy/decision-makers; Songco Barangay. Hall for the "School-on-the-Air" graduation rites; Lantapan Municipal Hall, for the Farmers' Information and Technology Services (FITS) inauguration and SANREM-SEA handover ceremony of various materials and equipments; Maramag Municipal Hall for the members of the League of Municipal Planners – Bukidnon Chapter. A presentation on "Sustaining and Upscaling of the SANREM Methodology and Outputs: The SANREM Experience", was given by Dr. Patricio Faylon, PCARRD Executive Director

during the meeting with provincial level policy and decision-makers. Meanwhile, Dr. Aggangan presented a synthesis of SANREM-SEA research and activities during the FITS inauguration, and Dr. Suminguit presented, on behalf of Dr. Ian Coxhead, a paper on "Economy and Environmental Linkages: A Synthesis of SANREM's Research Work in Lantapan" during the meeting with municipal planning and development coordinators in Maramag.

## **OBJECTIVE 6**

To improve public dissemination of research outputs.

### **Achievements**

1) Publications currently in press include the SANREM-SEA Update newsletter, Vol. 4 No. 3 covering the period of September –December 2003.

2) The edited volume on "Sustaining Upland Development in Southeast Asia: Issues, Tools and Institutions for Natural Resources Management", was released in January 10, 2004. The book includes selected papers presented during the international conference of the same title held in Makati City, Philippines in May 2001.

## **OBJECTIVE 7**

To facilitate access and sharing of primary data.

### **Achievements**

1) Dr. Vel Suminguit, Sid Bagares and a hired field-worker completed the geo-referencing of 163 plots owned by farmer cooperators and the mapping of Lantapan road networks. The georeferencing and mapping activities are essential inputs to other SANREM-SEA workplans, especially those on watershed and economic modeling.

### **Advances in Research**

The implementation of the of 2nd Lantapan Farmers Technology Forum took place in January 2004. The activity serves as a forum for farmers and researchers to come together and share experiences and expertise. Additionally, SEA\_2 coordinated the 7th Steering committee and the 11th Technical Working Group meeting for the Lantapan-Based R&D projects.

### **Advances in Capacity Building**

SANREM-PCARRD participated and displayed a SANREM-SEA project poster at the first National Agroforestry Congress entitled "Convergence for Agroforestry Development in the Philippines" at the Leyte State University, Baybay, Leyte, Philippines. A SANREM poster was developed and printed for use in future exhibits as well.

### **Advances in Scaling Up**

The Regional Program Co-Director assisted the SA and NRM model documentation of different farm activities in Lam Dong, Vietnam. The Regional Program Co-Director and the Site Coordinator served as evaluators and panelists of the NOM-CARRD-organized Region 10 R&D Symposium. The site coordinator represented SANREM-SEA in meetings held by the Technical Advisory Committee of the Bukidnon Watershed Protection and Development Council.

### **Advances in Policy Impacts**

SANREM-SCO assisted the policy analysis and governance workplan in planning the GIS training and in implementing the policy analysis workshop for members of the Technical Advisory Committee (TAC) of the Bukidnon Watershed Protection Development Council (BWPDC).

## **Major Outputs**

### **General Information**

SANREM-PCARRD. 2003. *SANREM Newsletter* Vol.4 No.2.

### **Proceedings**

Serrano, R. and R. Aggangan (eds). 2003. *Sustaining Upland Development in Southeast Asia (Issues, Tools and Institutions for Local Natural Resource Management)*. SANREM International Conference. May 28-30, 2001.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
SEA\_3**

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## Maintaining Watershed Integrity 1: Synthesis Volume

### ABSTRACT

This activity has integrated knowledge regarding the human and physical processes influencing watershed integrity. We have documented what is known about the connections between farmer behavior, land use practices, and economic and environmental outcomes in the Manupali watershed, seeking to underscore causality between incentives, activities, and outcomes. The activity has expressly taken the watershed as a unit of analysis and has worked across multiple scales and multiple disciplines. A research monograph was organized in Year 5. In Year 6 this was significantly expanded in scope beyond the theme of watershed modeling, so as to include additional and new research results that go well beyond the policy modeling work of SEA24. A Synthesis Conference with more than 100 participants from universities, government agencies, and NGOs was held in the Philippines in January 2004 to showcase SANREM research findings.

### OBJECTIVE 1

Produce high quality research monograph to be jointly published and distributed by an international publisher (CABI) and a Philippines publishing house (Ateneo Press).

### Achievements

In September 2003 Ian Coxhead and Gerald Shively (the editors) signed a contract with CAB International (the publisher) to produce a hardcover book

of 250-300 pages based on SANREM-SEA research. The title for the volume is "Land use changes in tropical watersheds: causes, consequences, and policy options." Although we had originally anticipated jointly publishing the book in the Philippines, we will instead distribute copies of the book published by CABI. Twelve chapters have been compiled and the book should appear in print near the end of 2004.

### OBJECTIVE 2

Disseminate research findings among Philippine research and policy community.

### Achievements

SANREM-SEA held a Synthesis Conference in January 2004 near the campus of the University of the Philippines at Diliman. This venue, in Quezon City, proved advantageous both in terms of travel and in terms of accommodating participants from national agencies in the Philippines such as the Department of Agriculture and the Department of Environment and Natural Resource. The conference was hosted by the Geography Department at UP Diliman and had two main purposes: 1) to share a set of related research findings with the academic and policy communities in the Philippines; and 2) to bring together final drafts of manuscripts for the SANREM-SEA research monograph. We have arranged for 200 copies of the book to be made available for free or "at cost" distribution in the Philippines.

**Principal Investigator**  
Gerald Shively

**Co-Principal Investigator**  
David Midmore

William Deutsch

Ian Coxhead

Agens Rola

Victor Ella

Maria Delos Angeles

Victoria Espaldon

### **Advances in Research**

The research conference and edited volume integrate research findings from previously separate activities, highlighting connections and synergies between biophysical, economic, and social research.

### **Advances in Capacity Building**

Output from the research monograph is likely to form the basis for improved policy making and academic understanding.

### **Advances in Scaling Up**

The research monograph was significantly expanded in scope beyond the theme of watershed modeling, so as to include additional and new research results that go well beyond the policy modeling work of SEA 24.

### **Advances in Policy Impacts**

Conference invitees included local, regional, and national representatives from the Department of Agriculture and the Department of Environment and Natural Resources.

### **Publications**

#### **Books**

Coxhead, I. and G. Shively (eds.). 2004. *Land Use Changes in Tropical Watersheds: Causes, Consequences, and Policy Options*. CABI Press, London, UK.

### **Other Major Outputs**

#### **Degree Training**

Charles Zelek, Ph.D., 1997 - 2003

# SANREM CRSP

Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)

May 2004  
Annual Report  
SEA\_4

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## Maintaining Watershed Integrity 2: Land Use Practices and Environmental Outcomes

### ABSTRACT

This activity aimed to identify patterns of causality between land use practices and environmental outcomes.

Biophysical features of farm plots and sub-watersheds will be linked to socioeconomic and land use data that have been collected over the years 1994-2002 by SANREM-SEA. Using state-of-the-art soil prediction technology (such as the WEPP model), land cover effects are being evaluated. Outcomes under contrasting management regimes are under study in adjacent watersheds. We have analyzed historical data to examine relationships between erosive rainfall events and the measurement of buildup of TSS in river samples. We have also quantified C sequestration (above and below ground, in lignified material) in various agroforestry systems, and spatially monitored the implementation of management practices that mitigate soil erosion. Since much of the research is still ongoing, to be completed shortly, and data are not consolidated, future outcomes from the project and conclusions/policy directives will continue to flow after official closure.

### OBJECTIVE 1

Through monitoring of TSS and pesticides of two adjacent micro-watersheds of contrasting land use, show how differences in land use (e.g. natural vegetative strips or agroforestry) relate to TSS and pesticide loading in streams and rivers.

### Achievements

One trip by David Midmore and Antonio Dano in August, followed up by a visit by Antonio Dano, and another trip by both in January 2004 has led to the designation of two adjacent microwatersheds for the monitoring of TSS and pesticide loadings. We were dependent upon availability of GIS data for this, and now have identified a micro-watershed that was used by the MSEC site in Mapawa Songco. Gauging stations are still providing data in this <90 hectare micro-watershed. We have monitored stream and TSS and pesticides in this and an adjacent watershed, with contrasting land use practices, and the data management is being coordinated by Dr. Vic Ella for his modeling activities. The strategy for the sampling, transport and analyses have been determined and circulated among cooperators. In-principle agreements to cooperate with the TW on water sampling and with HPI and the Macaulay Institute are in place. Our sampling station with the TW is according to what we have agreed, ie Tugasan, Maagnao, Alanib and Kulasihan rivers. An MS student from UPLB (Edward Lapong, under Dr Vic Ella) is monitoring the runoff, pesticide levels, TSS and other parameters for water quality in the new year. To date, during the dry season we have not encountered detectable levels of the pesticides commonly used in the watershed in river samples. Stream flow is just beginning to increase with the onset of the rainy season. We have also

**Principal Investigator**  
Gerald Shively

**Co-Principal Investigator**  
David Midmore

William Deutsch

Victor Ella

Steven Ventura

Gerald Shively

Gregg Clark

Ian Coxhead

Bayou Demeke

Antonio Dano

Vel Suminguit

Maria Delos Angeles

Victoria Espaldon

collected transect data along many N/S and E/W transects in the watershed, on the presence/absence of erosion mitigation practices (including natural vegetative strips, high value hedgerows, agroforestry and forestry), at c. 200 m intervals, to (a) quantify the importance of these on a landscape scale, and (b) to allow for ground-truthing of remote sensing approaches to quantify the same. Given the size of the data set, this analytical activity will continue beyond the life of the project, and output will be incorporated into Dr Ella's WEPP model for an integrated watershed.

## **OBJECTIVE 2**

Use these data to simulate and predict soil erosion and sediment yield using a WEPP model for a sub-catchment (based on geo-referenced land cover data) and evaluate the effect of land use changes on soil erosion and sediment yield using the WEPP model.

### **Achievements**

The WEPP computer simulation model to be used in this project was upgraded based on recent programming updates done at the National Soil Erosion Research Laboratory of USDA. Updates on breakpoint climate data generation have also been incorporated. Additional secondary data needed as inputs for the WEPP model are currently being gathered from various sources. Existing developed soil erosion hillslope and watershed scale models are continuously being refined to take into account additional data obtained at the sites and in preparation for model recalibration, validation and simulation of the effects of land cover changes. The DEM (Digital Elevation Model) for the MSEC site at Mapawa Songco has been developed, for the development and validation of WEPP, to include TSS and other parameters of water quality. A Masters student (Edward Lapong, from UPLB, under supervision of Dr Vic Ella) has commenced intensive sampling, and data has been inputted into the WEPP model. In January 2004 Dr Midmore met with the field water quality data collection team, and with Dr Ella and the student, to monitor progress and quality in data collections and analysis.

## **OBJECTIVE 3**

Identify connections between economic incentives and environmental outcomes at the individual farm level, and the potential impact of alternative economic and environmental policies at the watershed level.

### **Achievements**

This activity draws heavily upon the modelling activities of Dr. Gerald Shively (refer to SEA03), and these are being supported by data generation/analysis by other members of this project team. A number of research papers were prepared for the January 2004 Synthesis Conference, and these have provided the background for final conclusions on economic and environmental policies for the Philippines. Sharing of data among members within the project team is taking place, being further encouraged by the Synthesis Conference, as the benefits of multiple approaches to analysis and use of the data were presented.

## **OBJECTIVE 4**

Quantify important environmental services (e.g. C sequestration, nutrient uptake) of key agricultural systems and use this information as input to policy planning (e.g. as part of the RUPES project).

### **Achievements**

Sampling of tree plots (mainly aboveground, plus some root studies) has taken place, and analysed data have been presented in the January conference held in Manila. Root and timber samples for total carbon have been analysed at the Forest Products Research and Development Institute, Los Banos, and modelled predictions compare well with actual values for C-sequestration. Some of these data are presented in the CABI book mentioned before, and other data will be combined for a refereed publication on the topic. Soil samples collected from the sampled trees are still awaiting analyses at CMU, but the data, once derived, will aid in the interpretations of nutrient uptake by trees in an agroforestry system.

Other non-environmental services have been provided by the moves towards agroforestry in the watershed. Examples of these have been docu-

mented by ICRAF. For example, marketing of seeds and seedlings is becoming an additional source of income among tree farm growers in Lantapan. In response to the increasing demand for seeds and seedlings from visitors, ICRAF continues to assist both ATSAL and Landcare farmer-collectors and growers in drafting guidelines to ensure fair and equitable marketing and profit sharing schemes between and amongst the members of the two organizations. An initial draft on the sales and marketing of seeds and seedling produce has already been drafted and this will be presented to Landcare members during their strategic planning workshop by early next year. Institutional interactions that may lead to development of policy that promotes sustainable development in upland watersheds have been facilitated through visits to the watershed, by agencies such as: the IFAD-DAR Northern Mindanao Community Initiatives and Resource Management Project, IFAD-DAR Western Mindanao Community Initiatives Project, IFAD-DA Cordillera Highland Agriculture and Resources Management Project in Northern Luzon, CARE Philippines Project in Mt. Isarog in the Bicol Region, Catholic Relief Services - Southeast Asia and the Pacific, Ministry of Forest and Soil Conservation of Nepal, USAID-Nepal, Training Centre for Tropical Resources and Conservation Sustainability, EU-DA Upland Development Programme of Southern Mindanao, USAID-EcoGovernance, Davao City Water District, Watershed Management Coalition (Western Visayas Chapter), Provincial Government of Bohol, and a number of LGUs.

### **Advances in Research**

It is still too early to determine at what scale land use or land use changes can be correlated with soil erosion, sediment yield, and pesticide loads in waterways, for the correlation analyses have to be run. To date, some are under way. The quantification of Carbon sequestered identified the value of ecological services afforded by certain land use and crop management practices in the Manupali watershed (see paper presented at the SAN-REM-SEA Synthesis Conference in January 2004). The data continue to accrue, and full conclusions can only be drawn after completing the ongoing field work. Our approach to transect monitoring of

management practices to mitigate erosion is unique.

### **Advances in Capacity Building**

Some local involvement by TW in the sampling for pesticides has taken place. However, the required methods and costs preclude local participation. Interaction with the water quality monitoring workplan has been very useful. Involvement of the TW and the pesticide sampling team in the training on biological assessment in Lantapan conducted by Dr Bill Deutsch, 13-14 January 2004, now allows for combined analyses - for development of correlation tools between biological assessment and the logistically difficult and financially unaffordable pesticide analyses.

### **Advances in Scaling Up**

The ability to promote environmental stewardship across the region will hinge upon our ability to 'get the message across'. From now onwards, this will occur mainly through written outputs. We will continue to write research results and to make research outcomes available on-line as they are published and to use them in outreach activities. A one-year sabbatical in the UK will enable Dr. Midmore to write extensively.

### **Advances in Policy Impacts**

Tying in with the TW, the outcomes of the research have been publicized locally. The data are supporting policy modeling work and will be presented to various policy bodies in the Philippines during project closure.

### **Advances in Environment and Natural Resource Management**

We have now quantified the extent of C sequestration, and data can be used (a) for further verification and development of model scenarios, and (b) to provide the basis for a C credit payment scheme. Sequestration of nutrients lost to annual cropping through leaching has also been quantified. Data on the potential benefits of various land management practices in minimising pesticide pollution of waterways are still being analysed and will feed into the formulation of policy directives.

## **Publications**

### **Book Chapters**

Midmore, D., D. Poudel, T. Nissen, A. Daño and G. Zhu. 2004. *Biophysical Outcomes of Planting Annual Crops With Trees and in Rotation With Other Species in an Upland Tropical Environment*. In Coxhead, I. and G. Shively (eds.) *Land Use Changes in Tropical Watersheds: Causes, Consequences, and Policy Options*. CABI Press, London, UK.

## **Other Major Outputs**

### **Conference Paper**

Ella, V. 2004. *Simulating Surface Runoff, Soil Erosion and Sediment Yield in Manupali Subwatersheds Using the WEPP Model*. Paper presented at *Conference on Land Use Changes in Tropical Watersheds*. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

Midmore, D. 2004. *Updates on Our Understanding of the Impacts of Land Use and Farming Practices on Biophysical Outcomes in the Tropical Uplands of Mindanao, the Philippines*. Paper presented at *Conference on Land Use Changes in Tropical Watersheds*. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

### **Proceedings**

Dano, A. and D. Midmore. 2002. *Analyses of Soil and Water Conservation Technologies in Vegetable Based Upland Production System of Manupali*. In *Proceedings of International Soil Conservation Organisation Conference*. Beijing, China. May 26-30, 2004.

### **Working Paper**

Midmore, D. et al. 2005. *A Transect Approach to Monitoring Adoption of Erosion Mitigation Practices in a Highland Tropical Watershed*.

Midmore, D. et al. 2005. *Comparisons Between Land Management Practices in Their Effectiveness in Mitigating Erosion, and Pesticide Contamination of Waterways*.

Midmore, D. et al. 2005. *Carbon Sequestration in Agroforestry Systems, Matching Modelled and Harvest Data*.

## **Degree Training**

Edward Lapong, M.S., 2003 - 2004

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
SEA\_5**

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## **Maintaining Watershed Integrity 3: Water Resource Management and Education**

**Principal  
Investigator**  
William Deutsch

**Co-Principal  
Investigator**  
Jim Orprecio

### **ABSTRACT**

The Year 6 activities focused on integrating our work with that of other SANREM-SEA researchers and NGO partners to advance Community-Based Water Monitoring (CBWM) in the areas of 1) field methods and data management, 2) local group capacity-building and institutionalization, 3) use of the CBWM model for positive policy impacts and 4) spread of CBWM beyond Lantapan. Particular focus was given to development of an online database, connected to the Global Water Watch (GWW) program, for Filipino Water Watchers to enter their water sample data and 2) a Synthesis Monograph on Community-Based Water Monitoring (CBWM) projects in five countries over a 11-year period.

### **OBJECTIVE 1**

To build on the extensive database of the community-based water monitors in the Philippines, develop new sampling methods and efficiently manage and disseminate the water data.

### **Achievements**

Water monitoring by The Tigbantay Wahig (TW) in Lantapan, the Munong El group (Maitum, Sarangani Province), and the Magtubo Water Watch group (Bohol Province), with technical backstopping from project staff, produced a total of 681 new Total Suspended Solids (TSS) samples, 333 Water Chemistry samples, 95 Stream Discharge/Soil Export measurements, 32 Nutrient samples and 216

Bacteriological samples. In addition to monthly monitoring of four rivers in Lantapan, the TW also monitor a site at the MKAVI plantation monthly. Members of the TW and Ms. Sid Bagares (SANREM) assisted Mr. Rodd Dyer with his research on watershed management in Lantapan. Water sampling with Mr. Dyer was conducted at 22 sites throughout the Maagnao, Alanib and Kulasihan watersheds, 28 September – 3 October 2003. Fourteen of the chosen sites had originally been established and sampled by Heifer Project International (HPI)/TW between 1994 and 1996 and were chosen to represent the spatial variability of livestock density and production systems, human population and agricultural land use at the barangay and subwatershed level. Mr. Dyer conducted a short training on the use of a flow meter to the TW members. Samples collected will be analyzed by Mr. Dyer for nutrients and chemicals, TSS (Total Suspended Solids) and fecal coliforms. The results of his research effort with the TW have been used by four other SEA projects: SEA\_4 (Midmore and Ella), SEA\_6 (Rola and Coxhead), and SEA\_12 (Rola and Dyer). The online database for use by community-based water monitors in the Philippines is functional via CD and is planned to be functional online by May 31, 2004. The WQM (Water Quality Monitoring) Project Coordinator visited Auburn University last August 20-24, 2003 (at no SANREM expense) and met with Dr. Bill Deutsch and staff regarding procedures for logging water data on-line.

