Workshop

Abstracts

Scale Effects in Decision Making for Ecoregional Development.
San Jose, Costa Rica - July 4-6, 2000

[Global] [Country] [Region] [Microregion]

Global level

Ron Knapp

Methodologies for Ecoregional Projects

In 1996, CIAT and partners designed a project to assist the planning of collective action among representatives of organizations operating at multiple political and geographic scales. A formal proposal titled, “Methodologies for Integrating Data Across Geographical Scales in a Data-rich Environment: Examples from Honduras”, was submitted to, and funded by the newly created funding consortium: “The Trust Fund for Methodological Support to Ecoregional Programs”. The objectives of the Project, its purpose and outputs, remained unaltered over the course of the Project. The research strategy, however, evolved as part of a learning process following interaction with hillside stakeholders at different levels of decision-making. Originally, the scientists planned to deliver to partners and stakeholders finished databases including unique, multi-scale characterization of Honduran agro-ecosystems. However, from the process of participatory diagnosis and planning meetings, the strategy evolved away from providing ready-made answers (or characterization) to emphasize providing generic procedures to help stakeholders design their own questions and characterization for analysis, in addition to developing principles and procedures for building a database and for performing multi-scale characterizations, as stated in the original objective. During this workshop, there will be presentations by both project and non-project researchers the purpose of which is to assess our collective capacity to contribute to humanitarian development efforts through an ecoregional perspective…which is to say: to comment on the quality of the science and research management achieved by this Project… and to call to our attention any potentially bad habits or pitfalls that might jeopardize our future efforts and those of our colleagues involved in other ecoregional Projects.

[Top]

Mark Mulligan

Climate Change in the Latin American Hillsides : from Global Change to Local Impact

Development plans and projects whether for water resources, transport and other infrastructure or agriculture often assume a stationary climate. Whilst this at first appears a valid assumption, it seldom holds. All environments are subject to changes in seasonality and to inter-annual, decadal and longer-term fluctuations in climate to which biophysical, agricultural and socio-economic systems must adapt. An understanding of long term climatic norms and 'natural' climatic variability is critical for the successful and sustainable application of development objectives. This is especially true in the face of anthropic climate change.

The evidence for global anthropic climate change is increasingly clear both from the theoretical and empirical perspectives. Global mean atmospheric air temperature has varied by 0.3-0.6?C over the last forty years whilst proxy records indicate that these are unlikely to have varied by more than 1'C in a any century during the last 10 000 years (IPCC-WG1, 1995, p.31). The continued rise of greenhouse gas emissions and atmospheric CO^2 concentrations indicate that this temperature change is likely to continue, with important implications for global and regional patterns of climate.

Whilst general circulation models of the atmosphere (GCMs) provide good (robust and verified) indications of the impact of CO^2 emissions scenarios on global temperature and rainfall, these models have a spatial resolution of 100's of Km and are thus incapable of resolving regional and local climatic features and climatic change. This deficiency is particularly significant in areas with spatially complex climates such as the topographically complex countries of Central America and Andean South America, where topographic control produces dense climatic gradients.

Since most human activities interact, to some extent, with climate, climatic change will have significant consequences for most human activities, particularly agriculture. This is especially true where agriculture already takes place under marginal (environmental and economic) conditions. Understanding exactly who will be affected by climatic change, how they may be affected and what can be done to mitigate climatic impacts upon them is a multi-scale problem. GCMs produce scenarios for change at the country or continental scale but climatic impacts on human systems are realised at scales from the leaf, through the plant to the field and watershed.

In order to transcend these scale boundaries, regional or grid cell climate scenarios must be downscaled to individual points with known climates and then upscaled or regionalised to simulate climate and climate change over whole landscapes at the highest resolution feasible. This paper reviews the latest GCM predictions for climate change in Central and South America and examines the complex outcomes of simple climate changes over topographically complex landscapes. We examine who gets what and why and indicate how who gets what depends on the scale of observation and the topographic complexity. An analysis of population densities relative to the scenarios for climate change highlights the geographical and sectorial areas under greatest pressure.

[Top]

Hugh Eva

Multi-Scale Datasets for Highlighting and Assessing Forest Change in the Tropics

The TREES project was set up in the early 1990's by the European Commission for global humid tropical forest monitoring using Earth Observation techniques. The project's goals are to develop methods for rapid assessment of forest changes at regional to global levels, so that decision makers can more efficiently focus and measure the success of initiatives for forest conservation. Using a sample of high resolution satellite images spread across the tropics, the TREES project has carried out such an assessment for the whole of the humid forest belt. The methods developed, however, should be applicable at regional and national levels.