A Global Water Watch web page is under construction that includes data entry and access and features about the SANREM project.

## **OBJECTIVE 2**

To assist CBWM groups in leadership development and technical skills, and work with governmental and nongovernmental agencies to institutionalize CBWM programs after SANREM

### **Achievements**

TW members attended Rodd Dyer's workshop on the use of a flow meter for measuring stream flow and discharge in September, 2003). A Bacteriological Monitoring workshop and community-level survey of drinking water was conducted by HPI staff Trainers as part of the "Let's Help Bohol" (LHB) project and the local Magbalantay sa Tubig Bol-anon (MagTuBo) monitoring group on 26 November 2003 in Tagbilaran City, Bohol. Selected representatives from the Municipal Health Offices and Sanitary Engineers Offices participated in the training. A bacteriological survey was conducted after the training in the municipalities of Catigbian, Balilihan and Antequera. The surveys were the first of larger-scale surveys to be conducted in the municipalities of Bohol included in phases I and II of the LHB program. The Taglantaw Tubig sa Baungon (TATuBa) is a newly formed Water Watch group in the Municipality of Baungon, Bukidnon. HPI staff conducted a Bacteriological Monitoring workshop, followed by a bacteriological survey in the Barangays of Kalilangan and Laculac. The TATuBa group plans to present the results of the survey to the Barangay Councils for possible support in formulating Barangay-level ordinances. Bill Deutsch conducted a Stream Biological Assessment workshop for four Philippines Water Watch groups in January 2004. Two participants from the Forest Research and Development Sector of the Department of Environment and Natural Resources also attended the bioassessment workshop. A Memorandum of Understanding has been implemented between HPI and the Mt. Kitanglad Agriventures, Inc. (MKAVI) to provide assistance for continuation of the TW beyond the SANREM project. In addition to the regular monthly water monitoring of the TW, the group conducted monthly water quality monitoring

within the MKAVI banana plantation area. MKAVI's Pollution Control Officer assisted the group in the monitoring activity. The study of the sustainability and institutionalization of the TW is complete. Dr. Rosemary Fernholz completed two chapters of the Synthesis Monograph that will compare and contrast the TW with other water monitoring groups in Ecuador and the US. There is sustainable support from both NGOs and GOs for watershed monitoring and management by the established Water Watch groups in the Philippines and Thailand.

## **OBJECTIVE 3**

To develop and articulate the CBWM model (including group formation, sampling techniques, quality assurance, comparability with professional data and overall usefulness for natural resource management) for positive policy impacts at the local, national and international levels.

### **Achievements**

A Synthesis Monograph on Community-based Water Monitoring (CBWM) projects in five countries over a 11-year period is being finalized. During Year 6, the document was extensively revised with suggestions from the SANREM ME and with a new format and case studies for most chapters. Drafts of the document, including a flow chart model of CBWM, were used in numerous meetings and workshops to communicate the concept of CBWM to policy makers and potential project leaders in Thailand, Brazil and Ecuador. The document was also presented at the SANREM-SEA Synthesis Conference, Manila (January 2004). Updated water quality data collected by the TW and collated, interpreted, and summarized at AU was sent to Dr. Rola for development of a new Policy Brief. In addition to the Water Synthesis Document, summations of our work plan accomplishments are currently in press in three books: a chapter authored by Rola, Deutsch, Orprecio and Sumbalan for publication in a water policy-related book edited by Rola; a chapter in the UNESCO-sponsored book entitled 'Forests, Water, and People in the Humid Tropics' in press with Cambridge University Press; a chapter authored by Deutsch and Orprecio, for publication in a SANREM SEA edited volume.

## **OBJECTIVE 4**

To spread and develop CBWM groups outside of Lantapan.

### **Achievements**

Dr. Bill Deutsch, Jim Orprecio and other HI/Philippines staff participated in a series of meetings in northern Thailand on 7 –16 August 2003. The team met with professors and students of Chiang Mai University headed by Dr. Yuwadee Peerapornpisal to discuss possible collaboration in the CBWM project with CMU (Central Mindanao University), Heifer International and Auburn University. On 8 August, the work plan team and Heifer International/Thailand (HI/T) staff made presentations about the water monitoring activities in Sansuk Village to several press reporters. This led to a front-page article about the project in the Bangkok Post newspaper, and other local articles and radio interviews. The HPI International Study Tour brought participants (mainly U.S. donors and partners) to Lantapan in January 2004 to see demonstrations of water monitoring by the TW. The establishment of a Global Water Watch network has allowed new countries/groups to participate and learn from work plan experiences. Representatives from institutions in the Ukraine and Argentina visited AU to learn about CBWM and expressed interest in starting programs in their countries. The CBWM project has been modeled in Brazil with NGO (Christian Children's Fund) support, and a proposal has been submitted to expand the program in other states of Brazil with Kellogg Foundation support.

### **Advances in Research**

Biophysical Research: From January through May 2004, stream surveys resulted in preliminary evaluations of simple, biological assessment technologies for estimating impacts of pesticides. About 40 files of water data records were received in AU from the Philippines in November 2003 for entry into the Global Water Watch database. These data were combined with data from the nine previous years for a comprehensive analysis of watershed conditions and trends. A summary of water data was prepared for presentation at the SANREM Conference in Manila in January 2004. The conference presentation was expanded with considerable,

new data analyses, for a chapter in the Water Synthesis Document.

Social Research: The process of institutionalizing the CBWM groups has been documented, including ways that groups receive local funding and support for their continuation. Dr. Rosemary Fernholz completed a field study of CBWM groups in the Philippines and Ecuador and two chapters for the Water Synthesis Document related to institutionalization and group sustainability. The final draft of the Water Synthesis Document, entitled, *Community-based Water Monitoring: Global Experiences for Practical Programs in Watershed Management*, will be distributed for review in June 2004.

### **Advances in Capacity Building**

Several workshops were conducted in the report period on topics such as stream current measurements, water chemistry and bacteriological monitoring and stream biological assessment. Monitoring groups in four locations in the Philippines and in the Sansuk Village in Thailand are now able to collect water data themselves and are compiling multi-year data sets. Three of the four Philippine sites have local trainers who assist HPI and AU personnel in conducting workshops. The TW group of Lantapan will reach their 10th anniversary of water monitoring in July 2004. All groups have agreed to participate in the Global Water Watch network of citizen monitors and to be connected to similar groups in Ecuador, Brazil and the U.S. Local governmental units have received significant amounts of watershed data from the CBWM groups in every location where the SANREM project intervenes. These data have been presented in written and oral forms, with regular input and interpretation from local monitors. The Water Watch groups are committed to data-to-action strategies which maximize the use of their water data by LGUs. Pooling resources for development of internet-based databases has helped to strengthen U.S. based CBWM programs, especially Alabama Water Watch.

### **Advances in Scaling Up**

There has been a consistent expansion of CBWM groups in the Philippines, with growth of local

groups and formation of new groups. Currently, there are four active Water Watch groups in the Philippines and much of the scaling-up beyond Lantapan has been with local government support. Training workshops in water quality monitoring and group capacity building have been conducted or assisted by local trainers. Through HPI activities beyond SANREM, a new Water Watch group in Baungon, Mindanao (Taglantaw Tubig Baungon, or TaTuBa) has formed. There is strong support among the Heifer/Thailand director and staff for expansion of CBWM in northern Thailand beyond the current group in Sansuk Village, Chiang Rai. The workshops and meetings conducted there in August 2003 and January 2004 generated interest for new groups among several village leaders. The Mekong River Program of HPI collaborated with the work plan, supporting the attendance of representatives from Cambodia, Vietnam, Indonesia and China at the workshops and meetings that were held in Thailand in January 2004. Other Southeast Asian country representatives of HPI plan to become involved in the future and a strategic planning of CBWM expansion within HPI programs has been planned for July 2004 at the HPI International Headquarters. The establishment of a Global Water Watch (GWW) network has allowed new groups and countries to learn from our experiences and plan for participation and training in CBWM. Expressions of interest have been received in 2004 from the Ukraine, Argentina and Indonesia. A GWW brochure has been developed in English, Spanish and Portuguese, and hundreds of copies have been distributed. A GWW website is made accessible by the public in May/June 2004.

### **Advances in Policy Impacts**

National and Regional Policy: Dr. Agnes Rola of the University of the Philippines, Los Banos, has spearheaded the interaction with national and regional policy makers and assessing the influence of Policy Briefs related to this work plan. A new Policy Brief, authored by Rola, Deutsch, Orprecio and Sumbalan and based on the most comprehensive data set from the AU/HPI work plan, is complete. The brief was submitted to a Congressional delegation that is responsible for formulating the first Clean Water Act of the Philippines, and may influence how local communities participate in

national government efforts to protect and restore water resources. This manuscript is also currently in press in a book edited by Rola.

Local Policy: All of the CBWM groups have presented their data to local governmental units on a regular basis, and this has resulted in the development of local ordinances and natural resource management plans.

Institutional Change: The CBWM concept has influenced the future plans and formation of an International Center for Aquatic Resources and Agro-Ecology. The SANREM, CBWM project has also influenced the policy and approach of HPI's Agro-Ecology Initiative (with new, AU/HPI MOA for CBWM work), and CCF's Sustainable Human Development Program (with new AU/CCF MOA for CBWM).

### **Advances in Environment and Natural Resource Management**

There is an increasing amount of water and watershed data at all of the project sites. This information has documented the condition and trends of both surface and drinking water and has resulted in community action for the prevention of waterborne diseases and better use of water supplies. For example, the bacteriological survey in Sansuk Village, Thailand identified a swine project as being the source of E. coli bacterial contamination of a local river. The villagers and technical support staff of HPI are designing alternative swine holding facilities and streamside protection, with intentions of monitoring bacteria upstream and downstream from the site in the future. Many of the CBWM groups, with assistance from HPI, have involved local health officers and other officials in the training and monitoring activities, with expectations that this will facilitate use of local data in planning and NRM management. HPI has also assisted the water monitoring groups with livelihood projects, including the distribution of cattle with training in livestock management. Livelihood projects were integrated with CBWM to enable volunteers to monitor without sacrificing income. The UNESCO-sponsored book entitled "Forests, Water, People in the Humid Tropics" (currently in press) includes a chapter about CBWM that is based on the SAN-

REM work in Lantapan. The CBWM Synthesis Monograph, based on the experience with CBWM projects in five countries over a period of 11 years, is near completion. This monograph is specifically designed for the practitioner of CBWM projects and will be a resource for advancing participatory research, local capacity, scaling up, policy development and natural resource management.

## **Publications**

### **Book Chapters**

Deutsch, W. and J. Orprecio. 2004. *Community-based Water Monitoring in the Philippines and Beyond: a Decade of Investment and Potential*. In Coxhead, I. and G. Shively (eds.) *Land Use Changes in Tropical Watersheds: Causes, Consequences, and Policy Options*. CABI Press, London, UK.

Deutsch, W., J. Orprecio, A. Busby, J. Bago-Labis and E. Cequina. 2004. *Community-Based Hydrologic and Water Quality Assessments in Mindanao, Philippines*. In Bonell, M. and L. Bruijnzeel (eds.) *Forests, Water and People in the Humid Tropics : Past, Present and Future Hydrological Research for Integrated Land and Water Management*. Cambridge University Press, Cambridge, UK.

Rola, A., W. Deutsch, J. Orprecio and A. Sumbalan. 2004. *Water Resources Management in a Bukidnon Sub-watershed: What Can Community Generated Data Offer?* In Rola, A., H. Francisco, and J. Liguton (eds.) *Winning the Water Wars: Watersheds, Water Policies, and Water Institutions*. Philippine Institute for Development Studies, Makati City, Philippines.

### **Books**

Deutsch, W. and W. Hartup (eds.). 2004. *Community-based Water Monitoring, Global Experiences for Practical Programs in Watershed Management*. Community Based Water Monitoring Monograph. Auburn University. Auburn, AL.

## **Other Major Outputs**

### **Conference Paper**

Deutsch, W. 2004. *Community-based Water*

*Monitoring in the Philippines and Beyond: A Decade of Investment and Potential*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

## **Non-Degree Training**

### **Workshop**

*Bacteriological Monitoring* was attended by 38 person(s) and lasted 1 day(s).

*Introduction to Water Quality Monitoring* was attended by 30 person(s) and lasted 2 day(s).

*Water Chemistry and Total Suspended Solids Monitoring* was attended by 37 person(s) and lasted 2 day(s).

*Water Chemistry Monitoring Workshop* was attended by 32 person(s) and lasted 2 day(s).

*Stream Biological Assessment Workshop* was attended by 28 person(s) and lasted 2 day(s).

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
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SEA\_6**

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## **Policy and Governance 1: Synthesis Volume**

### **ABSTRACT**

This work integrated lessons learned for the past ten years of the SANREM-SEA project in understanding the environmental impact of economic development in a Philippine upland village. Panel data on land use, technology choices and other farmer practices; and socio-economic characteristics were analyzed to determine agricultural development pathways to attain income growth. Study results revealed that this growth was accompanied by environmental degradation (i.e. of water resources). Roles of local institutions and national policies in balancing economic and environmental trade-offs were discussed from a watershed management perspective.

### **OBJECTIVE 1**

To chronicle the responses of the study community in terms of land and labor use and sustainable farming practices to the structural changes brought about by decentralization and changing trade policies

### **Achievements**

Data analysis points to the following findings:

1. A significant structural transformation has occurred in this upland area during the past ten years. Traditional grains production is declining, while commercial crops production area are expanding. There is a definite movement towards non-farm income employment. New features of the economic landscape of the barangays (villages) are the newly estab-

lished service industry, such as the dress shops, the barber/beauty shops, the small eateries and even a furniture shop, which were not there when the project started in 1994. Public transport facilities are also easily available, whereas previously a motorcycle had to be hired to travel around the barangays of Lantapan.

2. Land use change appears due to relative prices, as commercial crops command higher prices than corn. Increasing market access is also a driver of land use change.

3. In the lower watershed (below 1000 masl), more corn farmers planted high yielding varieties in 2002 compared to 1994. Vegetable farmers in the upper watershed are using more pesticides than before. Organic fertilizers are popular because of increase in prices for inorganic fertilizer and of better technology transfer. Soil conservation measures are being practiced in the steep slopes. Inputs, such as seeds and chemicals, have become more accessible to farmers with the proliferation of farm input distributors in the barangays.

4. Most residents with high educational attainments obtained non-farm employment. Consistently with the national pattern, mean educational attainments of males are found to be lower than those of females. In the lower watershed, mean educational attainments of the native tribe members, the Talaandigs, and of migrants are almost similar; but in the upper watershed, migrants had higher educational

**Principal Investigator**  
Agnes Rola

**Co-Principal Investigator**  
Ian Coxhead

attainments. In the lower watershed, mean educational attainments of families with small farm sizes (less than or equal to 2 hectares) are lower than that of families with higher farm sizes. On the other hand, in the upper watershed, there is no distinct difference in the mean educational attainments of the two classes. Therefore, the probability to obtain non-farm employment seems to be higher for a lower watershed resident who is female and has a large farm size. In the upper watershed, a female migrant seems to have a higher probability to land a nonfarm job.

5. Population growth rate in this upland village has slowed down during the past thirty years. Population growth rate in the lower watershed during the past decade was higher than that in the upper watershed. Migration in the upper watershed has stopped due to two national laws (NIPAS and the IPRA) which are being rigidly implemented at the local level. Dependency ratio is higher in the upper watershed than in the lower watershed. It was declining in the lower watershed and remained steady in the upper watershed.

6. Data shows that households invest in timber production; given opportunities for non-farm employment of the population with higher educational levels, this shift to a less labor intensive land use may be beneficial in the long term.

7. These structural changes have brought about increased household incomes. In 2002, the highest quartile of our respondents had a mean annual income of P 113, 596 (in current prices), 33% of which was from crop income and 54% from the nonfarm work. In 1998, this income figure was only P52,630 (in current prices) with 46% of income share in crop agriculture and 53% in non farm work. Mean annual income of all families in our sample was P19,625 in 1998 and P42, 833 in 2002 (both in current prices).

## **OBJECTIVE 2**

To understand the impacts of these farmer decisions on the environment

### **Achievements**

Time series data analyses are now available for

understanding the impacts of farmer decisions on the environment. A recent paper (Rola, Coxhead, Deutsch, Sumbalan, 2002) reports of the relationship of land use to the water quality and quantity in the area. Results from our study were reported back to and validated by farmers during meeting held in June 2003. The meeting enabled us to learn more about factors driving farmers decisions and about their perceptions relative to the impacts of economic development on land and water resources. These interactions indicated that farmers are very concerned about soil erosion. In addition, key informants, including local government officials and employees of the National Irrigation Administration, point to the diversion of river water by plantations as the main cause for the decreased stream flow in the area and for the unavailability of water to rice fields in the dry season. Moreover the feedback obtained and our analysis of farmers' decisions points to the following: 1) Minimal or no clearing of forest margins is favorable to the environment. 2) Intensive agriculture in the cleared lands will bring in more soil erosion and negative environmental impacts of chemical agriculture; 3) Planting perennials will have a positive effect on the environment. 4) The effect on the environment of shifts in labor use from farm to non-farm activities is ambiguous (impact may be positive if farmers who remain in the household decide to plant perennials or leave the land fallow, but it may be negative if farmers rent out their farms); 5) Mechanized agriculture in sloping areas can accelerate soil erosion; 6) Inappropriate use of organic fertilizer can have negative environmental effects.

## **OBJECTIVE 3**

To investigate the role of local government in the pursuit of sustainable economic development.

### **Achievements**

(To crosslist with SEA 9 and SEA 11)

Following the training of 61 municipal and provincial planners in GIS use for policy and planning, the provincial government has pledged an amount of P 2.5 million for sustainable development activities starting in mid 2004 (and incumbent upon the victory of the current Governor). Local government units of the municipalities involved shared in the costs of the training.

## **Advances in Capacity Building**

We have trained 61 municipal and provincial planning and development officers in the use of GIS for planning purposes. The GIS training module was developed by Dr. Esteban Godilano.

A Manual for Training on Policy Analysis for Watershed Management was produced, as requested by the officials of the Department of Interior and Local Governments, who participated in our training. This manual will be used for training local government officials. We have trained potential trainers, including Dr. Antonio Sumbalan and Dr. Vel Suminguit, who can now conduct trainings for local groups in Bukidnon. We also provided a copy of the manual to the training coordinator of the Local Government Academy (LGA) in Manila.