To reduce the variance of deforestation estimates coming from the sample sites, the humid forest belt has been stratified into regions of high ("hot spots") and low forest changes. The stratification was undertaken using information solicited from national and international experts, convened at a workshop at Ispra in November 1998. In total 95 sites were examined by local in-country partners for forest change between the years 1990 and 1997. For each site a pair of high

resolution images (Landsat TM / SPOT) were acquired. A uniform hierarchical legend was produced so as to both allow the maximum information on forest type to be given whilst facilitating aggregate estimates of forest change, and allowing comparison with the widely available FAO FRA 1990 data set.
Recognising that an expert consultation has a subjective element, TREES is now undertaking work to try and produce these strata from regional data sets – both remotely sensed and other ancillary information. These data include, near-real-time low resolution data for forest mapping, data on fire occurrence, data on centres of population. The 95 sites are being used as validation for the hot spots derived from coarse resolution data. Initial results for Latin America show that for Brazil hot spots derived from fire and forest change at the low resolution are confirmed by the high resolution analysis carried out by local partners IMAZON and ECOFORCA. In contrast in Andean ecosystems and in the west of the Amazon basin, interpretations by CIAT, IIAP and CPDI, show that such data is insufficient to highlight areas of change. Data for Central America, analysed by CATIE and CONABIO has yet to be tested.
This regional stratification approach is though to be fundamental to improving the efficacy of tropical forest monitoring – and may indeed be applicable to other types of land-cover land-use change studies, essential for different levels of decision making.
With the aid of thirty local partners, the project has succeeded in assembling a multi-scale data set, ranging from continental scale maps of forest distribution to local analyses of deforestation. These data are currently being organised into a data base with a single Intra-net interface, which will allow decision makers to examine aspects of forest changes at different levels, appropriate to their requirements.
[Top]

John Thomlinson

Issues of Scale in Land-Cover Classification

Numerous entities are involved in mapping land cover at regional and global scales, for a variety of different purposes, including assessment of development patterns and calculation of carbon fixation by plants, among others. Few efforts have yet been made to validate the accuracy of these classifications using site-specific data, nor has there been much study of the impacts of using unvalidated data. There are many difficulties involved in such validations, including inadequate site-specific data and non-standardized methods of comparing site-specific to regional classifications. Compilation of site land- cover data is very time-consuming, and is usually conducted for site-specific purposes: there is thus a danger of creating data sets that are not readily scalable to a regional level, and that therefore would be of limited utility for validating regional land-cover sets.
As an example of some of the issues, I have taken land-cover classifications of eastern Puerto Rico based on spatial imagery at a number of different resolutions: aerial photography at 1:20,000 and 1:30,000; satellite imagery at a pixel size of 20 m; and satellite imagery at a pixel size of 1 km. The issues addressed include thematic generalization (the different land-cover class schemes at local versus regional scales) and spatial generalization (the assessment of locational error at the different scales), and how different imagery products and different classification schemes combine to create uncertainty in our confidence in regional land-cover products. Reducing this uncertainty is critical for the progress of regional and global science using remotely sensed data.
[Top]

Robert E. Rhoades

Scale Wars and Other Battles over Turf: Why Scale really matters in Sustainable Natural Resource Project Implementation

One of the most important contributions of the Ecoregional approach has been to raise awareness of the importance of time, space, and conflicting viewpoints of multiple stakeholders. Most of the time-space discussion has taken place at the level of science and very little on what difference this makes to people on the ground, especially farmers and project implementors. This paper examines the concept of "scale wars" wherein different groups (NGOs, scientists, planners, local people) actually see the problem through very different eyes. This, in turn, leads to project politics in which each group tries to get activities tied to the scale with which they are comfortable and have comparative advantage. Case examples are taken from the authors personal experiences in several Ecoregional Projects.

[Top]

Charles A. S. Hall

Spatial Modeling and Questions of National Assessments of Economies and Environments

It is obvious that there are many linkages between economic activity and environmental consequence, both in terms of depletion (e.g. oil, soil, forests) and in terms of impacts (e.g. climate change, air and water pollution, toxins). Many of the depletions and impacts take place at sites remote from the economic gains, and hence are neither obvious nor deleterious to the person who gains but instead fall on others. In addition, the sort of (neoclassical) economic models that we have tended to use in development are intrinsically divorced from the material aspects of economic production, and act instead as if wealth were generated by money alone. I give an example of how we have undertaken a comprehensive analysis of the Costa Rican economy based on a biophysical rather than neoclassical approach to economics. This analysis includes many spatial aspects that give great insight into the actually possibilities of development and help us to understand how many past developments could not possibly have met their objectives. Spatial assessments are an important part of this analysis, as are an understanding of implicit industrialization. I conclude by giving some guidelines as to how these concepts might be applied to the subject matter of this meeting in an effort to improve our abilities to undertake successful development projects.

[Top]

Myrna Hall

Land-Use Prediction at Different Scales

GEOMOD, a land use change prediction model, was developed by researchers at SUNY College of Environmental Science and Forestry (Hall, et al. 1995a; 1995b) with funding from the US Department of Energy, Carbon Dioxide Research Program, Atmospheric and Climatic Change Division. A computerized geographic model (Hall, M. et al. 2000), GEOMOD, simulates the pattern of land use change in the tropics from non-developed land to developed. The underlying assumption of GEOMOD is that we can predict the future spatial pattern of land use change based on historical patterns of human settlement. Through statistical analysis of the spatial pattern of change observed in the past, the model converts undeveloped cells that have attributes similar to those found in the areas already impacted by humans. We have applied GEOMOD at the continent and countrywide scale and we are about to test it at the local scale for determining