## **Advances in Policy Impacts**

While the book has yet to be published, results of our work and that of the collective SANREM-SEA research team have already had a policy impact at the provincial level. This is demonstrated by the fact that for two consecutive years, the province of Bukidnon has won the Provincial category of the Clean and Green award. This award recognizes not only effectiveness in combating pollution but also proactive implementation of institutional mechanisms and policy interventions that promote sustainable development.

Our close alliance with the key advisor to the Governor facilitated adoption of our study results. We were able to convince the Governor to focus on policies that seek to address the trade-offs between economic growth and environmental sustainability, by investing in training planners in the towns and province for capacity building of modern planning tools. As a follow-up activity, the Governor has pledged P 2.5 million for activities that can be done by these trained staff. Other political allies at various levels are also expected to contribute to the funds to modernize planning efforts for sustainable development in Bukidnon.

## **Publications**

### **Book Chapters**

Rola, A. and H. Francisco. 2004. *Towards a Win-Win Water Management Approach in the*

*Philippines*. In Rola, A., H. Francisco and J. Liguton (eds.) *Winning the Water Wars: Watersheds, Water Policies, and Water Institutions*. Philippine Institute for Development Studies, Makati City, Philippines.

Rola, A., W. Deutsch, J. Orprecio and A. Sumbalan. 2004. *Water Resources Management in a Bukidnon Sub-Watershed: What Can Community Generated Data Offer?* In Rola, A., H. Francisco and J. Liguton (eds.) *Winning the Water Wars: Watersheds, Water Policies, and Water Institutions*. Philippine Institute for Development Studies, Makati City, Philippines.

Tabien, C., A. Rola, W. Carada and E. Devibar. 2003. *Linking Research and Local Governance in Environmental Management: The Experience in Lantapan, Bukidnon, Philippines*. In Serrano, R. and R. Aggangan (eds.) *Sustaining Upland Development in Southeast Asia (Issues, Tools, and Institutions for Local Natural Resource Management)*. Los Banos, Laguna, Philippines: PCARRD.

### **Books**

Rola, A., H. Francisco and J. Liguton (eds.). 2004. *Winning the Water Wars: Watersheds, Water Policies and Water Institutions*. Philippine Institute for Development Studies, Makati City, Philippines.

## **Other Major Outputs**

### **Conference Paper**

Rola, A. and I. Coxhead. 2003. *Economic Growth and Upland Resource Management in Southeast Asia: Challenges for Policy and Institutional Development*. Plenary paper presented at the 25th International Conference of Agricultural Economists. Durban, South Africa. August 16-22, 2003.

Rola, A. and I. Coxhead. 2004. *Development Policies, Institutions and the Environment in the Uplands of Southeast Asia*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

### **Tools**

Paunlagui, M. and A. Rola. 2004. *Policy Analysis*

*for Watershed Management. A Trainer's Manual.*  
Institute of Strategic Planning and Policy Studies.  
University of the Philippines Los Banos. College,  
Laguna, Philippines.

**Working Paper**

Rola, A., A. Sumbalan and V. Suminguit. 2004.  
*Realities of the Watershed Management Approach:  
The Manupali Watershed Experience.* ISPPS  
Working Paper 04-04. University of the Philippines  
at Los Banos, College, Laguna, Philippines.

**Non-Degree Training**

**Workshop**

*Policy Analysis on Watershed Management* was  
attended by 26 person(s) and lasted 2 day(s).

*Geospatial Information Systems in Local  
Governance* (1st batch) was attended by 33 per-  
son(s) and lasted 5 day(s).

*Geospatial Information Systems in Local  
Governance* (2nd batch) was attended by 28 per-  
son(s) and lasted 5 day(s).

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## **Policy and Governance 2: Enhancing Local Government's Role in Environmental Regulation**

### **ABSTRACT**

This workplan reviewed the implementation of one major environmental regulation in the Philippines, i.e., the Environmental Impact Statement (EIS) system. This dealt with the process of Environmental Impact Assessment (EIA) and the Environmental Clearance Certificate (ECC) required of projects or undertakings that have environmental implications. The workplan looked into the following aspects - policies and procedures, institutions, and coordination among stakeholders involved in the EIS system. It examined the role of local government units (LGUs) in the implementation of the EIS system and recommended measures to improve the ECC policy and governance at the local level. The research distilled some lessons and experience in the province of Bukidnon, the SANREM study site. To harness a locally-based and more meaningful participatory EIS system, a policy framework for administration and enforcement at the local level must be improved. This framework should address constraints such as inadequate understanding of the process, weak involvement by the local government and community, and lack of coordination among stakeholders. These problems are largely due to limited information and communication, which calls for improved strategies for awareness and capability building.

### **OBJECTIVE 1**

To examine the implementation of

EIA/ECC and the role of LGUs in the process

### **Achievements**

Addressing this objective entailed a review of documents on the Philippine EIA system, e.g. Documents reviewed included the Procedural Manual for the Department of Environment and Natural Resources (DENR) Administrative Order No. 96-37, which promotes streamlining the EIS system and public participation in the process. Other policy issuances reviewed are Administrative Order (AO) No. 42, issued by the Office of the President in 2002 to further streamline the EIA process and the DENR's AO No. 2003-30, which provides the implementing rules and guidelines for AO No. 42.

Comments and insights of people involved in the system were obtained through interviews of key informants. These included officials or representatives from national and regional agencies like Environmental Management Bureau (EMB) of DENR; from the provincial government of Bukidnon, municipal planning and development officers and other municipal officials, and barangay (village) officials. Representatives from NGOs, POs such as farmers' organization, and ECC holders were also interviewed.

### **OBJECTIVE 2**

To recommend measures to strengthen

**Principal Investigator**  
Dulce Elazegui

**Co-Principal Investigator**  
Victoria Espaldon

Antonio Sumbalan

the participation of LGUs in the issuance of ECC and in EIA

### **Achievements**

Based on the review of EIS policies, the role of LGUs in the EIS system was identified. Through interviews with key informants, enabling and limiting factors relative to participation of LGUs in the EIA process were determined. Before finalizing the report, findings and recommendations were locally validated by presenting them in a discussion forum with local government officials. The final report has been issued in two formats, as a working paper and as a policy brief. An orientation seminar on the EIS process was also conducted in response to the expressed need of local officials to improve awareness of the EIS system. Public involvement depends on the degree to which constituents are allowed to influence the decision making process. Information dissemination and coordination among stakeholders are essential conditions. There is a strong rationale for local-level efforts, since democratically elected local authorities are the most effective agents of change.

### **Advances in Research**

The workplan provides research-based findings on the opportunities (e.g., legal mandate) and challenges (e.g., improving capacity) relative to local participation in EIA implementation. Experiences and views of local stakeholders in Bukidnon served as inputs to the analysis. The workplan contributes a set of lessons learned on EIA policies and practices in the context of a developing country. Data gathered include information on policies pertaining to environmental protection at the national level and at the local (provincial) level; land use data, number of ECCs issued from 1991-2003 by municipality and by type of project in Bukidnon.

### **Advances in Capacity Building**

The workplan identified areas where potential for local participation in the EIA process is significant but needs to be fully realized. The provisions of policies on the role of LGUs were examined. This analysis identified the specific stages in the ECC process where the LGUs are involved, pointing to the interventions needed to enhance such involvement. A possible facilitating factor would be an

information, education, and communication (IEC) campaign starting at the barangay (village) level. Local authorities are closest to the people and can play a significant role in educating and mobilizing their constituents to become more sensitive to environmental concerns. IEC must start with efforts to increase awareness on the EIS policy and procedures at all levels. In view of these conclusions, this workplan conducted a discussion forum and orientation seminar on these topics.

### **Advances in Scaling Up**

EIA policy in the Philippines is national in scope but its procedural enactment is locally based. However, site-specific studies, examining the EIS process at the local level, are rarely conducted in the Philippines. Findings from this study will serve as guidelines to improve EIA implementation in other areas. Distribution of policy brief and working papers to disseminate the findings and recommendations will enhance key stakeholders' awareness of their role in the EIS process.

### **Advances in Policy Impacts**

By using the Bukidnon case, this workplan shows how the Philippine policy on EIA is implemented at the local level by integrating environmental and social considerations in the LGU's decisions relative to the regulation of industrial activities. Sharing the results of the study with local constituents provides them a better understanding and appreciation of the EIS policies. The results reinforced the need for policy changes, such as the creation of local environment and natural resource office, the implementation of local monitoring activities, and the provision of funding and support to enhance the capacity of LGUs to participate in the EIS process.

### **Advances in Environment and Natural Resource Management**

The workplan presents site-specific lessons learned and highlights local initiatives that can improve the EIA system, ultimately mitigating negative environmental and social impacts of economic development. The need for direct involvement by LGUs and for regular monitoring by local constituencies is emphasized.

## **Publications**

### **Book Chapters**

Elazegui, D. 2004. *Governance of Water Resources: Realities and Challenges in the Philippines*. In Rola, A., H. Francisco, and J. Liguton (eds.) *Winning the Water Wars: Watersheds, Water Policies and Water Institutions*. Philippine Institute for Development Studies. Makati City, Philippines.

Sumbalan, A. and D. Elazegui. 2004. *Policy Setting for Participatory Natural Resources Management*. In Espaldon, V. et al. (eds.) *Participatory Natural Resources Management Resource Book*. PCARRD, Los Baños, Laguna, Philippines.

## **Other Major Outputs**

### **Briefs**

Elazegui, D. 2004. *Institutions and Water – The Vital Connections*. PIDS Policy Notes, PIDS, Makati City, Philippines.

Elazegui, D., V. Espaldon and A. Sumbalan. 2004. *Local Participation in Environmental Regulation*. CPAF Policy Brief No. 04-01.

### **Conference Paper**

Elazegui, D. 2004. *Challenges of Sustainable Agricultural Development in a Southeast Asia Watershed Setting: The SANREM Experience*. Paper presented at the International Workshop Towards More Effective and Efficient International Collaborative Research for Sustainable East Asian Agriculture and Rural Development. February 18-21, 2004.

### **Working Paper**

Elazegui, D. and E. Combalicer. 2004. *Realities of the Watershed Management Approach: The Magat Watershed Experience*. ISPPS Working Paper No. 04-07. University of the Philippines Los Baños, College, Laguna, Philippines.

Elazegui, D., M. Espaldon and A. Sumbalan. 2004. *Enhancing the Role of Local Government Units in Environmental Regulation*. ISPPS Working Paper No. 04-06.

## **Non-Degree Training**

### **Workshop**

*Philippine EIA System* was attended by 40 person(s)

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## **Policy and Governance 3: Devolution and Social Capital for NRM**

### **ABSTRACT**

SANREM-SEA's work in the Philippines has provided valuable opportunity to examine the relationship between local governance and natural resource management in the context of decentralization as well to implement institutional strengthening activities and to enhance local government's capacity in the implementation of its devolved functions. This study sought to deepen our understanding of the relationship between devolution and social capital through an examination of the interactions between local government and social capital for NRM. Are they complementary, or can one substitute for the other? Using the data collected from the impact evaluation, and complementing them with secondary and primary data, we have aimed to provide a qualitative and quantitative analysis on how local government could promote or obstruct the construction of social capital for NRM at the community level.

### **OBJECTIVE 1**

To analyze the role of local government in the creation of social capital for ENRM at the community level.

### **Achievements**

A primary data set on assessment of NRM activities in 15 Bukidnon municipalities is being analyzed. This data set consists of (a) a survey of respondents in 15 Bukidnon municipalities, which elicits their perceptions and opinions of local government activities relating to the environment; (b) data on each municipality's

ethnic, economic, and geographic features that might serve as proxies for social and economic heterogeneity (two key determinants of social capital); and (c) municipal budget analyses for the last 5 years, identifying planned and actual expenditures on a range of environment and natural resources activities, such as "clean and green" initiatives, watershed protection. Some data collection activities were held up in Year 6 due to late release of funds. The final data set is now being assembled (May 2004).

The analysis strives to identify characteristics that predispose a municipality or community to implement NRM projects in a more or less effective manner. Initial results of quantitative analysis point to three characteristics -- percentage of indigenous people, ethnic diversity, and electricity coverage (as a proxy for wealth) -- as most important. A greater proportion of indigenous people, and generally ethnic homogeneity, in the municipality facilitates consensus building in the decision-making process relative to NRM projects. Higher level of income (indicated by greater electricity coverage) is also associated with better NRM. With completion of the data set we can now control for other features (such as heterogeneity in land types).

### **OBJECTIVE 2**

To offer policy recommendations on how local government could promote and sustain social capital for ENRM.

**Principal Investigator**  
Gladys Buenavista

**Co-Principal Investigator**  
Antonio Sumbalan

Victoria Espaldon

## **Achievements**

Formulation of recommendations awaits the completion of quantitative analysis. This will be conducted under non-SANREM funding through the second half of 2004.

## **Advances in Research**

The idea of social capital as a 'network of relations of trust and reciprocity' may be an important factor explaining why some jurisdictions are able to make and implement NRM policies, while others are not. Preliminary results are consistent with this hypothesis, though more research-- in particular, controlling for other sources of heterogeneity that might affect the decision-making process-- is required before any definitive statement can be made. We anticipate a more definitive set of results shortly.

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## Policy and Governance 4: Integrated Fiscal and Environmental Policy Using Spatial and Economic Data

Principal Investigator  
Ian Coxhead

### ABSTRACT

This activity combines research on land use by farm and plot with GIS-based data on propensity to contribute soil and pollutant runoff into streams to create a data base for use in the design of local land tax policy. Municipalities impose land taxes as mandated under the Local Government Code; tax rates vary by land zoning classifications. With additional information on potential environmental damages by location and land use, the existing tax schedules can be augmented to include premia (or discounts) for land use or soil conservation practices. This activity is motivated by examples of similar schemes in the United States, notably, though not exclusively, the widely-praised conservation land tax in Pepin Co., Wisconsin

### OBJECTIVE 1

Combine existing farm and spatial data to create a data base of land use by ecological zone.

### Achievements

Georeferencing of farm survey sites in the landscape was delayed until April 2004 due to late release of funds from USAID, and georeferencing was completed only in May 2004. We now have a database that links the location, slope and size of each plot in the sample to geographic information such as roads, rivers, slope of the landscape, population centers and so on.

This activity will now continue under other funding sources after the end of SANREM Phase II.

### OBJECTIVE 2

Use results with an existing model (the Manupali Model) to simulate the likely land use and environmental effects of alternative tax or subsidy rates. Calculate fiscal implications.

### Achievements

Integration with spatial model has not yet been completed. We have accumulated additional data on the nature of local taxation systems and options, especially for the real property tax, which varies according to land use and quality. There is no explicitly spatial component to this tax system, but it appears from our research that there is no legal impediment to the inclusion of spatial data in the setting of real property tax rates.

This activity will continue after formal project completion. See information under Objective 3.

### OBJECTIVE 3

Assess the relative merits of zone-based interventions designed to achieve target environmental outcomes subject to fiscal constraints.

### Achievements

Findings in reported in Coxhead and

Co-Principal Investigator  
Agnes Rola

Antonio Sumbalan

Gerald Shively

David Midmore

Demeke (2004) indicate that substantial changes in agricultural land use in uplands may result from policy changes at national level. Corn area planted in uplands, for example, could contract by as much as 6.5 percent (more than 200,000 ha nationally) under trade policy reforms designed to bring the Philippines in compliance with WTO rules on agricultural trade barriers. Wage rises associated with expansion of labor-intensive industries could have similarly large effects. These findings, if robust, create considerable 'space' for local initiatives in land use and management.

These findings help us to parameterize a model of land use responses to policy interventions. Since farmers are assumed to maximize net revenues from each operation (corn, vegetable, fallow), changes in land taxes that are specific to activities, rotations, or conservation methods are seen to be likely to be influential in determining land uses. This motivates a tax system analogous to that applied for a time in the U.S., under which farmer participants in federal income and price support schemes (e.g. for corn) were required in several states to submit erosion-minimizing land use plans, the benefits from the support scheme being contingent on compliance with these plans.

Coxhead and Demeke (2004) have shown that farmers in our Philippine study site are responsive to such market-based instruments.

#### **OBJECTIVE 4**

Disseminate research findings among Philippine policy and research community.

#### **Achievements**

Initial econometric and policy results presented at the SANREM-SEA Synthesis Conference held in Manila in January 2004. A working paper was completed by May 2004 and circulated among Philippines researchers for comment and feedback.

A revised and improved version of the analysis is circulating in working paper form in the Philippine agricultural policy community. A shorter version in non-technical language is under preparation for publication in the PIDS newsletter Development Research News, which has wide circulation within

the national policy community. A more formal version of the paper is to be presented as a Principal Paper at the annual meetings of the American Agricultural Economics Association in Denver CO, in August 2004.

#### **Advances in Research**

We have made substantial advances in the components of the analysis: quantification of land use response parameters, identification of tax policy instruments, validation of general approach with Philippine research and policy community.

Delivery of final research outputs hinges on processing the (delayed) spatial data, which is part of Bayou Demeke's Ph.D. dissertation. This work will be completed under other funding sources following the end of SANREM Phase II.

#### **Advances in Scaling Up**

As it is the case for other SANREM-SEA research, our findings are now circulating in the national level research and policy community. Our research indicates potential broader implications of findings established at the local level, e.g. on land use responses to crop price changes.

#### **Advances in Policy Impacts**

Limited advances so far, at local level; greater impact will come with the completion of the analytical tax policy model. This work is now advancing since we have obtained the required spatial data.

#### **Advances in Environment and Natural Resource Management**

Expected impacts include greater efficiency and equity in the design and implementation of local real property taxes. Expansion of these taxes to include environmental values, analogous to U.S. schemes linking environmental conservation to participation in federal price and income support programs. While this type of scheme may be still 'over the horizon' in developing-countries, we expect our work to indicate what might be feasible in those contexts.

#### **Major Outputs Conference Paper**

Coxhead, I. 2004. *Economic Incentives for Land Use Change: Evidence from Lantapan*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

Coxhead, I. and B. Demeke. 2004. *Panel Data Evidence on Upland Agricultural Land Use in the Philippines: Can Economic Policy Reforms Reduce Environmental Damage?* Paper presented at the American Agriculture Economics Association Meetings. Denver, CO. August 2-4, 2004.

**Working Paper**

Coxhead, I., and Demeke, B. 2004. *Soil Erosion in the Philippines: Do Government Policies Matter?* To be published in PIDS Development Research News, 2nd or 3rd quarter 2004.

**Degree Training**

Gregg Clark, M.S., 2001 - 2003

Brian Wiley, Ph.D., 2001 - 2006

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## **Policy and Governance 5: National Dissemination and Advocacy to Policy Makers and Legislators**

**Principal  
Investigator**  
Jennifer Liguton

**Co-Principal  
Investigator**  
Dulce Elazegui

Agnes Rola

### **ABSTRACT**

This is SANREM-SEA's primary channel for bringing research results to legislators and their advisors/staffs in the Philippines. These efforts are largely focused on issues relating to water resources management and policy. During Year 6, the project emphasized promotion and advocacy relative to the watershed approach in the direction of water resources planners and managers. These efforts build on studies on water resource management conducted during Years 4 and 5, which pointed to the need to address the country's water scarcity problems in the context of a watershed unit. To achieve its goal of promoting watershed-based approaches amongst national and local decisionmakers and legislators and of helping them understand how to implement such approach in water resources planning and management, the workplan team embarked on a number of dissemination and advocacy activities, including case studies which were then presented before audiences in various provinces in the country.

### **OBJECTIVE 1**

To raise the level of consciousness of the public on the importance of watersheds and their protection to ensure the quality and supply of water.

### **Achievements**

We have identified four case studies that will be analyzed to illustrate the operationalization of the watershed approach,

and especially the enabling and hindering conditions. The case studies focus on four watersheds, respectively those of the Magat, Pangil, Maasin, and Manupali rivers. We have developed a conceptual framework to be used for in the analysis of these case studies and completed research and analysis.

The papers have been finalized and highlights extracted for presentation during regional fora. We have packaged information kits that contain handouts about watersheds, including definitions, illustrations, and layman versions of the case studies. These kits will be distributed during the fora as well as disseminated to the media and other concerned parties. Materials contained in the kits are also being revised and repackaged as an Economic Issue of the Day release.

In collaboration with PCARRD and the Philippine Watershed Management Coalition (PWMC), a nationwide advocacy coalition, we have finalized arrangements for a series of regional fora to be held in May 2004 (Los Baños, Laguna on May 14, Iloilo City on May 24, and Davao City on May 26). Academics, government officials, NGOs, cooperatives, media representatives, and public and private sector operators involved in water resource management have been invited to these fora.

Press releases have been drafted and distributed, addressing issues such as

watershed management and water pricing policy. A special issue (March-April 2004) of the PIDS publication Development Research News (DRN), including selected papers presented at the SAN-REM Synthesis Conference in January 2004, has been prepared and is in press.

## **OBJECTIVE 2**

To push for the adoption of a watershed-based water management strategy.

### **Achievements**

A book containing the four papers originally presented in the August 2002 Water Policy Forum, as well as five additional papers written to complement and validate the findings, is almost completed and targeted for release in mid-2004. The book contains 9 chapters and an epilogue, and highlights recommendations that have been presented to policy/decisionmakers in both the executive and legislative branches of government.

Among the recommendations that emerged from the book was the need for case studies that exemplify the operationalization of watershed management approaches in different settings and identify potential constraints to its successful implementation. A good opportunity for outreach and advocacy was offered by the process of planning for the National Water Forum held in March 2004 and sponsored, among others, by the DENR, the National Water Resources Board, the National Economic and Development Authority (NEDA) and other relevant water-related agencies. By virtue of its collaboration with the Philippine Watershed Management Coalition, team members were able to participate in the preparatory committees tasked to draft position papers on water management. The papers served as basis to develop an agenda that was presented to the DENR secretary and to the President of the Philippines.

Foremost among the team's recommendations was the need to address water resource management in the context of integrated watershed management. The project team also concurred with other points raised during the planning meetings, including valuing water as an economic good, whose price must reflect its scarcity value, increasing national

and local cooperation, reviewing of water tariff structures and the existing institutional framework for the management and governance of water resources, establishing tradable water rights for competing water uses, and strengthening river basin/watershed organizations.

The team also presented the watershed approach before a joint session of the PIDS-Congressional Planning and Budget Department (CPBD) at the House of Representatives, which included various technical committees at the House (the Committee on Environment and Natural Resources, and technical staffs of the CPBD). Also present were key officials of the major players in water resource management, such as the DENR, National Water Resources Board, National Irrigation Administration, National Power Corporation, Department of Agriculture, the Forest Management Bureau and Environment Management Bureau of the DENR, Laguna Lake Development Authority, the Metropolitan Waterworks and Sewerage System (MWSS) and the Local Water Utilities Administration. Likewise in attendance were representatives from the private water distribution concessionaires for Metro Manila, the Maynilad and Manila Waters. The presentation and discussions proved to be timely since the Clean Water Act has just been signed and preparations for the drafting of the Implementing Rules and Regulations (IRR) for the Act are underway.

## **OBJECTIVE 3**

To continue to bring to the attention of concerned parties the existing institutional constraints that hinder the effective and efficient management of water resources.

### **Achievements**

This issue was raised and explored during the presentation at the House of Representatives mentioned under Objective 2. It was also discussed during the preparatory committee meetings for the National Water Forum, pointing to the need for an assessment of the existing institutional setup to improve management of water resources. A Policy Note on the link between institutional arrangement and water resource management was completed. Recommendations for reforms that local government officials may consider to ensure a sustainable

management of local water resources were also produced before and during regional fora.

#### **OBJECTIVE 4**

To endorse the formulation of an appropriate water pricing policy based on an optimum allocation of uses for water resources.

#### **Achievements**

See Objective 2.

#### **OBJECTIVE 5**

To advocate for reforms in certain provisions of the Local Government Code that would strengthen the role of local government units in environmental governance, including in the management of water resources.

#### **Achievements**

See Objectives 2 and 3.

#### **Advances in Research**

The four case studies detail the challenges and opportunities of operationalizing the watershed approach and identify factors that can either enable or hinder its implementation in similar settings.

#### **Advances in Scaling Up**

The four case studies were presented in various regional fora, i.e., Los Baños, Iloilo and Davao and were translated into popular versions (to be printed in the magazine of the nationwide PWMC and in a forthcoming issue of the PIDS' Development Research News). A book containing a set of studies on water resources management (both from the supply and demand aspects), with focus on the watershed-based approach, is due for release in the mid-2004. Its key recommendations have been put forward in various meetings and committee interactions and in press releases.

Documentation about the experience of the Water Watch group, Tigbantay Wahig, and other SANREM activities was submitted to the Department of Interior and Local Government (DILG) for possible inclusion in its synthesis of best practices of local and community experiences in water resource governance. The "best practices" documentation proj-

ect of the DILG will be part of a regular information dissemination program to all LGUs in the Philippines.

#### **Advances in Policy Impacts**

Our contribution to the discussion surrounding water governance and management issues and our insights concerning the operationalization of the watershed approach to water resources management are our most prominent accomplishments. The presentation at the House of Representatives and participation in the preparatory committees of the National Water Forum brought the recommendations that emerged from SANREM research to bear upon the country's water policy agenda in the country and upon a legislative bill's implementing rules and regulations for the Clean Water Act.

#### **Advances in Environment and Natural Resource Management**

This activity's recommendations in terms of the national water policy agenda and the IRR for the Clean Water Act are expected to generate greater commitment to and more focused operationalization of the watershed approach as well as a closer cooperation between local and national government agencies and grassroots groups in water governance.

#### **Major Outputs**

##### **Briefs**

PIDS. 2004. *Watershed Definition and Explanations*. PIDS Economic Issue of the Day. Philippine Institute for Development Studies (PIDS).

Rola, A. and G. Shively. 2004. *Selected Papers from SANREM Southeast Asia Research Synthesis Conference*. Development Research News, March-April 2004. Philippine Institute for Development Studies (PIDS).

##### **Conference Presentations - Other**

Contreras, A. 2004. *A Win-Win Water Management Approach in the Philippines*. Presentation at the Lower Legislature and Regional Fora. Philippine Institute for Development Studies (PIDS).

PIDS and PCARRD. 2004. *The Realities of the Watershed Management Approach in the Philippines*. Presentation at the Lower Legislature and Regional Fora. Philippine Institute for Development Studies (PIDS).

Philippine Institute for Development Studies (PIDS).

Rola, A. and A. Sumbalan. 2004. *Realities of the Watershed Management Approach: The Manupali Watershed Experience*. Philippine Institute for Development Studies (PIDS).

### **General Information**

PIDS. 2004. *Press Release: Study Proposes New Pricing Scheme for Water*. Philippine Institute for Development Studies (PIDS).

PIDS. 2004. *Press Release: DENR Urged to Set Clear Rules in Using Watershed Approach in Managing the Country's Water Resources*. Philippine Institute for Development Studies (PIDS).

PIDS. 2004. *Project Folio: Compilation of Previous Publications Related to the Water Resources Management Project*. Philippine Institute for Development Studies (PIDS).

PIDS. 2004. *Four Fliers on Local Watersheds*. Philippine Institute for Development Studies (PIDS).

### **Tools**

PIDS. 2004. *Printed Information Kit with a Watershed Photo that Shows 2 types of Watersheds: A Sustainable One and Degraded One*. Philippine Institute for Development Studies (PIDS).

### **Working Paper**

Contreras, A. 2004. *Community-led Watershed-based Water Resources Management: The Case of Balian, Pangil, Laguna*. Philippine Institute for Development Studies (PIDS).

Contreras, A., F. Herminia and A. Rola. 2004. *Framework of Analysis for Case Studies*. Philippine Institute for Development Studies (PIDS).

Francisco, H. 2004. *Synthesis of the Case Studies: Lessons Drawn*. Philippine Institute for Development Studies (PIDS).

Francisco, H. and J. Salas. 2004. *Realities of Watershed Management in the Philippines: The Case of the Iloilo-Maasin Watershed Management*.

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## From Project to People: SANREM SPADEwork (Synthesis, Packaging, Dissemination, Advocacy, Dissemination, Etc.)

**Principal Investigator**  
Victoria Espaldon

### ABSTRACT

The SANREM-SEA project has made significant progress in ensuring that research results are packaged and disseminated to appropriate audiences. However as more research outputs were delivered in Year 5, the project faced the challenge of developing an innovative strategy to reach a wider and more diverse set of information users, especially at the community, municipal and provincial levels. We conducted activities that a) led to the creation of an IEC strategy, b) strengthened capacities for environmental decision making among communities, governments and academic institutions and c) assessed the effectiveness of our IEC activities Project to people: SANREM SPADEwork (Synthesis, Packaging Dissemination, Advocacy, Dissemination, Etc.) Highlights of the workplan was the development of an IEC strategy that targeted various audiences. The strategies implemented included the launching of the School on Air (SOA) and graduating 33 farmer-participants. SOA ran from February 8-April 8, 2004. Farmers Technology Forum, calendars (exhibiting results of 9-year price and production pattern observation), and use of "warik-warik", a four wheel vehicle that goes around remote areas to sell fish and other basic goods, as a carrier of development and environmental messages, are some of the strategies used to disseminate the outputs of SANREM-SEA at the municipal and community levels. A series of

Geographic Information Systems (GIS) trainings for 61 municipal and provincial planners were conducted to enhance the capacity to plan and manage natural resources of planning and development officers of provincial and municipal government. Training modules for farmers and agriculturists and participatory natural resource management resource book for extension and academic institutions were also completed. The team also explored collaboration with projects and organizations such as the USAID-funded ECOGOVERNANCE. However, we were only able to conduct initial meetings with the management. Although ECOGOVERNANCE showed initial interest with PLLA, there was not enough time for it to materialize as they are also on their last year of implementation.

### OBJECTIVE 1

To develop and implement a coordinated IEC strategy designed to enhance the dissemination of SANREM results;

### Achievements

1. The SPADE work team prepared an integrated IEC strategy directed at enhancing media linkages, technology extension, development of curriculum materials and capacity building of local government professionals, teachers, agricultural extension workers and farmers.
2. The SCO and PCARRD organized and facilitated media coverage of SANREM activities in the site, and the distribution

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of IEC materials produced under this specific work-plan and other SANREM publications. The School on Air (SOA) was designed in a magazine program format and was launched last Feb 8, 2004. The one-hour program included recorded radio spots on sustainable agriculture and natural resource management. Topics included soil and water conservation, agroforestry systems, and integration of livestock, particularly goat raising in evolving agroforestry systems. Of the initial 56 participants, 33 completed the course (12 women and 11 men). The graduation ceremonies was conducted on May 18, 2004 at Songco Barangay Hall in Lantapan in time with the culminating activities for the SANREM 10-year program.

3. Technology extension was conducted through a Farmers Technology Forum by Central Mindanao University and NOMIARRC-RACO. Training modules for farmers were also developed by ICRAF.

4. The participatory Natural Resources Management Resource Book for teachers and extension workers was completed. In connection with this, a training course for teachers and extension workers was conducted in Nong Lam University In Vietnam, May 2004.

5. A series of training of provincial and municipal planners on GIS use for policy and planning was conducted by UPLB-ISPPS.

## **OBJECTIVE 2**

To disseminate SANREM community based action research/extension activities lessons and achievements to wider communities of farmers and resource users/managers;

### **Achievements**

1. An interagency IEC team was organized in October 2003. Composed of representatives from SANREM-SEA SCO, ICRAF, CMU and Lantapan LGU, the team reviewed available IEC materials, which included flip charts, training modules, leaflets and brochures. The team identified materials that can be improved or reproduced and designed appropriate and gender-sensitive resources.

2. In support to the joint SANREM-ICRAF-LGU environmental awareness campaign, key messages and slogans on agroforestry, soil and water conservation and environmental protection were formulated and pre-tested together with the SANREM-SEA Site Coordination Office. These were printed in streamers and mounted on the sides of pick up trucks used by mobile fish vendors in Lantapan who are participants in the “Fish Vendors on Wheels for the Environment” project, an innovative way of presenting environmental messages to remote communities that are hardly reached by the regular extension system.

3. The team sponsored a Farmers Technology Forum last January 27, 2004. The activity aimed to disseminate research results, to respond to farmers’ queries; and to facilitate interaction between farmers and researchers. With over a hundred participants (about half of which were farmers), the forum focused on meeting information needs that had been identified during the technology and information needs assessment (TINA) conducted in July 2003. These information priorities were: Integrated Pest Management (IPM), soil nutrient management, financing and marketing, agroforestry based farming system, soil erosion control system and animal management. Participants were farmers, development facilitators, barangay officials and agricultural technicians. Resource institutions that participated included ICRAF, DENR, DA, HPI, LGU, MKAVI, NOMIARRC, CMU and BIDANI, Northern Mindanao Producers Association (NORMINVEGGIES) and Quedancor (a government entity for credit/financial support.)

4. The SPADE team with SCO produced a calendar with price and production patterns for different crops in Lantapan. The calendar showcased the results of a 9 year study by Dr. Agnes Rola and her collaborators. About 300 copies of calendar were printed. The calendars were distributed to farmers, technicians, and facilitators who participated in the 2nd Lantapan Farmers’ Technology Forum on January 27, 2004, and to over 50 farmer-respondents in the recent farm surveys conducted by the GIS team.

5. The SOA was conducted in partnership with ICRAF, HPI and the LGU of Lantapan. It aimed to enhance the knowledge, attitude and practice of farmers in soil and water conservation and agro-forestry systems, and facilitate integration of animals, particularly goat raising in evolving agro-forestry systems. Recorded radio spots on sustainable agriculture and natural resource management are played during the SOA.

The Agricultural Technicians (AT) from the Municipal Agriculture Office of Lantapan monitored the SOA students as they collect from them the answer sheets for the weekly evaluation/quiz. The ATs, and 2 Landcare Volunteers from ICRAF helped SANREM-SEA staff in the listing, selection and enrolment of SOA students. Initially, 56 were enrolled in the program, but eventually 33 participants graduated.

The SOA ran for 8 weeks and broadcast schedule was every Saturday and Sunday at 5-6 pm. Assistant Development Communication Specialist Lulu Valdez hosted the program with one Subject Matter Specialist from World Agroforestry Centre (ICRAF) or Heifer Project International (HPI).

6. The use of "warik-warik" or the fish vendor on wheels disseminated development and environmental messages in remote areas of Lantapan. Pretesting of the messages for this activity among Lantapan farmers has been done through the help of ICRAF. Appropriate revisions were made based on pretest results. The Market Administrator of Lantapan facilitated our link with the mobile vendors. An example of a message: "Salamat mag-uumang higala sa kinaiyahan ka nag-amuma" (meaning: "Thanks to you our farmer friends for taking care of nature"). Messages were written in streamers and mounted to the "warik-warik" or fish vendors' trucks.

7. News releases were also prepared by the IEC Team to disseminate the activities under the SPADE project, thus, adding to public awareness on local initiatives. Two SANREM-SEA press releases made it through radio station DXDB and local newspaper, Central Mindanao Newswatch.

### **OBJECTIVE 3**

To produce research based materials for use by university level programs locally and in Vietnam;

#### **Achievements**

1. On April 18-22, 2004 in Tagaytay, Philippines, a writing workshop on participatory natural resources management was conducted. The primary objective of the workshop was to develop a draft of the Participatory Natural Resources Management Training Module and Resource Book. Nine SANREM scientists and researchers were invited to contribute to the book. The Resource Book consisted of 9 chapters: Chapter 1. The state of the environment; Chapter 2. Sustainable development and participatory natural resources management; Chapter 3. Participatory natural resources management and its process; Chapter 4. Participatory Landscape Lifescape Appraisal; Chapter 5. The use of geographic information system (GIS) in participatory natural resources management; Chapter 6. Community organizing and resource mobilization; Chapter 7. Participatory monitoring and evaluation tools; Chapter 8. Legal bases for participatory natural resources management; and Chapter 9. Communicating and upscaling experiences. The Resource Book is now complete and ready for printing. parts of the Resource Book were translated into Vietnamese and used as lecture materials for a training on participatory natural resource management in Vietnam.

2. On May 11-15, 2004, a training workshop on participatory natural resource management was conducted in Nong Lam University (NLU) in Vietnam. Thirty-four participants (9 women and 25 men) from the Faculty of Economics of NLU, extension workers of the National Center for Extension, agricultural extensionists, and local government officers attended the course. Course topics included: 1) State of the Global Environment: Focus on Southeast Asia; 2) Sustainable Development: The Philippine Strategy; 3) Global Threats to Environmental Sustainability ; 4) Vietnam State of the Environment; 5) Vietnam Legal Framework for the Environment; 6) Participatory Natural Resources Management with cases highlighting the Bukidnon experience; 7) Participatory Landscape-Lifescape Appraisal (PLLA) (with a presentation of

Vietnam PLLA results), 8) Participatory Monitoring and Evaluation, and 9) Communication Skills in Natural Resource Management. SANREM-SEA researchers (Espaldon and Magsino) and faculty from the Faculty of Economics of Nong Lam University served as resource persons. Dr. Buic Tuyen, Rector of Nong Lam University also participated and served as a lecturer.

#### **OBJECTIVE 4**

To strengthen GIS capacity of the Province of Bukidnon

#### **Achievements**

UPLB-ISPPS conducted the training of 61 municipal and provincial planners in GIS use for policy and planning. Following this training, the provincial government has pledged an amount of P2.5 million for sustainable development activities starting in mid 2004. Local government units of the municipalities involved shared the costs in the training (see also in SEA\_9 and SEA\_6). The GIS module was developed by Dr. Steve Godilano.

#### **OBJECTIVE 5**

To assess the effectiveness of the IEC using an agreed upon set of indicators and instrument

#### **Achievements**

The team developed a pre-and post Knowledge, Attitude and Practice(KAP)evaluation instrument to determine the effectiveness of the IEC strategy. For the School on Air, the assessment was completed with 33 participants completing the course. Pre-KAP evaluation was completed and is being written up. The post-KAP evaluation has not been conducted due to budgetary constraints.

#### **Advances in Research**

No research was done except for archiving and examining existing documentation of NRM practices in the Philippines and in selected areas in Vietnam. These were used as examples in the training modules and the Resource Book on participatory natural resource management.