the "without project" scenario in a number of carbon sequestration projects in the tropics. The model is particularly useful in analyzing historical patterns of land use change and predicting future spatial distribution of various land uses. The consequences of such development, i.e. loss of habitat, loss of protected watersheds and hence water quality, loss of natural resources, e.g. good soils for agricultural production and forests for sustainable harvest can be assessed through application of the model and comparison of different land use decision scenarios can be undertaken. GEOMOD determines both the rate and the location of land use change. The first is derived from analysis of land use maps representing two or more points in time. The area converted versus time (i.e. acreage deforested/yr.) is the rate we apply to future scenarios. If we find correlation between the conversion rate and population and/or economic growth (or decline) over that same period of time we are better positioned to parameterize the model, given expected future population growth rates and economic activity. Scale plays an important role, not only in terms of data inputs to the model, but also in terms of economic rate drivers which may be external to the ecoregion being analyzed.
[Top]

Thomas R. Leinbach

Regional Development Investment Decision-Making: Issues of Accessibility, Integration, Scale and Sustainability

While regional, and especially rural, development continues to receive considerable attention from governments and lending agencies, too little consideration is being given to the real needs of target areas in light of their environmental constraints, potential for growth, and resources. Moreover too often investment impacts on local populations are neglected. Increasingly such investments must be made bearing in mind the notions of accessibility, integration, scale, and sustainability. The paper emphases a broad methodological framework which, allows assessment in priority fashion, given certain constraints (ecological, capital, etc.) and objectives, appropriate investment decisions. Transport investments along with other critical projects are examined in a particular regional situation where the goals of integration, scale criteria (including the hierarchical aspects of infrastructure and urban system) and sustainability are paramount. In addition consideration is given to the growing importance of decentralized decision-making and its implications for appropriate and sustainable development models.
[Top]

Carlos E. Hernandez

Reducing Pesticide Run-off to the Caribbean Sea Project Development under the Global Environment Facility

The United Nations Environmental Program for the Protection and Development of the Marine Environment for the Wider Caribbean Region and the countries of Nicaragua, Costa Rica, Panama, and Colombia have developed a regional project to study the agricultural systems, to identify and document the problems, and to propose solutions at a regional, national and local level. The legal base for the project is the Cartagena Convention and its Land-based Marine Pollution Protocol. The project benefits the entire region. However the cost of implementation would have to be assumed by the four participating countries mentioned above. Therefore, the project was presented to the Global Environment Facility for financial assistance in order to share some of the cost. EARTH University is co-ordinating the regional effort. Agriculture is the mainstay of the economies of the Wider Caribbean Region which produces approximately 60

percent of the world's coffee, 40 percent of the bananas, 25 percent of the beans, and 20 percent of the cocoa along with significant quantities of sugar, corn, cotton, and rice. On a regional level, export-oriented agricultural production is the main source of foreign exchange earnings. Specifically, the agricultural sector provides approximately 50 percent of GNP in Colombia, 20 percent in Costa Rica, 27 percent in Nicaragua and 8 percent in Panama. Export-oriented production is mainly monoculture on large private plantations that generally occupy the most fertile land. However, subsistence farming has a significant stake and impact in the region.

Because of this focus on agriculture, the region has become a major user of pesticides. In addition to agriculture, substantial quantities of pesticides are used in programmes for the control of disease vectors such as dengue and malaria. Significant quantities of pesticides are mobilised from agricultural land uses and transported through watercourses into coastal waters. There is evidence on the levels of contaminants in sediments and marine organisms to reveal the transboundary/regional character of marine environmental problems. Environmental impacts of pesticides, including the degradation of the quality of ground water, coastal areas, estuaries, rivers, coastal lagoons, and marine ecosystems have been confirmed in separate studies. The contaminants accumulate in aquatic food sources, and can reach levels that present significant risks to human consumers. Intensive and excessive use of pesticides can result in disease vectors becoming resistant, thereby increasing the threat to human health and pest management efforts.

Even though the environmental and human health risks are evidenced on a regional scale, the solution to these problems involve the development and enforcement of policies at a national scale, and the implementation of better management practices at a watershed level. The question remains as to who benefits from the implementation of these programs and who should bear the costs.

[Top]

Gaston Grenier

Watershed Scales and Levels (Experiences with projects in Central America)

A strategy of all projects is to classify all or part of the watershed area. Most projects support the classification strategy of beginning with the diagnosis and participatory planning of the whole area (capacity for use, current use, conditions of use). This results in the prioritization of zones and critical areas (often in the higher parts), the definition and demarcation of protected areas, communal strategic plans, and a joint vision of the watershed and its problems. The other instrument that contributes to the classification strategy is that of planning at plot or farm level. This is called territorial classification on the basis of microplanning. The two instruments should include the characterization of land ownership and of water availability as soon as possible in the diagnosis.

Projects favor the strengthening of organizations at different levels and for different functions. At the local level, local and municipal governments, town councils, municipal development councils, agroecological associations, water boards, groups of producers, of women, of juveniles, et cetera are at the same time participatory tools. They are instruments of economic and social autodevelopment, of evaluation, and of knowledge transfer, and are promoters of sustainable resource management. Some administrate financial services at local level. The projects offer examples of local organizations that make watershed management compatible with processes of participatory development. Involving women in the strengthening of local organizations gives greater force and objectivity in defining priorities and in implementing respective actions.