## **Publications**

### **Books**

Espaldon, V. (ed.). 2004. *Participatory Natural Resource Management Resource Book*. SANREM CRSP SEA. PCARRD, Los Baños, Laguna, Philippines.

Espaldon, V., D. Ha, P. Phuoc, N. Thuy, L. Du, L. Thong, P. Hung and A. Magsino. 2004. *Challenges on Sustainable Agriculture and Natural Resources in Vietnam Uplands: A Case Study*. SEAMEO-SEARCA, SANREM, PCARRD and USAID. College, Laguna, Philippines.

### **Other Major Outputs**

#### **Briefs**

Cai, H. 2003. *Participatory Agricultural and Forestry Extension Approach: An Alternative Approach to Address Needs of Sustainable Agriculture and Natural Resources Management in the Uplands of Vietnam*. SANREM CRSP SEA and Nong Lam University, Vietnam. PCARRD, Los Baños, Laguna, Philippines.

Du, L. D. Ha, P. Phuoc, L. Thong and M. Espaldon. 2003. *Soil Erosion: Causes or Consequences?* SANREM CRSP SEA and Nong Lam University, Vietnam. No.2., PCARRD, Los Baños, Laguna, Philippines.

Giang, P. 2003. *Can Forestland Allocation Policy Succeed Without the Participation of Local People?* SANREM CRSP SEA and Nong Lam University, Vietnam. No.4., PCARRD, Los Baños, Laguna, Philippines.

Ha, D. and V. Espaldon. 2003. *Sustaining Rural Livelihoods and Environment: The Need to Assist Resource Poor Farmers in the Upland Cope with Changes in Market Prices*. SANREM CRSP SEA and Nong Lam University, Vietnam. No.3., PCARRD, Los Baños, Laguna.

Nhat, T. 2003. *Women and Rural Development*. SANREM CRSP SEA and Nong Lam University, Vietnam. No.5., PCARRD, Los Baños, Laguna, Philippines.

Ut, T. 2003. *Speed Up or Go Slow Policy: Water Intervention In Bac Lieu Province, Mekong Delta*. SANREM CRSP SEA and Nong Lam University, Vietnam. No.6., PCARRD, Los Baños, Laguna, Philippines.

#### **Conference Paper**

Espaldon, V. and L. Florece. 2003. *Impact of Globalization on the Environment and Local Institutions in the Philippines*. Paper presented at the Open Science Meeting on Human Dimensions of Environmental Change. Montreal, Canada. October 2003.

Magdato, Jr., F. 2004. *Capability Building for NRM: The Participatory Landscape Lifescape Appraisal (PLLA) Training on the Communities in Bukidnon*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

Rebancos, C., V. Espaldon, and A. Custodio. 2004. *Impact Assessment of SANREM's Training Program on Participatory Landscape-Lifescape Appraisal (PLLA) for Community Based Resource Management in the Municipalities of Lantapan and Valencia, Bukidnon*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

Suminguit, V. and D. Tabbada. 2004. *Technology Information Needs Assessment Among the Farmers of Lantapan Bukidnon*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

Tabbada, D., V. Suminguit and L. Valdez. 2004. *Information, Education and Communication Strategy for SANREM Southeast Asia*. Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

#### **General Information**

Espaldon, V., D. Ha, P. Custodio, S. Veluz and A. Magsino. 2004. *Challenges for Sustainable Agriculture and Natural Resources Management in Vietnam Uplands: A Case study*. PCCARD, SANREM, USAID. A Video Documentation. 20 mins.

#### **Proceedings**

Espaldon, V., D. Ha and L. Thong. 2003. *Globalization and Transition from Subsistence to High Input Agriculture in Southeast Asia: Selected Communities in the Philippines and Vietnam. Proceedings of the International Conference on Local Land Use Strategies in a Globalizing World*. Institute of Geography, University of Copenhagen, Denmark. August 2003.

#### **Tools**

Godilano, E. 2004. Training Module on GIS for Use in Policy and Planning. SANREM, PCARRD and USAID.

#### **Non-Degree Training**

##### **On the job training**

*School on Air* was attended by 33 person(s) and lasted 56 day(s).

*Participatory Natural Resources Management* was attended by 34 person(s) and lasted 5 day(s).

##### **Workshop**

*GIS* was attended by 61 person(s) and lasted 10 day(s).

*Visual Graphics* was attended by 1 person(s) and lasted 5 day(s).

# SANREM CRSP

Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
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## Environmental Studies 1: Economics and Environmental Effects of Intensive Livestock Operations in Lantapan

Principal  
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Co-Principal  
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Rodd Dyer

### ABSTRACT

A short-term study was conducted to address environmental issues relating to livestock intensification in the province of Bukidnon, The Philippines. Provincial and municipal policy makers and planners required information regarding livestock impacts on water quality, benefits and costs associated with livestock intensification and, the effectiveness of environmental policy instruments and land use guidelines to achieve sustainable growth in livestock production. During Year 6, this workplan has achieved the following results: 1) Development of a model framework to evaluate the potential environmental impacts of intensive livestock operations on stream water quality in Lantapan. A best sub-set multiple regression model incorporated land use area data, livestock, poultry and human population density variables and, stream water quality results to identify contributing causes of nutrient loss, faecal contamination and other water quality parameters at a sub-watershed scale; 2) Development of the spatial application of a crop-livestock nutrient balance model (NuFlux) to quantify barangay level nutrient supplies and demands, and evaluate economic and environmental costs and benefits relating to the utilisation of livestock manure under current and future intensification scenarios; 3) Development of an optimisation modelling framework and a mathematical programming model that, once adapted, can enable evaluation of envi-

ronmental policy instruments and waste management options. Key areas relating to policy impacts include exploring changes in spatial distribution of livestock development between urban and rural areas, relative responses of small-holder and commercial enterprises and ability to simulate changes in environmental water quality resulting from changes in the livestock sector.

### OBJECTIVE 1

Within four Manupali sub-watersheds: Quantify the relationship between livestock type, density, system and management and (a) stream quality and (b) farm nutrient balance

### Achievements

Livestock and human sources can both potentially contribute to faecal contamination and nutrient pollution of streams, while agricultural land-use in upland areas causes erosion and nutrient loss to water bodies. A simple best sub-set multiple regression model has been developed to incorporate land use area data with livestock, poultry and human population density variables to identify contributing causes of nutrient loss, faecal contamination and other water quality parameters at the sub-watershed scale. This model has required the novel integration of agricultural, livestock and population census data, remotely sensed land use classification layers, and stream water quality results at a sub-watershed scale, and has

relied heavily on spatial data utilisation and analysis within a GIS framework.

To facilitate the calibration of the watershed model, stream water sampling was undertaken from twenty two sites within the Maгнаo, Alanib and Kulasihan sub-watersheds during high (October 2003), and low (April 2004) stream flow periods. Final stream sampling are being completed by May 2004 (mid-stream flow), therefore only preliminary observations are presented. Laboratory analysis was completed for twenty-eight chemical, nutrient, physical and bacteriological water quality parameters. Results to date suggest Total Suspended Solid (TSS) levels were strongly correlated with Al, Cr, Cu, Fe, Mn, Zn and total P concentrations ( $p > 0.75$ ). Parameters such as biological oxygen demand (BOD) faecal coliform (E.coli) levels and ammonia (NH<sub>4</sub>-N), often associated with livestock, and-or human sourced faecal contamination, showed no correlation to suspended solids levels in streams.

Although a detailed temporal picture of stream chemical concentration and load changes is not possible from the data, very large variations in stream flow, nutrient concentrations and nutrients loads between high and low flow sampling periods was observed in some watersheds. While relationships between livestock and human population densities and water quality across sampled watersheds are to be completed, some preliminary observations confirmed results noted by Deutsch et al (2001) relating to significantly poorer water quality in the Kulasihan watershed in the lower Manupali. In 2003-04, downstream sites throughout the Kulasihan system showed significant increases in TSS and other strongly positively correlated chemical parameters during the high flow sampling period compared to the Alanib and Maгнаo sub-watersheds. Stream E.coli levels were also considerably higher, and increased greatly during the high flow sampling period for downstream Kulasihan sites, compared to other sub-watersheds. Considerable variability in seasonal and spatial faecal coliform responses was observed. On both sampling occasions, faecal coliform levels in Kulasihan sites frequently exceeded 5000 CFU/100ml, which greatly exceeds the DENR classification of Class C water (> 5000 Total coliforms). BOD levels showed little

variation between sites and seasons and remained less than 5 mg BOD/litre, well within minimum standards set by DENR.

A range of activities were undertaken to develop spatial data layers of land use and livestock and human population densities within sub-watershed boundaries. Household level Census of Agriculture (CAG) data for 1991 and 2002 (preliminary data) was recently received from the National Statistics Office (NSO) for the municipality of Lantapan. Data for over 8,200 households were configured within a relational database and data summaries and aggregation to barangay level undertaken. Data summaries were linked to barangay boundary map data provided by NSO, for display and further spatial analysis in ArcView GIS.

The spatial location of all twenty-two stream sampling sites was recorded in the field using a GPS. Upstream watershed boundaries for all sampling sites were generated from a Digital Elevation Model (DEM) for Lantapan using ArcView GIS tools. Location and areas of broad land use activities within sub-watersheds for each sampling site were estimated by intersecting watershed boundaries with land-use classification overlays generated from remotely sensed LANDSAT imagery captured in 2002. A spreadsheet model was developed to spatially re-distribute census data (livestock and human population densities) according to the relative classification human population densities along road buffers in urban and rural areas. The purpose was to produce a more realistic spatial representation of human and livestock population density.

Upon completion of the model calibration process, historical water quality data collected by Tigbantay Wahig and Heifer Project International along with 1991 agricultural census data will be used to test and validate the model. If the model is found to be useful it will be used to explore the impact of various land uses, livestock and human population density scenarios on stream water quality and watershed nutrient loss.

## **OBJECTIVE 2**

Undertake partial estimation of economic and environmental costs and benefits of livestock systems

## Achievements

Throughout Lantapan, livestock provide important socio-economic functions to smallholder households relative to animal traction for cultivation and transport, income generation opportunities, provision of capital reserves and a desirable protein-rich source of food. Livestock are also important in cultural and festive celebrations and have other non-cash uses such as providing organic manure for crop fertilization and enabling utilisation of low value crop residues. For the few, but increasing larger-scale commercial enterprises, dominated mainly by poultry and hog raising, capital intensive production is focused on profit maximisation, incorporation of improved breeds, concentrate feeds and advanced nutritional and veterinary support. Benefits of horizontal and-or vertical integration such as contractual arrangements with large corporations are often a feature.

The main focus of this objective remains the production and utilisation of livestock waste at a regional (barangay) level. The spatial application of a crop-livestock nutrient balance model (NuFlux) was adopted to evaluate the economic and environmental costs and benefits relating to the utilisation of livestock manure. Census of Agriculture (CAG) data for 1991 and 2002 recently received from the National Statistics Office (NSO) were used to provide a detailed summary of livestock and poultry populations and ownership throughout Lantapan at the barangay level. Total nutrient production was calculated using published N and P excretion rates for each livestock species. Parameterisation of post-excretion nutrient flows was based on published data combined with assumptions regarding manure management and utilisation practices based on observations, informal interviews and household census and survey data.

Quantification of crop nutrient demand was undertaken at the barangay level. Data obtained from 2002 CAG enabled calculation of crop area within each barangay, while statistics from the local Department of Agriculture and from socio-economic household surveys provided data on expected crop yields, fertilizer use and N and P application rates from which total crop nutrient requirements were calculated. Farmers' willingness and tendency

to use organic fertilizer for a range of crop species was determined from 1991 and 2002 CAG data.

From a total of 8,279 agricultural operators enumerated in Lantapan during the 2002 CAG, 78 percent raised livestock, while 98 percent undertook agricultural cropping activities and 91 percent owned or used some form of farm equipment. Between 1991 and 2002 horse, hog and cattle populations increased by 42 percent, 26 percent and 21 percent respectively, while goat numbers declined by 2 percent, however livestock production was dominated by smallholder operations. As a proportion of households owning each species, only 6 percent, 17 percent, 19 percent and 35 percent of households raised more than two head of horses, hogs, cattle, or goats respectively. Less than 2 percent of hog raisers, (only 43 operators) raise more than ten hogs. Increasing scale and intensification of poultry enterprises has been the most significant feature in Lantapan in recent years. Although most poultry are held by smallholders, numbers have increased by 213 percent from 64,081 to 200,346, with 6 operators raising more than 1,000 birds in 2002.

Although the number of livestock raised by each household is very small, a range of land use policy and development scenarios remain to be tested. If manure nutrients from both small-holder and larger-scale commercial livestock operations can be economically and willingly captured, collected, transported and-or applied as organic fertilizer to meet local crop nutrient demands at the regional or watershed scale, then significant net benefits may arise from intensification and transfer of nutrient between livestock and crop sectors. In contrast manure supply may exceed local demands for crop nutrients if local policies allow intensification of livestock in close proximity to increasingly populated "urban" areas, or if livestock waste management and manure utilisation is uneconomical, unacceptable or ignored. In these cases serious pollution of stream water resources may result in wider, but difficult to estimate, socio-economic and environmental costs.

Where supplies of livestock manure are able to meet local demand for crop nutrients, economic and environmental benefits arise from substitution of

chemical fertilizer with organic fertilizer. Upon completion of barangay level nutrient balance calculations the change-in-cost or replacement-cost method will be used to estimate the economic benefit from organic fertilizer substitution of chemical fertilizers. The quantification of economic costs resulting from localised nutrient surplus and water pollution is more complex, as there are few obvious market impacts that can be readily valued, requiring the use of an environmental risk and potential socio-economic impact index derived from nutrient balance values.

### **OBJECTIVE 3**

Evaluate management and policy options that could optimize economic, environmental and social objectives within given constraints.

#### **Achievements**

Experience from other municipalities shows that unless municipal councils develop and, more importantly, enforce a range of strategic environmental policies and guidelines controlling the establishment, location and operation of both small-holder and large-scale commercial livestock enterprises then environmental degradation will result. Analysis of agricultural and population census data revealed that livestock population totals were significantly correlated to human population totals at the barangay level. The close link between livestock ownership and human settlement implies that, as human populations increase (particularly in urban areas), higher livestock populations also tend to occur, causing problems with livestock waste management, pollution of water bodies and conflict with non-livestock owner households. At the same time, rapid and uncontrolled growth of large-scale commercial livestock enterprises can also produce serious point sources of pollution, either in rural or peri-urban areas within the serious adoptions of adequate environmental policies.

A range of environmental policy instruments exists, however their impact at the farm and barangay level is unclear. Furthermore, to be most effective, environmental policies should attempt to consider overlying watershed frameworks rather than be restricted solely to barangay or municipal boundaries.

Analysis of environmental policy on livestock intensification and environmental pollution for Lantapan remains to be completed. A mathematical programming optimisation model developed for smallholder and commercial hog enterprises has been developed for Laguna province using Generalised Algebraic Modeling System (GAMS) and was adapted for use in Lantapan. Once complete, the evaluation of environmental instruments, such as livestock zoning regulations, livestock head taxes, incentives for adoption of approved waste management practices, pollution fees and effluent standards was undertaken. Waste management options ranging from zero waste management to collection of manure for use as organic fertilizer can be applied. The model framework was based on a farm-level model aggregated to a regional level. The impact of these policies can be applied, to small-holder and-or commercial livestock operations and be used to determine possible livestock development outcomes between rural and "urban" (more densely settled) areas. Current and project livestock growth scenarios can be explored.

Production constraints at the farm level include availability of household labour, land area, capital and livestock productivity. Prices are exogenously determined. Although not yet functional, one possibility was to adapt the model to run at the watershed scale and include empirical relationships between livestock and water quality developed from Objective 1.

It was anticipated that only hog and poultry livestock enterprises will be examined, although agricultural production parameters for small-holder farms will be included and obtained from an analysis of various economic policy options on cropping enterprises at the watershed scale from Shively (unpublished report, 2002)

#### **Advances in Research**

Upon completion the project will have: 1) Developed a model framework to evaluate the potential environmental impacts of intensive livestock operations on stream water quality in Lantapan. A best sub-set multiple regression model incorporated land use area data, livestock, poultry and human population density variables and, stream

water quality results to identify contributing causes of nutrient loss, faecal contamination and other water quality parameters at a sub-watershed scale. 2) Developed the spatial application of a crop-livestock nutrient balance model (NuFlux) to quantify barangay level nutrient supplies and demands, and evaluate economic and environmental costs and benefits relating to the utilisation of livestock manure under current and future intensification scenarios. 3) Developed an optimisation modelling framework and a mathematical programming model that once adapted enables evaluation of environmental policy instruments and waste management options.

### **Advances in Capacity Building**

Members of the local community based Water-Watch group, Tigbantay Wahig, staff from MKAVI commercial banana plantation and the non-government organisation Heifer Project International were involved in project planning, training activities and collection of stream samples. Water quality results were shared and discussed with all participants. This increased communication between parties and contributed to awareness of livestock-environment issues. Interaction also enabled the further development of stream monitoring and in-field analytical skills by these local agencies.

### **Advances in Scaling Up**

The integration of spatial data with census data to develop livestock-stream quality models and livestock production optimisation models that operate at the watershed, barangay or municipal scales enables presentation of results at scales familiar and useful to municipal policy makers. The provision of results in map-based formats, combined with the possibility for scenario testing to be undertaken at a barangay-municipal level provide hope that scaling up will occur. The experimental approach and framework could also be applied to other municipal areas where similar agricultural and spatial data sets exist.

### **Advances in Policy Impacts**

The project outputs have been designed to meet the demands of provincial and municipal planners in relation to trends in livestock development. Although policy scenarios have yet to be tested and

reported, the interest from provincial and municipal governments regarding the potential environmental impacts resulting from livestock operations and the desire to identify effective environmental policy instruments to ensure sustainable livestock intensification provides evidence that the project outcomes, tools and-or framework will be used to assist land use policy decision making.

### **Advances in Environment and Natural Resource Management**

The project potentially will influence livestock development policy and environmental policy instruments throughout Lantapan. Adoption and implementation of effective environmental policy ideas could effectively manipulate the spatial distribution of livestock operations and intensification and the adoption of livestock waste management practices resulting in: 1) socio-economic and environmental benefits relating to the improvement and-or maintenance of stream water quality; 2) socio-economic benefits of preserving or improving living conditions surrounding livestock enterprises and; 3) economic and environmental benefits from effective utilization of manure waste from all livestock species for use as organic fertilizer.

# SANREM CRSP

Sustainable Agriculture and Natural Resource Management  
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## Environmental Studies 2: Industrial Crops and Land Use in the Uplands of Vietnam

Principal Investigator  
Gerald Shively

Co-Principal Investigator  
Dang Thanh Ha

### ABSTRACT

This study focused on economic and environmental aspects of two industrial export crops being produced in upland areas of Vietnam: coffee and cacao. In the case of coffee, the main undertaking was to use farm survey data to seek a better understanding of how smallholder farmers responded to a collapse in coffee prices. In the case of cacao, which has yet to be produced on a large scale in Vietnam, ex ante analysis was used to assess some of the likely economic and environmental impacts of cacao production.

Highlands. The survey data were compiled, cleaned, and analyzed, resulting in a research paper (Shively and Ha 2003). Data include information on land use patterns, the feasibility of cacao and other crops, household perceptions regarding various crops, and the likely changes in land use that might accompany the promotion of industrial crops.

### OBJECTIVE 1

To examine the comparative advantage of cacao and other competing cash crops in the Central Highlands.

### Achievements

Production data were compiled for various food and industrial crops, including coffee and cacao. Farm survey data were also collected in January 2004. These have been used to assess the economic potential of a range of crops.

### OBJECTIVE 2

To investigate the potential land use changes associated with cacao expansion.

### Achievements

In January 2004 farm surveys were administered to a sample of 209 households in four villages of the Central

### OBJECTIVE 3

To examine the impacts on household incomes and food security and impacts on the environment that will likely result from future cacao expansion in Vietnam.

### Achievements

Although an effort was made to examine outcomes related to cacao production, few farmer experiences have been registered, in large part due to a delayed roll-out of anticipated government cocoa promotion efforts. Instead, experiment farm data have been used to construct a research case study for cocoa.

### OBJECTIVE 4

To examine policies and institutional setting needed to ensure sustainable cacao production in Vietnam.

### Achievements

Policies and measures implemented by government units to support cacao production in Vietnam have been studied.

### **Advances in Research**

We examined the recent boom and bust in Vietnam's coffee economy. We analysed survey data collected on smallholder coffee farms in the Central Highlands in 1999 and 2004 and used these data to examine smallholders' responses to a collapse in coffee prices. We estimated a multinomial logit model to measure the factors associated with four specific patterns observed among smallholders: no response, changes in input use, changes in land use, and liquidity responses. We conclude that patterns of response were not uniform across smallholders and that, in particular, the actions undertaken on the smallest farms differed markedly from those undertaken on the largest farms.

### **Advances in Capacity Building**

Working in cooperation with an ALO project we have improved skills among a 12 person multidisciplinary team at Nong Lam University in the area of case study design.

### **Advances in Scaling Up**

In February 2004 we participated in a roundtable discussion with government and private industry in Vietnam regarding cocoa promotion efforts. This meeting focused on the "Success Alliance Project" a project designed to promote cocoa in Vietnam among 18,000 farmers over 3 years. The project is being undertaken with funding and cooperation from USDA, USAID, Materfood, and the Vietnam Ministry of Agriculture and Rural Development. This is a high-profile industrial crop promotion effort and it is likely that we will continue to participate in research and development activities related to this effort beyond the end of SANREM Phase II.

### **Advances in Policy Impacts**

We have been able to identify some of the environmental consequences of industrial crop activity and to examine some tradeoffs between income growth and natural resource depletion or environmental damage, especially in the area of water use. The experience of coffee production in Vietnam has provided lessons that can be used in examining current efforts to promote cacao.

### **Advances in Environment and Natural Resource Management**

We have enhanced understanding among those in the research and policy community regarding efforts and policies necessary to balance the goals of improved livelihood (through agricultural development strategies) and natural resource management.

### **Major Outputs**

#### **Conference Paper**

Shively, G. 2004. *Promoting Sustainable Upland Farming: What Does Economics Tell Us?* Paper presented at Conference on Land Use Changes in Tropical Watersheds. SANREM South East Asia Research Synthesis Conference. Manila, Philippines. January 13 - 14, 2004.

#### **Working Paper**

Shively, G and D. Ha. 2003. *Economic and Environmental Impacts of Cocoa Production in the Central Highland Region of Vietnam: A Research Note*. Purdue University and Nong Lam University.

Shively, G and D. Ha. 2004. *Coffee Boom, Coffee Bust, and Smallholder Response in Vietnam's Central Highlands*. Purdue University and Nong Lam University.

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
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**May 2004  
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SEA-14**

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## **Environmental Studies 3: Environmental and NR Consequences of the WTO in Vietnam**

**Principal  
Investigator**  
Ian Coxhead

### **ABSTRACT**

What are the implications of current and anticipated trade policy reforms, including accession to international treaties, for domestic environmental and economic development targets and programs? We know that these types of changes have large effects on resource allocation, and thus in environment. Understanding the likely effects of large future changes will help Vietnam's planners to address with NRM and environmental challenges and potential problems before their occurrence. This research sets the stage for a larger, longer-term project addressing these questions

future changes due to trade policy reform and the growth of bilateral trade.

A comprehensive literature review entitled "Vietnam: integrated assessment of globalization, resources and agriculture" was conducted, with entries being classified by type. Results can be viewed at <http://www.aae.wisc.edu/coxhead/projects/vietnam>. Data sources were obtained during field visits to Hanoi in October 2003.

**Co-Principal  
Investigator**  
Bui Dung The

Dr The (Hue University) worked with the PI during a visit to Madison in March 2004, and on a reciprocal visit to Hue in April 2004. We undertook field visits and assembled a team of researchers from the Faculty of Economics at Hue University. A proposal requesting funding to support capacity building at Hue University has been presented to the Ford Foundation.

Ian Coxhead (PI) obtained a two-year grant (2004-06) from UW-Madison to further develop this research.

### **OBJECTIVE 1**

Link data on upland forest conversion and land use to prices in national and world markets. Use data on industrial investment and trade to estimate non-agricultural job growth related to international markets. Use models to predict the labor market, land use and environmental effects of future changes.

### **Advances in Research**

We have acquired three 5-year rounds of the Vietnam Living Standards Survey (VLSS), which will enable analyses of incomes, resource use, etc., at the household and commune level. We have identified a case study region (Central Vietnam, and especially Thua Thien Hue) and a team of researchers at Hue University to carry on the study. The region has a high poverty incidence of about 44 percent and shows a slower pace than the national

### **Achievements**

Earlier work on the same theme in the Philippines (Coxhead, Rola and Kim 2001; Rola and Coxhead 2003) used econometric estimates of land use responses to national prices and policies, and to macroeconomic instability arising from the regional financial crisis. Our approach in Vietnam builds on this analysis, making use of aggregate land use data, past price trends and predictions of

level in participating in the growth process. About two third of household income in rural areas of the North Central region is derived from agriculture and other resource-based activities. It is legitimate to claim that the persistence of poverty is due to poor resource endowment, difficult physical environment and poor infrastructure, markets and service delivery in the region. These factors appear to prevent the region from taking advantage of the benefits of economic openness and growth.

A growing concern over growth, income distribution and uneven poverty alleviation are closely linked with environmental issues. These raise a need for in depth research to better understand the links between trade liberalization, growth and environmental resources for more sustainable development of the region, that is desperately absent in the Vietnam context.

Another emerging concern is that the changes that the Ho Chi Minh Highway, which crosses the Truong Son range of the Central region, will bring to the region. For most people, the Highway is expected to bring about more opportunities for economic growth in the uplands, especially the Central region. But others fear that the region will bear a disproportionate share of the costs, including environmental damage and resource degradation. Since most forests and other environmental resources remain largely unregulated, they are vulnerable to overexploitation. Our research and field trips to the locality, have identified this mountainous region as a key area in which the tradeoff between economic growth and the environment will be played out.

Local data collection from secondary sources such as district and provincial government is now under way.

In a related study, empirical research was conducted on the likely effects of WTO accession on the rural Vietnamese economy. Using commune level data from the VLSS we established that expansion of export crops (coffee, tea, rubber, etc.) can be expected to diminish rural inequality, while expansion of industrial employment, especially labor-intensive manufacturing (another sector which will expand after WTO accession) will increase

inequality only if it raises returns to highly skilled labor faster than it does the wages of other labor categories. These results can now be linked to distributional issues over the access to and control over natural resources, another important source of inequality.

### **Advances in Capacity Building**

Dr. The visited UW-Madison in March 2004, and Dr. Coxhead held meetings with faculty and led a seminar (in addition to conducting field trips) at Hue University in April 2004. These exchanges and discussions laid a firm foundation for collaborative work. Capacity building gains on the US side consist of exposing UW researchers to learning about Vietnam and the Vietnamese research system. On the Vietnam side, collaborators are acquiring new analytical tools. Dr. Coxhead's visit to Hue, including presentation of a seminar, exposed VN researchers to new methodologies for economic and environmental analysis and stimulated a search for ways to acquire additional training for faculty and students alike. At UW-Madison, Ms Diep Phan (2nd year PhD student) and several others continue graduate training.

### **Advances in Scaling Up**

Potential scaling up mechanisms are in place at the International Center for Agricultural and Rural Development, the information storage and policy dissemination unit of the Ministry of Agriculture and Rural Development, which has manifested a high level of interest in the research output.

At this point in the project the relevant scaling activity may in fact be 'scaling down' -- from hypotheses and research methods developed for relatively large units, including national and provincial government, to the level of the district and below. In A Loei District of Thua Thien Hue Province, where the road-building project is far advanced, there is a need to promote local understanding of national international trends in policies and markets, in order to anticipate economic and environmental changes and, where appropriate, help plan policy responses.

### **Advances in Policy Impacts**

Although this project has started slowly, it has

acquired substantial momentum and the resources (human, insitutional and financial) to continue beyond completion of SANREM Phase II. Most importantly, there has been widespread acknowledgment within Vietnam of its relevance and timeliness for policy debates.

## **Advances in Environment and Natural Resource Management**

See Advances in Policy Impacts.

### **Major Outputs**

#### **Working Paper**

Pahn, D. 2004. *Rural Inequality in Vietnam*. Manuscript, University of Wisconsin-Madison

Phan, D. and I. Coxhead. 2003. *Literature Review: Economy and Environment in Vietnam*. <http://www.aae.wisc.edu/coxhead/projects/Vietnam/>



# SANREM West Africa





# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
Funded by the U.S. Agency for International Development (USAID)**

**May 2004  
Annual Report  
WAF\_1**

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## **Coordination and Management of West Africa Regional SANREM Project**

**Principal  
Investigator**  
Keith Moore

**Co-Principal  
Investigator**  
Salmana Cisse

### **ABSTRACT**

This activity has ensured proper management and coordination of SANREM WAF project activities during this last. The Manager has coordinated with US and local PIs and partners, the USAID Mission, the SANREM ME, and the associated Carbon from Communities Project to achieve integrated project objectives. Special emphasis has been placed on synthesizing, integrating, and publishing project results.

project and stimulated a significant interchange of approaches, models and technologies for sustainable agriculture and improved natural resource management. Drs. Keith Moore and Salmana Cissé (respectively SANREM WAF Program Manager and Country Coordinator) have kept the USAID Mission in Bamako, Mali informed of progress and achievements.

### **OBJECTIVE 1**

Provide leadership for regional project development and implementation.

### **OBJECTIVE 2**

Coordinate program development amongst U.S. and international collaborators.

### **Achievements**

The SANREM WAF team has implemented three workshops in Mali this year and has submitted a book on SANREM WAF achievements. The first workshop involved demonstration and training of IER scientists in the CROPSYST Model by Dr. Oumarou Badini. This workshop was followed by a workshop with local leaders in the Communes surrounding Madiama in the Cercle of Djenné. IER and the NRMAC took the program leadership for this activity which was appreciated by all local officials and government service providers. The Malian NGO, GRAD, which has recently replaced CARE/Mali as our NGO partner, assured the logistics for this event. The Bamako conference for West African research and development specialists highlighted the achievements of the SANREM WAF

### **Achievements**

The Bamako workshop, entitled "Institutional Innovations and Technological Development for a Decentralized and Sustainable NRM" showcased SANREM WAF findings and demonstrated the successful completion of Phase II of the SANREM WAF program. This collaboration continued through the publication of the edited volume of SANREM WAF accomplishments entitled "Conflict, Social Capital, and Managing Natural Resources."

The objective of this research workshop was to share experiences, approaches and methodologies for improved natural resource management in the Sahel. The main focus was on techniques and methods for improved decision-making in the context of democratic, decentralized governance in West Africa. The workshop

provided an opportunity for SANREM WAF researchers to share their experiences and findings with colleagues interested in similar problems affecting the region. Proceedings from the workshop will be published in French to promote wide readership throughout the region.

The three organizing themes for the workshop were: 1) Local governance and its role in the management of natural resources and related conflicts; 2) Participatory development of soil fertility and pasture management technologies; 3) New decision-making tools for agricultural and environmental policy development.

This workshop drew approximately 100 participants representing international and national NGOs, USAID (Washington, DC, USA; Mali Mission), US and foreign universities, International Agricultural Research Centers, policy analysis and consulting firms, and USAID-funded development projects.

### **OBJECTIVE 3**

Coordinate financial and programmatic reporting of regional activities.

### **Achievements**

SANREM WAF regional activities have been fully documented during the course of the entire Phase II program. This year's accomplishments include the workshop on crop and weather modeling tools being held in Mopti, Mali during December 2003, the workshop on the expansion of the NRMAC model for community level natural resource management in the Cercle (district-level administrative unit) of Djenné, Mali in February 2004, and the Regional Conference, exchanging SANREM and other West African experiences, tools, and achievements in Bamako, Mali in February 2004. The proceedings of the latter conference were prepared by IER as a publication, and the manuscript for a book in English has been submitted for publication in May 2004.

### **Advances in Research**

The SANREM WAF project has successfully completed a full information dissemination campaign with three workshops and two edited volumes.

### **Advances in Capacity Building**

Other SANREM WAF activities undertake capacity building.

### **Advances in Scaling Up**

The Djenné Workshop was the major scaling-up activity of the year. It brought together a range of Communes surrounding Madiama in the Cercle of Djenné to inform local officials about and discuss the issues involved in scaling-up these activities to other Communes and to the inter-Commune level.

### **Advances in Environment and Natural Resource Management**

Other SANREM WAF activities undertake direct improvements in livelihood, environment and natural resource management.

### **Publications**

#### **Book Chapters**

Moore, K., C. Brewster and M. Bertelsen. 2004. *What We Have Learned*. In Press. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Moore, K., M. Bertelsen, S. Cissé and A. Kodio. 2004. *Conflict and Agropastoral Development in the Sahel*. In Press. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

#### **Books**

Moore, K. (ed.). 2004. *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

### **Degree Training**

Todd Crane, Ph.D., 2001 - 2006

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**Sustainable Agriculture and Natural Resource Management  
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WAF\_2**

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## **Replication and Sustainability of a Commune-Level NRM Advisory Committee**

### **ABSTRACT**

The NRMAC has played a pivotal role in community-led NRM in Madiama. It has applied a Holistic Management methodology reinforced by training in conflict management and resolution. This past year we have documented the specifications for a model of community-led NRM planning and the type of training program required to replicate this experience across other Communes. Integral to this model is the mechanism by which rangelands and bourgoutières can be communally managed for improved productivity. An additional dimension crucial to the model is the extent to which it can be maintained without sustained external support. Based on lessons learned over the past five years, we have been disseminating this model within North Central Mali and sharing our experiences with West African colleagues for application across locations.

### **OBJECTIVE 1**

Specify the steps in the NRMAC model for community level planning of natural resources.

### **Achievements**

A paper, entitled "Building Social Capital in the Sahel" and documenting the establishment and reinforcement of the NRMAC, was presented at the 2003 Annual Meeting of the Rural Sociological Society. This work has been elaborated upon, presented at the SANREM WAF Regional Conference in Bamako

(February 2004), and expanded on in several chapters of the edited volume on "Conflict, Social Capital and Managing Natural Resources" to be published later this year by CABI. The work describes how the NRMAC has come to deal with conflict issues and contributes to the planning and development of NRM in the Commune. The NRMAC played a major role in the Djenné Workshop in February 2004 which focused on how the NRMAC model can be extended to other Communes in the Cercle of Djenné.

### **OBJECTIVE 2**

Document and evaluate the training methods, tools and materials used to build the capacities of the NRMAC and determine which should be used for scaling-out to other communes.

### **Achievements**

CARE/Mali withdrew as a SANREM WAF partner so we have contracted with another local NGO, Groupe de Recherche Action pour le Développement (GRAD) to provide the facilitation for and liaison with the NRMAC during its transition to independent functioning. GRAD has submitted a report describing the strengths and weaknesses of the NRMAC and how this model can be expanded in the region. A paper was presented and a book chapter completed on the classification of the community's land resources using QuickBird GIS Imagery (2002-3) comparing their use to aerial photography from 1952.

**Principal Investigator**  
Keith Moore

**Co-Principal Investigator**  
Salmana Cisse

Abdoulaye Toure

Ahmed Nadif

Jeff Goebel

Michael Bertelsen

### **OBJECTIVE 3**

Determine the factors enhancing the adaptation of the Holistic Management methodology to communal building of open range and bourgoutière management programs.

#### **Achievements**

A chapter for the edited SANREM WAF volume has been completed. The chapter analyzes the SANREM WAF experience with the Holistic Management Model which notes how it was adapted to communal management of open range pastures and bourgoutière (wetlands), what features were readily adopted by the local community, and how it influenced the research program established in the Commune of Madiama. A major strength is that the combination with conflict management training greatly enhanced the value of the overall approach.

### **OBJECTIVE 4**

Determine the factors ensuring sustainable institutional linkages of NRMAC in the Commune of Madiama.

#### **Achievements**

A paper presented at the Annual Meetings of the Rural Sociological Society (then revised for presentation at the SANREM WAF Regional Conference in Bamako) explored the functional linkages and perceived legitimacy of the NRMAC with respect to government service providers, local officials, village leaders, farmers, herders and women. The NRMAC, being an institution founded on both customary and modern administrative bases and addressing issues important to the community, is perceived as a highly legitimate and valued organization in the civil society of Madiama. This work was further revised and the analysis advanced with critical input from colleagues in West Africa and the US and is now a chapter in the SANREM WAF edited volume to be published later this year.

### **OBJECTIVE 5**

Disseminate the NRMAC model and lessons learned to Communes in the Region and to practitioners across West Africa.

### **Achievements**

The Cercle-level Workshop in Djenné was held successfully in the community building in the city of Djenné on 19 and 20 February 2004. Participants included elected local government officials from communes of the Cercle, agents from the national government technical services, village chiefs, and NGO representatives. IER SANREM colleagues and NRMAC members were responsible for the program that presented technical research findings as well as the institutional software of the NRMAC. Logistic and programmatic arrangements were made by GRAD. The SANREM WAF Regional Conference in Bamako (24-26 February 2004) was an important opportunity to share the SANREM WAF experience with researchers and development professionals across West Africa, as well as in Europe and the US. The successful conference created an environment of rich discussion and exchange of decision making tools and appropriate technologies. The SANREM WAF researchers clearly demonstrated their leadership in the field. The SANREM WAF book on "Conflict, Social Capital and Managing Natural Resources", provides a clear and integrated presentation of the results of our research program, highlighting how the SANREM approach based on community participation, interdisciplinarity, landscape scale and multiple institutions contributes to the development of cutting edge decision making tools and technological innovation.

#### **Advances in Research**

Getting started late in the annual cycle as a replacement for CARE/Mali, GRAD has held the scaling up workshop in Djenné and provided a report analyzing the issues involved in scaling-up and scaling-out the soft technology associated with establishment of NRMAC type organizations in other communes and at the Cercle level.