Examples of coordination are found at national, regional, and local levels, which are defined according to project size. Local organizations only operate in small watersheds, while projects with important resources require national and regional organizations. At national/regional level, the organizations designate norms for development (land use, hydroelectric power, forestry, health, landscape, rural development, etc.). In most projects, they often form a superstructure of interinstitutional coordination (e.g., watershed network, association). In some cases they are linked more or less formally with financial groups that offer the financial resources required to generate the expected benefits. Once the project is concluded, in order to achieve continuity in the sustainable management of the watershed's natural resources, coordination passes into the hands of local groups. For many of the participants, the local governments or municipalities should assume the leadership of interinstitutional coordination at this stage. In reality, this requires conditions that are not found in most municipalities: a greater decentralization of State institutions toward municipalities, commitment, strengthening and active participation of the municipalities, and a sufficient level of revenues from good management of the collection of municipal taxes and payment of water services, ecotourism, protection of the civil infrastructure, et cetera. As external assistance withdraw, communal groups and groups of interest are often those that lead interinstitutional coordination after having developed a basis of sustainable autodevelopment and automanagement.
Finally, many projects benefit from the support of groups representing other actors in the watershed (peripheral organizations) and that are dedicated to delivering different services to the communities. The participation of stakeholders from different levels should be balanced. Settling agreements and treaties that define responsibilities and commitments among parties facilitates communication and participation.

[Top] [Global] [Country] [Region] [Microregion]

Country Level

Guillermo Suazo

Agro Ecological Zoning Of Coffee In Honduras

The Honduran Coffee Institute, aware of its responsibility with respect to the generation and transfer of technology, has been involved in the last years in the "Agro-ecological Zoning of coffee production in Honduras". The main purpose of this study is to carry out a very detailed and documented characterization of the different coffee regions of our country, as well as to know better the present factors that condition the yield and productivity of the crop. This data intensive exercise will serve as a basis to propose and implement more objective policies that address sensitive issues such as technical support and marketing of this strategic crop, in relation to land zoning and administration, with a geographical perspective. The scale of the final products will be down to department level. According to the extension of the coffee park in each department and the Agro ecological conditions present, the proposed models will help us to locate the regions with the highest possibilities to obtain the best coffee qualities (there are 18 departments in our country). We expect more than 335 thematic maps to be produced in this study (close to 20 maps by department).

Data coming from diverse sources, including CIAT "Mitch Atlas" and other georeferenced information such as the Coffee census, have been used for the analysis.
The study variables are distributed in four main components: soil fertility, climate, productivity and qualities of coffee (from census data). In total, up to 230 variables are being considered in the analysis of this study, where the relationships among the different variables were analyzed. Close to 18,000 soil fertility samples, 2,000 coffee quality analysis, 5,000 crop handling census and several climatic data were considered in the realization of this study By identifying significant variables and relating them to important characteristics of coffee production (such as quantity and quality), we can locate areas that present the ideal conditions for the cultivation of coffee, looking for an answer to: "Where can we obtain the best production and the best qualities of coffee?", "What crop management is the most suitable in this zone?".
We present results for the western part of Honduras concerning this zone as one of the areas with high potential for productivity and quality coffees in Honduras.
[Top]

Andy Nelson

Analysis of Market Potential

Transportation is a critical function for an economy. It affects the movement of people, goods and services, and development, and it is clear that the poor state of any transport system acts as a powerful brake on agricultural productivity and growth. Accessibility has social, economic and environmental dimensions and can be seen both as a pressure on existing natural resources and as a key factor in the development process. Just as (catchments) watersheds are defined by topographic surfaces; economic catchments can be defined by market-potential surfaces. Using this analogy, we create new areal units of physical and economic relevance, which reveal patterns and processes within the Honduran agro-ecosystem at levels of organisation from town, through regional and national. Scenarios for the impact of seasonal weather changes are created and their impact assessed at the same levels.
[Top]

Ian Turton

Honduran Mortality: The Effect of Location and Time

An analyst with, for example, a mortality dataset wants to know where people are dying, but would also like to know if there are any areas where more people than expected are dying in any areas, are there particular types of area that have higher or lower death rates than expected, or are there any particular times that have more deaths? This paper considers ways that can be used by the analyst to answer these and other questions. It will show the application of spatial data mining techniques to mortality data from Honduras over a variety of scales. The aim of the analysis is to demonstrate how regular (and automated) analysis of health data (but also other data sets) can help analysts discover hidden knowledge with in their databases. The data is initially analysed using the geographical analysis machine (GAM) of Openshaw et al (1987). This method searches for clustering in spatial data at a variety of user defined scales. GAM allows the user to consider the results of the analysis by combining the results at all scales to allow the discovery of unexpected clusters in the data, however more experienced or curious users may investigate the types of clustering at the individual scales investigated. This is often used to focus a search into specific areas of a country to allow more resources to be used in the further analysis of the clusters found.