#### **Advances in Capacity Building**

The withdrawal of CARE/Mali from the project at the beginning of the project year disrupted progress of capacity building activities.

#### **Advances in Scaling Up**

The Cercle-level SANREM Workshop held in

Djenné has interested leaders in several Communes to replicate the overall approach.

### **Advances in Policy Impacts**

At the Cercle-level workshop in Djenné, local decision makers were provided with lessons learned concerning the process of communal management of natural resources, specifically open-range pastures and bourgoutière (wetlands). In addition, the SANREM WAF edited volume presents new knowledge concerning the principles involved in promoting the decentralized management of natural resources.

### **Advances in Environment and Natural Resource Management**

Improved community relations have been the major immediate outcome of SANREM-led activities in the Commune of Madiama. By networking community groups across villages, new relationships are building and trust is being created between groups who never really worked together for a common objective before. This building of social capital has reduced conflict and improved the likelihood of new NRM institutions being developed to increase agricultural productivity and improved NRM.

### **Publications**

#### **Book Chapters**

Earl, J. and A. Kodio. 2004. In Press. *Participatory Landscape Lifescape Appraisal*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Moore, K. and S. Cissé. 2004. In Press. *Social Capital and Improved NRM*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Cissé, S., K. Moore and C. Brewster. 2004. In press. *The Lifescape - Production Systems and Social Institutions*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Goebel, J., C. Ampagoomian and A. Touré. 2004. In Press. *Conflict Management Training*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Moore, K., S. Cissé and A. Touré. 2004. In Press. *Building Social Infrastructure for Sustainable Development*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

### **Other Major Outputs**

#### **Conference Paper**

Moore, K., S. Cissé, and A. Touré. 2003. *Building Social Capital in the Sahel*. Paper presented at the Rural Sociological Society Annual Meeting. Montreal, Canada. July 30-31, 2003.

#### **Proceedings**

Moore, K. 2004. In Press. *Renforcement des Liens et Construction des Ponts*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

Cissé, S., K. Moore and A. Touré. 2004. In Press. *Un Modèle de Décentralisation de la Gestion des Ressources Naturelles au Sahel*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

# SANREM CRSP

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WAF\_3**

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## **Application and Scaling-Up of Socio-Economic Tools**

### **ABSTRACT**

In West Africa, declining soil fertility, degradation of pasture quantity and quality are driven in large part by social and economic factors. Technical solutions to the problem offer little chance of success if stakeholders do not perceive clear social and economic benefits to their use. This activity cuts across other SANREM WAF activities, and provides an economic evaluation of the technical solutions proposed in West Africa.

### **OBJECTIVE 1**

Assess and document the relative net economic returns and adoption potential of (i) improved grazing practices (open-range as well as controlled grazing) and (ii) soil fertility management practices to ensure that recommendations improve both the natural environment and farmers' economic and social welfare.

### **Achievements**

Relative net returns were assessed for farm management practices designed to conserve soil fertility when growing millet. The evaluation used the results from both on-farm trials and the modeling carried under WAF\_4. Combining the efforts of the trials and the modeling in a coordinated fashion proved highly productive. The trials allowed the modeling to be properly calibrated against reality as well as providing farmers with first hand experience of both the benefits to be obtained and the costs entailed in implementing the practices. The modeling, combined with economic analysis, allowed simula-

tions of crop yields and profits that permitted comparisons among practices over 30 years. In both the farm trials and the modeling the treatments were compared against returns to growing pure stands of millet year-on-year without any kind of fertilizer.

Similar evaluation of grazing practices was intended but will not have been carried out in detail by the end of the project.

The following conclusions emerged:

1) The practices that produced the highest yields and profits on average were: (a) corralling animals on the fields at night prior to planting; (b) applying microdoses of chemical fertilizer; and (c) spreading animal manure on fields either with or without PNT (natural phosphate rock).

(2) Practices involving either intercropping or rotating millet with cowpeas (niébé) do well in years when there are good rains, but in the farm trials the cowpeas failed in years of poor rain. The other tested practices held up well relative to unimproved cropping even when rainfall was poor.

(3) Fertilizing with animal manure, either at 2 tons per year or 5 tons every three years, produces the most sustainable yields and profits.

(4) When yields were high, profits were high, indicating that none of the good returns were obtained only at unduly high cost, and farmers who do not keep

**Principal Investigator**  
Peter Wyeth

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Charlene Brewster

Mohamed Toure

Michael Bertelsen

Todd Crane

accounts could easily perceive which practices do best economically by observing their performance in the field.

The Natural Resource Management Advisory Committee (NRMAC) provided a forum for the discussion of the trial results with the farmers. Farmers were also interviewed on their perceptions regarding the qualitative differences between various soil conservation practices. Research results corresponded closely with their perceptions. What farmers had wanted from the research, and what they were interested in during the discussions of results, was the quantitative assessment of the returns and costs of the practices. While some farmers will certainly alter the techniques that they practice, they will not all converge on what the research shows to be the most profitable ones. They will continue to implement a variety of practices according to their varying means and preferences, but they will be better able to estimate the optimal amount of inputs (e.g. manure or microdoses of fertilizer) to apply and what returns to expect.

## **OBJECTIVE 2**

Use the socio-economic tools developed for Madiama (i.e. Social Accounting Matrix) to project potential economic impacts of new management practices on the community.

### **Achievements**

Analyses by Kaboré and Brewster using the Social Accounting Matrixes (SAM) developed by Kaboré came to the following conclusions:

(1) The commune is very open to the larger national economy. Except for rice, most cereals are grown largely as subsistence crops. Some cereals, however, are also important as “exports” (sales outside the commune).

(2) Economic linkages are important among the four major occupational groups within the commune: farmers, agro-pastoralists, sedentary pastoralists and transhumants (transhumants are pastoralists who have a sedentary base but follow their animals to pasture other regions of Mali and other countries during the dry season.) Transhumants are the least closely integrated of these four groups, but

improvements in the welfare of one group, for example through increased crop yields, do pass on through to the other groups.

(3) In terms of generating income effects among occupational groups, millet is more important than rice and almost as important as small ruminants or cattle.

The results indicating interdependence among occupational groups are particularly important in Madiama, which was chosen as a research site because of actual and potential conflict among them. When researchers explained the SAM results SAM to farmers, the latter readily understood them as evidence of economic interdependence.

### **Advances in Research**

Concerning knowledge of effective techniques for raising soil fertility in the Niger Delta the research provided worthwhile information that would allow farmers to compare the relative net benefits of alternative practices. More research is needed on the viability of cowpeas as a crop in the area, since the model output was more optimistic than the on-farm trials.

Concerning research methodology, the following lessons learned were obtained:

(1) The collaborative development of on-farm trials, biosystems modeling, and economic analysis was very fruitful. The on-farm trials grounded the modeling in reality and provided a basis for communicating effectively with the farmers on the other aspects of the research. The biosystems modeling generally increased confidence in the on-farm findings. It also allowed greater insight into the long term sustainability of the different techniques that three years of on-farm trials could possibly offer. The economic analysis added confidence that the increased yields were obtained in an efficient manner.

(2) Because farmers already had a sound understanding in general terms of alternative techniques for improving soil fertility, they had a realistic understanding of the purpose of the trials and what additional knowledge they would gain from them.

(3) Reception by farmers of the research results was facilitated by the fact that the researchers presented the findings and allowed the farmers to draw their own conclusions regarding the relative net benefits of the different techniques.

### **Advances in Capacity Building**

Boureima Traoré, the agronomist in charge of the soil fertility trials, participated closely in the development of the farm budgets that evaluated their economic viability. Mohamed Touré, the economist at IER Mopti, set up the initial templates for these budgets. Both were closely involved in the discussions with farmers. The biophysical modeling of the same soil fertility improvement techniques will complement the trial results from farmers' fields and IER personnel were trained in this modeling under WAF\_4.

### **Advances in Scaling Up**

The results of the farm trials and the biophysical modeling are directly applicable to the areas surrounding Madiama. The conclusions from the SAM are applicable to those communities with a similar mix of livelihood practices. Researchers presented at the SANREM WAF Regional Conference in February 2004 that was attended by representatives of the Malian government and others from neighboring countries.

### **Advances in Policy Impacts**

All the techniques tested in the soil fertility trials, with the partial exception of those involving cowpeas, proved better than unimproved farmer practices. Furthermore, farmers in Madiama showed great interest in learning about the quantitative differences among the alternative techniques and were ready to act on what they learned from the research. For the full potential impact of the research to be felt in Madiama and beyond, extension services and NGOs working with farmers need to be made aware of these results, and extension materials prepared that are based on them. The US-based institutions involved are looking for resources to do this work as part of a broader project.

### **Advances in Environment and Natural Resource Management**

See information reported under Objective 1.

## **Publications**

### **Book Chapters**

Crane, T. and B. Traoré. 2004. In Press. *Farmers' Knowledge and Perceptions of Soil Fertility*. In Moore, K. (ed). *Conflict, Social Capital and Managing Natural Resources*. CABI, London, UK.

Brewster, C., D. Kaboré, M. Bertelsen, and P. Wyeth. 2004. In press. *Economic Linkages Among Occupational Groups in the Madiama Commune of the Niger Delta of Mali*. In Moore, K. (ed). *Conflict, Social Capital and Managing Natural Resources*. CABI, London, UK.

Wyeth, P., B. Traoré, O. Badini, M. Sidi, M. Touré and C. Brewster. 2004. In Press. *An Evaluation of Alternative Soil Management Techniques on Farms in Madiama Commune*. In Moore, K. (ed). *Conflict, Social Capital and Managing Natural Resources*. CABI, London, UK.

### **Other Major Outputs**

#### **Conference Paper**

Kaboré, D., B. Traoré, D. Taylor, P. Wyeth, M. Bertelsen and D. Holland. 2004. *Modeling district-level socioeconomic linkages and growth*. Paper presented at the American Agricultural Economics Association Annual Meeting. July 30-August 2, 2000.

#### **Proceedings**

Traoré, B. and M. Touré. 2004. In Press. *Utilisation des Résidus de Récolte et du Fumier en Zone Semi-Aride au Sahel: Cas de la Commune Rurale de Madiama dans le Delta Central du Fleuve Niger au Mali*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

Kaboré, D., C. Brewster, M. Bertelsen, O. Badini and P. Wyeth. 2004. In Press. *Liens Economiques Entre Groupements Socioprofessionnels dans la Commune de Madiama*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

# SANREM CRSP

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## Application of Bio-Physical Decision-Making Tools, Soil Carbon Monitoring, and Soil Fertility Improvement Technologies

**Principal  
Investigator**  
Oumarou Badini

### ABSTRACT

This research activity integrates biophysical research, timed rotational grazing to improve biomass and carbon sequestration begun in 2002 in collaboration with a NASA program, and the soil fertility enhancement activities begun in 2001. The Sahel is typified by highly variable rainfall and in Madiama the two years have produced 700 mm and 350 mm respectively. Year 6 produced important additional observations that strengthen, both scientifically and in the eyes of local farmers and livestock raisers, the assessment of the NRM techniques being tested.

### OBJECTIVE 1

Monitor and evaluate the impact of community-based timed rotational grazing management practices on soil fertility improvement, soil carbon sequestration potential and biomass production in the pastoral zones of Torokoro and Siragourou.

### Achievements

Soil Sampling and Analyses for Organic Carbon in Grazing Zones: Baseline soil sampling was done at the onset of the project in May 2002. Soil samples at depths of 0-5, 5-15 and 15-30 cm were taken at 3 randomly selected points in each of the plots of the zones for a total of 108 samples. An additional soil C sampling was conducted in May/June 2003. The sampling scheme integrated all soils

and pastures types in control and treatment plots to better evaluate the impact of the rotational grazing management. At the Torokoro site, comprising a total of 5 soil units and 6 plots, a total of 69 sampling points were selected. Samples were taken at three depths (0-5, 5-15 and 15-30 cm) for a total of 207 samples. At Siragourou, a total of 48 random samples were identified making a grand total of 144 samples for the 3 depths. The samples were analyzed at IER/Sotuba lab for pH, Organic Carbon (Walkley-Black method), Nitrogen and Phosphorus to help with model calibration and extrapolation. After just two years of pasture management experiment, additional sampling and analyses would be needed to allow refinement of modeling (Badini et al., 2003; Bostick et al., 2003) and Soil C geospatial analysis is underway in collaboration with the Universities of Hawaii and Florida.

In-situ measurements and analysis of soil carbon aim to develop estimates of soil C and verify the long-term impact of timed rotational grazing on plant and soil carbon sequestration potential in Madiama commune. The soil types characterizing each pastoral zone were identified and mapped. The pastoral zone of Siragourou (122 ha) has only 3 soil units with about 90% of the total area made of laterized indurated pediment and ironstone plateau (in French: Versant glacis induré – landscape type Vi and Bas plateaux cuirassés

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– landscape type Bk on the landscape/soil map of Madiama). In addition to the lack of water availability and access, the low pasture productivity and soil C estimate (20 t/ha at 30 cm depth) makes this zone difficult for rotational grazing and underscore the need for long-term monitoring of performance in different rainfall conditions. The zone of Torokoro (150 ha) is made of a total of 5 soil units. The diversity of soil and pasture types found in this zone as well as the presence of water points make it suitable for timed rotational grazing. A landscape of old alluvial plains and terraces (in French: *cuvette ancienne* – landscape type Ca on the landscape/soil type map) representing 60 percent of the total grazing area dominates this zone. The main soils found in this landscape are classified as USDA Plinthic Haplustalfs. They are deep (105 cm) with a texture varying from sandy loam to clay with depth. The soil Organic Carbon content is about 0.84 percent in the first 5 cm and decreases with depth. Soil organic carbon estimates at 30 cm depth is about 30.24 t/ha. Results from this sampling indicate that soil organic carbon levels are slightly low although higher than levels found in croplands. This is a hint of the higher Soil C sequestration potential that can be expected from grazing land.

Grazing Zones: Pastures Biomass and Botanical Composition Analyses: In collaboration with Dr. Amadou Kodio and Moussa Keita from IER/Mopti, sampling for plant biomass and botanical composition was conducted in September and October 2003 in each of the 2 pastoral zones of Siragourou and Torokoro. Samples were taken both in the rotational grazing plots and the control (existing traditional grazing zones) with similar soil and pastures types to determine the impact of the alternative grazing management system on pasture productivity and species diversity.

Botanical Composition Analyses: For the baseline evaluation of species diversity (richness), composition and vegetation cover, the method of “points quadrants” (Daget et Poissonet, 1971) was applied for a total of 69 line-transects in Torokoro and 40 transects in Siragourou. Measurements are made in each 20ths of meters along the line for a total of 100 observations per transect. The grazing zone of Torokoro has a relatively high species richness

(number of total species varying between 25 and 41, depending on landscape and soil type). The zone is essentially dominated by annual grasses (83 percent of gramineae and 17 percent of legumes). The gramineae pasture types (cereal-like grasses) are dominated by *Loudetia togoensis* (31 percent) found mainly on the old alluvial plains and terraces and *Schoenefeldia gracilis* (23 percent) found on the laterized indurated pediment and ironstone plateau. The legumes are essentially composed of *Cassia tora* (13 percent), found on young alluvial formation such as the levees and alluvial terraces (Landscape type t1 on the landscape/soil map of Madiama), and *Zornia glochidiata* (4 percent), found on poor, degraded and shallow lands such as the laterized indurated pediment (landscape type vi). A specific characteristic of the pastures found in the dry landscape that makes up most of the grazing area is the total absence of perennial grasses such as *Andropogon gayanus* well known in the Soudano-Sahelian zone and indicator of healthy pastures and soils. Breman and Cisse (1969) have shown that, under the influence of drought and overgrazing, a shift from vegetation dominated by perennial to annual and mediocre legumes, such as *Zornia glochidiata* can occur. The pastures in the Torokoro site, which are presently dominated by annuals, show a sign of only moderate sign of degradation, and improved management such as the rotational grazing can contribute to an improvement of productivity, species richness and conservation of the resource base.

Pastures Biomass Analyses: The pattern of productivity was studied on the basis of weight of grass obtained at maturity by clipping two 1 m<sup>2</sup> around each georeferenced soil sampling point (48 and 69 sampling points in Siragourou and Torokoro respectively) for a total of 96 and 138 biomass samples in Siragourou and Torokoro respectively. Samples were then oven dried to express productivity in units of dry matter per hectare. In 2003, pasture productivity varied between 477 kg/ha and 1073 kg/ha for a total of seven identified pasture types in Torokoro. The highest productivity was measured for the pastures types dominated by *Eragrostic gigantea* (1073 kg/ha), *Loudetia togoensis* (1048 kg/ha) and *Brachiaria lata* (1010 kg/ha). The legumes dominated pastures had the lowest dry

matter yields, due in part to their high water content before drying with *Zornia glochidiata* (540 kg/ha) and *Cassia tora* (477 kg/ha) being the most common legumes. Overall estimated soil vegetative cover was comprised between 46 and 73 percent dependent on soil and landscape type. The values are year-specific and cannot extrapolated to all years given the variability and erratic nature of rain in the Sahel, which stresses the need for long-term monitoring and simulation modeling applications. However, these observed results are useful in determining the importance of each pasture type and in helping corroborate models for long-term simulation and impact analysis.

Grazing Zones - Modeling of Pastures Productivity and Carbon Sequestration Potential: In collaboration with the NASA Carbon from Communities project partners including Dr. Jim Jones from the University of Florida, Dr. Claudio Stockle from Washington State University and Dr. Amadou Kodio from IER/Mopti, a modeling effort is underway to possibly contribute to the knowledge of long-term pastures productivity and C sequestration potential in grazing zones (Badini et al., 2004; Bostick et al., 2004). To test the hypothesis that rotational grazing will increase both soil carbon and pasture biomass production, the CROPSYST model was adapted for simulating pasture in the Torokoro area (Badini et al., 2004). Management consisted of continuous grazing, no grazing, and different frequencies of grazing return periods to the 150 ha area. Simulated results compared were total area biomass productivity per year, livestock grazing capacity, and soil carbon changes over a 50-year period of simulation.

Preliminary results agree with our initial hypothesis that stated that more biomass will be allowed to grow by rotating animals with no livestock grazing during weeks to permit re-growth. Regarding the effect of grazing intensity on productivity, it was shown that for annual pastures such as *Loudetia togoensis*, a grazing intensity of 30 percent which exhibited the overall highest plant resiliency and biomass production, is the right norm to ensure pasture survival and re-growth throughout the rainy season. Overall for total biomass production, the 2-plot and 3-plot rotations where animals are rotated

every two and three-week respectively, seem to be the most adapted system for annual pasture grazing in the study zone, with a simulated output of 1495 and 1520 kg/ha respectively. The continuous grazing (every day) and no grazing plots exhibited the lowest total biomass output ((347 kg/ha and 1296 kg/ha respectively). These findings confirm that controlled grazing is a positive stimulator of pasture growth and dynamics, and bring in more soil nutrients through animal feces and residue trampling, such as included in the grazing sub-model of CROPSYST. As for carbon sequestration potential, in general, carbon accumulation potential decreased as grazing frequency levels increased. The shorter the rotation interval, the lower the total carbon because of higher biomass taken up by animals. These preliminary results from long-term simulation of pastures provide strong evidence that over time, properly managed grazing lands will improve their productivity, and overall ecological integrity. By comparing different systems that have not been tried on the ground, and by helping decide which one best fits the environment at hand, computer technology and simulation modeling such as applied here (with CROPSYST and the Grazing sub-model) are useful tools that allow managers the opportunity to manipulate and analyse vast quantities of information for consideration in management decisions. However, the simulation outputs are based on only a 1-year biomass and botanical composition results from the grazing site of Torokoro. Parameters for phenology and growth cycle were derived from previous studies that we conducted in similar environments in Burkina Faso. The bulk of SANREM WAF biophysical modeling for the past few years was focused on cereal (millet and sorghum) in cropping systems. For pasture modeling corroboration and completion of the development of a carbon accounting system in grazing system, at least, an additional year of field-work would be needed to determine phenology, growth and production functions of all main pasture types found in the grazing zone. Thus, resources are still needed to complete the data collection and analysis of the grazing system being conducted in collaboration with the NASA-funded Carbon from Communities project.