Extensions to the GAM can be applied to these newly discovered areas or to the whole map if the clusters are dispersed over the whole study region. The geographical explanation machine (GEM) (Openshaw et al, 1999) can be used to investigate the relationships between other geographical information available in an organisation's GIS. This gives the user an opportunity to discover what factors occur in relation to the clusters found. A recently developed extension to the GAM system (Turton et al, 2000) allows a user to examine the stability of a cluster over time. This allows the analyst to discover if there are disease clusters as a result of contaminated water supplies or an insect vector at a certain time of year. The analysis of the whole data set aggregated over the available time period may well hide this sort of seasonal or one off cluster.
The remainder of the paper will discuss preliminary ideas on how recent work at Leeds on the automated handling of census data confidentiality could be combined with the automated analysis methods above to provide far better populations at risk by making use of individual data for a census rather than aggregate data as currently used. The FOSS (flexible output statistics system) would allow the GAM to draw the population at risk for each circle to be examined with out a risk of individuals being identified. A broader overview of the FOSS will also be given with an indication as to how it could be applied to the Honduran census.
[Top]

Gregoire Leclerc
Labor Productivity and Natural resources in Honduras
Is there a strong relation between soil, climate, germplasm, pest and labor productivity in an region? One can guess that natural resource conditions will have a strong impact on any society. Aren't temperate countries more developed than tropical countries, mountainous areas less developed than valleys, semi-arid conditions more adverse to agriculture than sub-humid or temperate conditions? We will analyze the village level Honduras census database together with biophysical variables such as climate and soils, and accessibility data computed with the accessibility tool. Simple econometric methods will be applied for the country as a whole (which is how it is done classically), then repeated at different spatial scales. We will analyze what are the gains and tradeoffs in using a cross-scale approach
[Top]

Gregoire Leclerc
The Use of Unit-Level Census Data for Research on Poverty: A Multiscale Approach
Unit-level data (individual, household or farm) from the 1988 population and 1993 agricultural censuses of Honduras have been integrated into a Geographic Information System (GIS). We showed how poverty indices can be computed for different scales of aggregation from village to country, and how they compare to other published figures. Indicators derived from the analysis of well-being ranking by local informants in 90 communities have been extrapolated to the entire country by means of proxy indicators computed from reasonably well correlated census data. We found that the choice of the indicator as well as the scale of analysis result different geographical representations of distributions of poverty, which may affect significantly the relevance and impact of poverty alleviation policies. We briefly introduce spatial statistical methods to process the data on a given scale, which allows analyses of correlation with other factors significant on the same scale. The same methods also help to detect errors in the data or to determine the optimum scale of a particular indicator
[Top] [Global] [Country] [Region] [Microregion]

Regional Level

Juan-Rafael Vargas

Regional Economic growth in the San Ramón River Basin

The Costa Rican Central Valley is where most of the economic, political and social life takes place. The Valley will end this century with more than a million inhabitants while the country had less than that fifty years ago. To spell it out mildly, the environmental impact is very large. The San Ramón River Basin is at the Western end of the Valley and for most part it is still a rural area going into a significant process of change. There are many other interesting features, including the fact it is a relatively affluent region (both in factor endowment and economic output terms). It has some mid-sized towns going through rapid change, and it also has a wide (and balanced?) range of economic activities, and it is crossed by major communication networks connecting the main Pacific Ocean port with the Capital (San José) City.

The first regional input-output table ever constructed in Costa Rica was developed for the River Basin with 1991 data. Input-output is a planning and structural analysis tool developed by Leontief in the fifties and widely used by economist and regional scientist. It resembles a still picture of the economic activity and its relationship at a moment in time. It assumes a specific type of production function and it holds while relative prices change little or none at all. The table was built with a hybrid method that took advantage of the national table and the regional data base developed by Produs.

Several applications were developed, mostly doing with forward linkages out of export bound activities (coffee and sugar cane). Yet, this paper discusses the result of an experiment evaluating the regional impact of air pollution out of the River Basin-wide economic activities. The work follows the research by Leontief and Ford; it is argued that economic activity-air pollution analysis is best if it is applied to a small region than on a country base. The results are interesting and do not contradict earlier findings.

[Top]

Fernando Sáenz

Land Use and Policy Analysis at Two Different Decision Making Scales

This paper presents an application of a bio-economic modeling approach to explore land use options for policy analysis, in two different decision making levels in Costa Rica. The so-called SOLUS (Sustainable Options for Land Use) methodology has been developed by the REPOSA (Research Program On Sustainable Agriculture) program in the last 11 years in the Atlantic Zone of Costa Rica. The main feature of SOLUS is the simultaneously integration of biophysical and socio-economic data, in order to identify possible land uses at different scales. SOLUS allows identifying and quantifying relations between an economic objective and social and physical variables. The main components of SOLUS are: 1) a bio-economic linear programming model, 2) two expert systems that generate technical coefficients for crops and livestock activities, and 3) a geographic information system (GIS). SOLUS has been applied to the following different scales: 1) peasant colony, 2) Watershed, 3) Canton, and 4) Region. In this paper we want to compare the outcomes of two levels of analysis, in two different zones: 1) regional level (Atlantic Zone) and 2) watershed level (Aranjuez river, Central Pacific Coast). In this paper we present the main economic features of the two models developed for each study zone. Furthermore, two policy scenarios are analyzed that address policy issues relevant for each case: agricultural labor availability, the effect of real wage increases, and use of alternative production

technologies. The study also aimed to show the usefulness of SOLUS to the Ministry of Agriculture and Livestock (MAG) as an instrument for policy support, analysis, and plan preparation.
[Top]

R. Azofeifa

Sustainable Options for Land Use Systems: A case study of the Application of a Methodology for Agrarian Analysis and Policy Making at the Ministry of Agriculture and Livestock in Costa Rica.

The present paper presents information about the results of a case study which was realized by the Research Program On Sustainability in Agriculture (REPOSA) of the Wageningen Agriculture University, the Netherlands, and the Ministry of Agriculture and Livestock of Costa Rica (MAG), as well as about technology transfer between the specialists who developed the model for Sustainable Options for Land Use Systems Methodology (SOLUS) and a group of national technicians.

An important objective of the interaction between REPOSA researchers and the technicians of the Ministry of Agriculture and Livestock was the establishment of a group of national technicians able to manage and further develop the model. This objective was realized through the execution of a training course as well as in service training on the SOLUS Methodology during the final year of the Program. Part of the training included the application and adaptation of the model in the watershed area of the Aranjuez River, as well as its validation as an instrument for agrarian analysis and definition of agrarian policies at a watershed level.

The study area, located in the Pacific Region, was selected on basis of selection criteria which included the presence and availability of biophysical and socioeconomic information as well as the level of interest of the regional authorities of the Ministry of Agriculture in the project and their awareness of its potential as a planning instrument. The projects' success also depends to a great extend on the interest and active participation of stakeholders such as policy makers and farmers in the studies and land use analysis to be developed.

To execute the explorative land use study in the of the Aranjuez River watershed area, a team was formed which consisted of a core of researchers and extensionist of MAG, including specialists in both socioeconomic as well as biophysical sciences. The team concerned reached a high level of interdisciplinary interaction and realized an integrated matrix of interdisciplinary knowledge which serves both extensionists and researchers from the various participating Institutions in their work of land use analysis, planning and agrarian policy decision making.

Once the SOLUS Methodology was set up, runs for the watershed based on a variety of agrarian policies and varying scenarios were designed and evaluated. The results were discussed among all team members and presented in two workshops, one with different stakeholders in the study area and one at a central level amongst representatives of several Institutions of the agricultural sector.

Costa Rica plans to continue with the research and application of the SOLUS Methodology as a tool for agrarian policy making and continues to look for collaborative interaction and cooperation between interested institutes and stakeholder groups. To strengthen the national capability for doing so, these institutes which now include two universities and an international agricultural cooperation institute for agriculture, are undertaking efforts to realize a project for the use and validation of the model in two regions of the country. The project referred to will permit to train a multidisciplinary group of technicians from the National Extension Service in

collaboration with the International Center for Agrarian Policy (CINPE) and other Organizations, both in Costa Rica and Honduras.
[Top]

Hans G.P. Jansen

On Tools for Land Use Analysis: Role and Complementarity of Methodologies for the Evaluation of Land-Use on Different Scales

This paper provides an overview of a number of different methodologies for land use analysis aimed at agricultural policy support, developed during a decade of collaborative research in Costa Rica. The methodologies are classified in five groups, (i) projective, (ii) explorative, (iii) predictive, (iv) generative and (v) prototyping. Whereas the first three involve land use analysis on (sub-)regional to national scales, the fourth quantifies actual and alternative land use systems on the plot level, and the fifth provides completely new farm or field management designs. For all methodologies, their implementation domain is explicitly specified, as well as their mutual complementarity and role in agricultural policy support. Together, the methodologies form a coherent toolbox to support policy design by analyzing (i) current land use, (ii) likely changes in future land use and their drivers, (iii) technical options for future land use, and (iv) policies intended to induce land use changes in the (near) future. It is concluded that, in order for quantitative, systems- based tools for land use analysis to be useful for policy makers, they should have a multidisciplinary and multilevel character, involving both biophysical and socio-economic sciences. Finally, reflections are offered on the importance of user involvement in both the development and the application of land use analysis methodologies for successful policy support.
[Top]

Sergio Velasquez
[Top]

Matilde Somarriba-Chang

Causality in Land-Use Trends at Small-Watershed Scale

Analysis of natural resources degradation, particularly soil erosion process, water scarcity and deforestation at a watershed level should take into account the social and economic constraints that evidence particular patterns under different conditions. Three different watersheds in Nicaragua can be used as examples to emphasise the linkage between socioeconomic components and natural resource degradation at a watershed scale.

Farm size and land tenure, for instance are associated to changes in land use which turn up to determine soil erosion risk in El Pital watershed. Erosion hazard is increasing at an increasing rate. The primary reason is that more of the watershed is being cultivated for annual crop production (e.g. beans, maize) than previously. Second, the portion of farm devoted to annual crop production is inversely related to farm size. Farm fragmentation associated with agrarian reform and inheritance customs have contributed to the increase in cultivation of annual crops, leading to an increase in erosion hazard (Somarriba-Chang, M. 1997).