## **OBJECTIVE 2**

Finalize soil fertility enhancement experiments (integrating organic fertilization, rock phosphate additions, micro-dosing and legume rotations) and analyze the local perception and adoption of these soil fertility techniques.

### **Achievements**

Todd Crane, a University of Georgia doctoral student in anthropology concluded an eight months (July 2003-March 2004) period of fieldwork in Madiama. During this period, he engaged in intensive participant observation of farmers' crop and soil management practices and conducted over 80 in-depth interviews in local language with Marka farmers, semi-sedentary Fulani herder-farmers, and nomadic Fulani herders, village chiefs, extension workers, and governmental officials. Interviews focused on natural resource management in local fields and pastures, conflicts between farmers and herders, and local governance. Protocols for semi-structured interviews varied according to type of respondents. Mr. Crane was also able to observe and analyze institutional interactions and deliberations, by participating in NRMAC meetings as well as in commune and cercle-level meetings concerning livestock migrations across the territory and natural resource conflict management. He also assisted in the implementation of farmers' workshops, training in conflict resolution, and research activities conducted under other workplans.

Research on the local knowledge of soils and soil fertility maintenance strategies has identified several elements that may influence the integration of SANREM's scientific research into local NRM practices. These include the ways that residents of the commune of Madiama conceptualize the biophysical processes that constitute soil ecology, variability in methods of soil amendment production and acquisition, the role of ethnic identity in perception of conflicts over natural resources, and the NRMAC's preliminary perceptions of the cumulative findings of the soil fertility trials.

In general, farmers in Madiama were previously familiar with all of the techniques tested in SANREM field trials. However, they have not been uniformly employed and when they were, their application to varied in degree, intensity and situation.

Rather than introducing completely new techniques, the experiments have served to scientifically measure and illustrate to the NRMAC and the community the variable utility of known techniques and their long-term impacts. The presentation of findings has already caused several participants to revisit their soil fertility management regimes and reconsider the application of certain techniques.

Following the presentation of findings, all NRMAC members and participating farmers recognized the benefits of all the methods tested, but they were most interested in microdosing and corralling herds in fields during the passage of transhumant herds. These methods are favored as they yield significant soil fertility gains relative to their low financial and labor costs. Both methods, however, are cited by informants as having limitations. Financial cost is still seen as a significant impediment for fertilizer microdosing. It is also recognized that microdosing is most effective in conjunction with the application of organic fertilizers, which is currently insufficiently available. The low density of livestock in relation to cultivated area was also recognized as a major limitation for the corralling method. The inability of livestock to remain in the area is due to the lack of water sources.

## **OBJECTIVE 3**

Evaluate, synthesize and publish soil fertility tests findings, biophysical methods, tools, data gathered (soils, crops, weather, cropping systems and management practices) and modeling outputs to improve scientific knowledge and inform NRM decision-making.

### **Achievements**

The past year has been a year of scientific production with emphasis on grazing systems evaluation, results synthesis, transfer, and publication through written technical papers and preparation of referred articles. We also contributed several papers for workshops and book chapters. In February 2004, we contributed to the SANREM WA international workshop (Dioni and Badini, 2004) and to the NASA carbon from communities' regional workshop (Badini et al., 2004; Bostick et al., 2004) in Bamako, Mali. To share findings with the scientific community we are contributing 2 chapters (Chapter

3: Badini and Dioni, 2004 and Chapter 11: Badini et al., 2004) in an edited volume on SANREM WAF research. We are also finalizing at least 2 papers (Badini et al., 2004; Bostick et al., 2004) for potential publications in the refereed journal *Agricultural Systems*.

In order to improve the capacity of IER researchers, extension service personnel and NGO members to apply SANREM modeling and biophysical analysis tools, a training workshop was organized by SANREM at the IER Regional Center in Mopti from December 2 to 5, 2003. A total of about 30 participants from IER Mopti, Sotuba, Bamako headquarters, regional extension services and NGO contributed to the success of the workshop. The main objective was the transfer through hands-on training and exchange of decision-making tools such as the cropping systems model (CROPSYST), climate data generator (CLIMGEN), cooperators CROPSYST-GIS (ARCCS) and Campbell Weather Station. The workshop was comprised of lectures (Badini and Stockle, 2003; Badini, 2003) and practical laboratory sessions, where the software was distributed and used for presentations of outputs and demonstrations of application scenarios. The training was well received by the participants who found these tools very useful for the analysis and understanding of the impact of cropping systems technologies and natural resource management impact on production, and sustainability.

### **Advances in Research**

For Cropping Systems: The project has produced improvements and validation for millet and sorghum production in West Africa through biophysical monitoring and modeling. Subroutines for millet and sorghum phenology have been improved for African genotypes. The CROPSYST Model was used to analyze the productivity, sustainability and biophysical viability of soil fertility management practices in Mali.

For Pasture Systems: The bulk of our fieldwork at the research site in Madiama for the year 2003-2004 was on pasture systems. Our work is an essential contribution to the development of a soil carbon account system in grazing systems.

### **Advances in Capacity Building**

The capacity of IER researchers, extension service personnel and NGO members to use and apply SANREM modeling and biophysical analysis tools was improved through pro-active collaborative research and training workshops organized at the IER Regional Center in Mopti. A method of biophysical assessment of the viability of technologies was proposed. Also, the new grazing and carbon sequestration model in grazing systems proposed improves on existing carbon accounting systems for grazing areas.

### **Advances in Scaling Up**

Ensemble Kalman Filter Simulation of Carbon Dynamics in Semi-Arid Rotational Grazing Systems will help integration of field measurements and simulation outputs for extrapolation to larger areas. Also, work under a different, NASA-funded project is ongoing and relates soil C with satellite imageries.

### **Publications**

#### **Book Chapters**

Badini O. and L. Dioni. 2004. In Press. *Landscape and Soil Characterization of Madiama Commune*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Crane, T. and B. Traoré 2004. *Farmers' Knowledge and Perceptions of Soil Fertility*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Badini O., B. Traoré, and S. Touré. 2004. In Press. *Biophysical Assessment of the Viability of Alternative Technological Improvement Through Modeling in Madiama Commune, Mali*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

Wynne, R., M. Sidi, M. Touré, N. Sengupta and A. Ballo. 2004. In Press. *Land Use Changes in Madiama Commune*. In Moore, K. (ed.) *Conflict, Social Capital and Managing Natural Resources*. CABI Press, London, UK.

## **Other Major Outputs**

### **Conference Paper**

Badini, O., C. Stockle, J. Jones, A. Kodio and M. Keita. 2004. *Analyzing Potential Increase in Productivity and Soil Carbon Using Rotational Grazing in Madiama Commune, Mali (West Africa)*. Paper presented at an International Workshop on Land Management for Carbon Sequestration. Bamako, Mali. February 26-27, 2004.

Bostick, W., O. Badini, J. Jones, C. Yost, C. Stockle, and M. Kodio. 2004. *Ensemble Kalman Filter Simulation of Carbon Dynamics in a Semi-Arid Rotational Grazing System*. Paper presented at the International Workshop on Land Management and Carbon Sequestration in West Africa. Bamako, Mali. February 26-27, 2004.

### **Proceedings**

Dioni, L. and O. Badini. 2004. In Press. *The Soils of Madiama*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

Touré, M. and R. Wynne. 2004. In Press. *Études de 50 ans de changement d'occupation des sols dans le commune de Madiama*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

Traoré, B., P. Wyeth and C. Brewster. 2004. In Press. *Modèles Pour L'analyse de la Gestion du Sol et de la Socio-Economie*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

### **Tools**

Badini, O. 2003. *Programmation, Utilisation et Entretien de la Station Météo Campbell Scientific*. Atelier de Formation SANREM, IER/CRRA. Mopti, Mali. Décembre 2-6, 2003.

Badini, O. and C. Stockle, 2003. *Introduction au Modèle de Simulation des Systemes Agricoles (CropSyst Suite)*. Atelier de Formation SANREM, IER/CRRA. Mopti, Mali. Décembre 2-6, 2003.

## **Non-Degree Training**

### **Workshop**

*Modeling* was attended by 30 person(s) and lasted 5 day(s).

# SANREM CRSP

**Sustainable Agriculture and Natural Resource Management  
Collaborative Research Support Program  
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## **Sustainable Grazing Practices and Carbon Sequestration**

### **ABSTRACT**

In the Commune of Madiama, Mali, the lack of pasture and forage resources is a growing problem. This research activity has collected data and is in the process of analyzing the results in order to design, implement and monitor environmentally and economically sound grazing systems within this area. The project has two main components. The current use of holistic open-range grazing for large ruminants has been examined and a community survey to determine appropriate monitoring indicators has been completed. Secondly, the potential of tethered and rotational grazing methods for small ruminants (managed primarily by women and children) has provided initial results to establish appropriate monitoring indicators.

### **OBJECTIVE 1**

Determine the current level of use of holistic open range grazing planning in the Madiama commune

### **Achievements**

Key person and focus group interviews and structured interviews with male household heads in Siragourou, Torokoro, Bangassi and Toumadiama have been completed. Key person and focus group interviews indicate that the direct beneficiaries of Holistic Management training (IER staff in Madiama, members of the NRMAC, and environmental monitors) are aware of the planned grazing experiments and the basic elements of how to plan grazing holistically. These persons

are also aware of the intended benefits of holistic planned grazing. Some residents of Madiama beyond these direct beneficiaries are also aware of the presence of the planned grazing experiments. However very few commune members are aware of the objectives of the experiment or methods used. Because there is very little monitoring being done by the community members themselves for the first signs of change, the planned grazing that is being carried out in Madiama is closer to intensive grazing than holistic planned grazing. This research has provided cultural and institutional indicators as to why diffusion of learning and information in Madiama concerning holistic planned grazing has been minimal, and provides questions to be followed up with further research.

In addition, the potential for scaling up of holistic pastureland management approaches was explored through interviews with stakeholders and decision makers at the local, district, and regional levels. In conjunction with the NASA-funded Carbon from Communities project, this activity generated two papers presented at International Conferences. The first, entitled "An Analysis of Institutional Supports for Community-Based Land Management Systems with Carbon Sequestration Potential in Mali" was presented at a Workshop on "Reconciling Rural Poverty Reduction and Resource Conservation: Identifying Relationships and Remedies" at Cornell University (May 2-3, 2003). The second,

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entitled "Lessons in Social Learning, Visions of Scaling out: Fostering Institutional Capacity for Community-Based Land Management in North-Central Mali" was presented at a Workshop on "Land Management and Carbon Sequestration" held in Bamako, Mali in February, 2004.

Biological monitoring data could not be entered into ArcMap by IER staff.

## **OBJECTIVE 2**

To determine the influence of the tethered rotational grazing method on biomass, plant diversity, forage quality, and soil fertility.

### **Achievements**

Our research indicated that grazing intensity has a profound impact on species diversity. The response to intensive grazing was highly dependent on the morphological characteristics of the plant species. Plants with a horizontal growth pattern were able to re-grow at a faster rate after being defoliated to 3 cm stable height compared with more upright types of plants. This was mainly due to the fact that the growing point (the site of rapid cell division) on the horizontal plants is close to the ground, out of danger of being removed by the grazing animal. It is critical that these tissues be close to the soil surface to escape damage during defoliation and thus permit re-growth. Plants with an upright growth habit are more sensitive to defoliation, and are slower to recover than plants with a horizontal growth patterns. At the end of the growing season, the less frequent plant species found were those with upright growth habits, which also happened to be highly desired (selectively grazed) by the animals.

## **OBJECTIVE 3**

To study the effect of intensive tethered grazing method on weedy, invasive and undesirable plant species and explore their potential feed values.

### **Achievements**

The goal for this activity was to find a feed source that can be tapped into during the dry season when livestock feed is in short supply. In a drought year such as 2002, the entire feed source for the livestock was gone at least two months before the end of the "normal" production season. By early 2003,

Cassia tora was the only live and visible plant in the entire Commune. Cassia tora, even at its late stage of maturity, can provide a good feed source with reasonably high nutrient content. In 2003, a year when the rainy season was wetter and longer than usual, Cassia tora was still abundant. Unfortunately, in a fresh state, this grass is unpalatable for livestock. However, our research has shown that in terms of the nutrient values (as indicated by acceptable crude protein, fibers and relatively high in vitro dry matter digestibility and total digestible energy values) ensiled Cassia tora has a great deal of potential as a livestock feed. The addition of honey, molasses or sugar improves the quality of the ensiled material.

## **OBJECTIVE 4**

Implement a simple, scientifically valid method of community-based rangeland biological monitoring.

### **Achievements**

Because the structured interviews of male household heads could not be completed in time by the IER technicians, a community based rangeland biological monitoring system could not be put in place. However, the results of the interviews identify ecosystem health indicators used by community members when interacting with their environment, including indicators highly correlated with soil and biomass carbon. These indicators can be used in a pilot monitoring program in the future.

### **Advances in Research**

Research on establishing a community based rangeland biological monitoring system has provided indicators specific to rangeland health in Madiama commune, and familiar to commune members that can be integrated into a rangeland monitoring system so as to encourage community members themselves to monitor changes in their ecosystem.

The seasonal survival and regeneration of annual grasses is solely dependent on self-reseeding. Therefore, the management of these type of grass needs to focus on the importance of rest period and defoliation heights. The rest period between defoliation need to be long enough to allow sufficient re-growth for grazing as well as reseeding. Our data showed that close grazing of these annual plants

will cause a shift in botanical composition, that is, redistribution and replacement of the more desirable grasses by a more weedy type of plants. Based on one season's observations, the 6 cm compared with the 3 cm grazing height would promote regrowth within the same season and possibly allow the plant to reseed for the following growing season.

If silage making of *Cassia tora* was to be adopted, it could affect the ecosystem within this region. As discussed earlier, exotic species can bring both positive and negative effects into an existing ecosystem. *Cassia tora* may have positive effects in the recycling of nutrients; however it is also aggressive in its growth and excludes grasses and other species from growing. In order to control *Cassia tora* without eliminating the plant, a cutting regime would need to be developed. Ensiling *Cassia tora* could be a solution to two problems. Cutting the plant at the beginning of the growing season, when still at the vegetative and leafy stage, would ensure optimal quality for conservation and for feeding to small ruminants during the dry season. In addition, it would allow other species to emerge and establish themselves early in the season.

### **Advances in Capacity Building**

Where cutting and measuring of forages for biomass evaluation is not always practical, IER technicians were trained in how to quantify individual forage species visually. Village women were trained in the preparation of *Cassia tora* for ensiling. Through the interview process, key points in holistic planned grazing were reviewed and reinforced with NRMAC members and environmental auxiliaries. Karim Ouattara, IER zootechnician, through participation in this research, has received on the ground training in conducting of open ended and semi structured interviews.

### **Advances in Scaling Up**

Although this research was designed as an evaluation, data on the scaling up potential of holistic planned grazing has been obtained. More work will need to be done on verifying the non-toxicity of *Cassia tora*. Additional precision is needed in the specifying the best biological indicators for rotational grazing of tethered plots.

## **Advances in Environment and Natural Resource Management**

All the experiments were designed to improve/restore natural resources as well as utilize resources that are not traditionally used, such as invasive weeds species. We have demonstrated the potential for use of an invasive plant, known as *Cassia tora*. This plant, if managed properly, can increase soil fertility through N fixation and P extraction and recycling of nutrients. The feeding value of this plant is also being explored. The result we obtained so far indicated that the quality of this plant is equal to or superior to most of the common forages grown within the community.

## **Publications**

### **Book Chapters**

Bingham, S. 2004. In Press. *Holistic Management Applied to SANREM Research and Development in Madiama*. In Moore, K. (ed.) Conflict, Social Capital and Managing Natural Resources. CABI Press, London, UK.

Ballo, A. and A. Ouattara. 2004. *Investigation Into the Movement of Cattle, Sheep and Goat Herds Through the Commune of Madiama*. In Moore, K. (ed.) Conflict, Social Capital and Managing Natural Resources. CABI Press, London, UK.

Abaye, O., M. El Hadj, A. Kodio and M. Keita. 2004. *Controlled Grazing: Botanical Response and Animal Performance*. In Moore, K. (ed.) Conflict, Social Capital and Managing Natural Resources. CABI Press, London, UK.

El Hadj, M., O. Abaye, A. Kodio and M. Keita. 2004. In press. *Dry Season Feed Supplements: The Potential Role of Cassia tora*. In Moore, K. (ed.) Conflict, Social Capital and Managing Natural Resources. CABI Press, London, UK.

## **Other Major Outputs**

### **Conference Paper**

Roncoli C., C. Jost, K. Moore, A. Ballo and S. Cissi. 2004. *Lessons in Social Learning, Visions of Scaling out: Fostering Institutional Capacity for Community-Based Land Management in North-Central Mali*. Paper presented at the International Workshop on Land Management and Carbon

Sequestration in West Africa. Bamako, Mali. February 26-27, 2004.

Roncoli, C., K. Moore, A. Berthe, S. Cisse, C. Neely and C. Perez. 2004. *An Analysis of Institutional Supports for Community-Based Land Management Systems with Carbon Sequestration Potential in Mali*. Paper Presented at the Workshop on Reconciling Rural Poverty Reduction and Resource Conservation: Identifying Relationships and Remedies. Cornell University, Ithaca, New York. May 2-3, 2003.

### **Proceedings**

Ballo, A., A. Nadif and A. Kodio. 2004. In Press. *Gestion Holistique des Pâturages Naturels: Cas des Deux Sites Pastoraux de la Commune Rurale de Madiama*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

El Hadj, M., O. Abaye and M. Keita. 2004. In Press. *Qualité de L'ensilage, Caractéristiques Chimiques, et Palatabilité de la Cassia tora Ensilé Contre Frais*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

Kodio, A., M. El Hadj, O. Abaye and M. Keita. 2004. In Press. *L'impact du Pâturage Des Moutons Attachés sur la Performance Animale, Biodiversité, Régénération, et Production de Biomass*. Proceedings of a Workshop on Institutional Innovations and Development of Technologies for a Decentralized Natural Resource Management. Bamako, Mali. February 24-26, 2004.

### **Degree Training**

Meriem El Hadj , Ph.D., 2001 - 2004