Low crop yields, lack of crop diversification, poor use of appropriate technology are strongly related to land degradation, genetic erosion, lost of biological diversity and high erosion risk in the Acayo river basin, in a dry tropical area of Nicaragua (Blandon, V, J. Morales y J. Lopez, 1998).

Ecological indicators (soil, water, forest and crops quality) have a similar pattern than socioeconomic indicators (land tenure, nutrition level, education and management of agrosystem knowledge), in the Calico river basin, San Dionisio, Matagalpa (Gonzalez, B. J. Morales y N. Espinoza, 1999). At 6 of the 17 micro basins that compose the Calico river basin, the trends showed by the ecological indicators are associated to the tendency presented for socioeconomic indicators (Somarriba-Chang M. & B.Mendoza, 1999).
Knowing the relevance of the various social and economic factors that drive natural resource degradation will make planning and actions at watershed level more meaningful and applicable for the actual stakeholders. By addressing the causes of the problem and not the consequences sustainable watershed management would be more feasible.
[Top]

Alden Rivera

[Top] [Global] [Country] [Region] [Microregion]

Microregion Level

Nathalie Beaulieu

The Role of Decision-Makers at Different Administrative Levels on the Efficient Use of Landscapes: A Case Study in the Municipality of Puerto López, Colombia

Different people and institutions have different visions of how they would like to see the rural tropics. In spite of these differences, most would agree that they would like to see clean rivers, lush natural environments interleaved with productive agricultural land, with healthy and independent rural populations. Nobody has ever consciously wished for rural poverty, land degradation, urban migration of rural poor, the contamination of the environment, or the depletion of biodiversity and wildlife. These unplanned tendencies towards the "undesirable conditions" are encouraged when decisions are taken with a short-term or individualistic focus or without considering all of their consequences. They also occur as a result of negligence, when nobody takes the responsibility of making decisions or taking engagements to avoid or solve problems. This is much more likely to happen when the people who have the power to make decisions are not the ones who suffer the consequences of these decisions or negligence. Unfortunately, this is often the case in the management of natural resources because many important decisions made at different administrative levels affect individuals and institutions of other administrative levels.
One of the problems that concern us most critically at CIAT is land degradation. Agricultural land that is degraded and has lost its agricultural productivity does not give the environmental services of natural areas nor does it participate in the local economic prosperity. It is land that is "wasted" because it gives much less benefits than it could. The "effective" use of a landscape involves wasting as little land as possible, managing the minimum area of agricultural land but with the best possible management to insure the best productivity, and conserving natural areas to benefit from their environmental services. Many factors can encourage the "inefficiency" in the use of land, including the lack of agronomic technical knowledge, subsidies based on planted

area rather than on production, high interest rates that stimulate land speculation, and simply the lack of any long-term development strategy.
Our hypothesis is that undesirable tendencies in rural development, including land degradation, can be reversed if this development is planned with a multi-scale, multi- stakeholder and multi-disciplinary approach. In this approach, each stakeholder should be given its part of the responsibility and power in a collective set of actions planned to attain the "desirable conditions". As a case study, this article presents the recent process of land use planning in the municipality of Puerto López, with an emphasis on the aspects related to sustainable agricultural productivity, environmental quality and effectiveness of use of the landscape. This planning process was conducted by the municipality with CIAT's collaboration, with the long- term and participatory nature required by Colombian legislation. Although the planning was done at the municipal level, it involves stakeholders at different levels and formulates actions by individuals, enterprises, associations and communities. It also formulates actions by the municipality in collaboration with other administrative levels. The stakeholders of the different levels are partners in the different programs and projects put forward in the plan. Because this municipal plan has only recently been formulated and accepted by the municipality and the population, it is not yet possible to demonstrate the effects of this planning on environmental and human well-being. However, this article presents how stakeholders and decision-makers at different administrative levels have been involved in the planning and implementation of actions towards a common vision of the desired development for the municipality. It also discusses the role of each stakeholder and other related decision-makers in the aspects related to the effective use of the landscape. But the answers to all the problems have not been found yet.
[Top]

Glenn Hyman
Alternative poverty mapping strategies to address needs at national and sub-national scales.
In recent attempts to map poverty indicators, we found that many of the standard indicators in national censuses were developed for cross-country comparison and overlook needs to analyze geographic distributions of poverty at regional, national, and local scales. Many indicators fail to discriminate levels of well being because some aspect of the indicator is irrelevant or hard to measure for a given region. For example, house type and sewerage indicators work poorly in tropical humid lowlands because of the way people in these areas adapt to environmental conditions. International organizations funding the census programs have promoted the use of indicators that permit international comparisons at global and regional scales and which address global development agendas. In this paper we show examples of how many indicators found in censuses are inappropriate at regional and sub-national scales. We present alternative methodologies for analyzing the geographic distribution of poverty for 2 sites. In the Peruvian Amazon, we used alternative indicators from the census to develop indices of poverty at the village level. In Honduras, we extract indicators from the census and compare them to locally derived indicators. The strategies presented in these studies are of great interest to our national partners who have had similar difficulties with poverty indicators developed for international comparison.
[Top]

Bruno Barbier
Economic Modeling In The Rio Jalapa Watershed, Honduras.

The objective of this study was to predict what would be the effect of reducing erosion upon farmers' incomes in a small watershed using GIS and an optimization model. Our hypothesis was that reducing erosion through alternative land use would reduce sharply incomes. We also hypothesized that there are thresholds in the relation between incomes and erosion. The GIS/optimization model maximized the income of the whole watershed, considering the watershed as one large farm. The model had the choice between different land uses such as pasture, pine tree forest, broadleaf forest, coffee production, fallow and crops. The GIS/optimization model is a decision support tool that can help communities and policy makers select the best option, taking into account economic and environmental criteria.
[Top]

Alexander Hernández
Trade Off Between Income and Erosion in a Small Watershed: GIS and Economic Modeling in the Rio Jalapa Watershed, Honduras.
[Top]

Joep Luijten
Modeling of Strategic Water Availability in the Tascalapa Watershed, Honduras.
Water availability and quality has become a major threat to food security, human health and natural ecosystems. People in developing countries are particularly at risk in areas experiencing high population growth and limited means of managing water resources. One example are areas in the Latin American countries with steep slope hillsides where small-scale farming is the predominant production activity and means of food supply. An example area is the 11,200 ha Tascalapa watershed in Yoro, Honduras.
Decision-makers could greatly benefit from quantitative information on (i) variation in water availability over space and time, (ii) accessibility to water, and (iii) interdependencies between land and water resources. This paper presents the results of a simulation study that provides such information. We made use of the Spatial Water Budget Model, which was intended for supporting local level decision making processes and for teaching local stakeholders about basic landscape responses. Results of this study have also been included in the form of numerous images in the Honduran Community-based Decision Support System tutorial.
Specifically, we looked at the following aspects of water availability

1. Simulated river flow at the watershed outlet;
2. Locations of streams using various minimum flow rates
3. Accessibility to water for 495 households
4. Water yields from different zones of the watershed.

Materials and Methods The Spatial Water Budget Model (SWBM) (Luijten et al., 2000) was used for computing availability of stream water as it flows down slope in the Tascalapa watershed. SWBM is a continuous, distributed parameter, watershed-scale model that simulates water supply and demand over space and time on a daily basis using Geographical Information System (GIS) data structures.
SWBM requires various types of data (for details, see Luijten, 1999). Most importantly, we used a 100 m resolution Digital Elevation Model (DEM) for computing the direction of surface flow and delineating streams, as well as a 1985 land use grid (10 classes) at the same resolution. The land use grid was based on classification of remotely sensed imagery and air photography. Daily weather data (maximum and minimum temperatures and rainfall) collected in the watershed were

available for the years 1995 through 1999. In addition, 25 years of weather data were generated using the WeatherMan software.

Results The 5-year (1995-1999) average simulated river flow rate at the watershed outlet was 2273 L s-1, but it more doubled or even tripled during periods of heavy rainfall whereas it decreased below 500 L s-1 during the dry months of April and May in every year. The base flow index, i.e., the ratio of base flow over river flow, was 0.764. Note that Hurricane Mitch occurred in October 1998, causing tremendously heavy rainfall. A second simulation was carried out using 10 years of generated weather, which did not include any extreme events. This resulted in a lower average river flow rate of 2033 L s-1 and a higher base flow index of 0.853.

Results demonstrated that seasonal differences in precipitation caused a significant variation in the location of streams through the year. Any grid cell was considered a stream cell if its accumulated flow rate exceeded a threshold value of 10 L s-1. The location of streams was calculated for every day in the 10-year simulation period, and the combined length of all streams and the stream density was calculated for each stream network. Next, all daily stream networks were ordered by flow rate at the watershed. For the 1%, 10%, 50%, 90% and 99% percentile days (out of a total of 3652 days), the flow rates at the watershed outlet were, respectively, 310, 676, 1954, 3543 and 5406 L s-1. The combined lengths of all streams were, respectively, 45, 70, 109, 145 and 171 km. The stream densities were, respectively, 3.7, 5.8, 9.0, 11.9 and 14.1 m ha-1.

Accessibility to streams was calculated from the delineated stream networks and known locations of 495 houses, and plotted as cumulative distributions. On average, i.e., the 50-percentile case, half of the households were located within 200 m of a stream that carried 10 L s-1 and all households were within 1 km of such stream. Half of the households were farther than 2.1 km for a 250 L s-1 stream. For the 1-percentile case (very dry), only 63% of the households were within 1 km of a 10 L s-1 stream. The maximum distance was 3.4 km. Half of the households were within 6.5 km of a 250 L s-1 stream. On the other hand, for the 99-percentile case (very wet), half of the households were within 142 m of a 10 L s-1 stream and within 539 m of a 250 L s-1 stream. The farthest people would have to walk to any stream was 730 m.

Lastly, we studied differences in water yields of 6 different zones in the watershed as caused by differences in land use between these zones. Per-hectare water yields were calculated by month and by zone and compared to the average per-hectare water yield of the watershed as a whole (index of 100%). Whereas the relative water yield of some zones did not vary much from the watershed average, it varied between just 50% to nearly 140% for other zones during part of the year. In general, most extremes could be observed during or immediately after the dry season. These results demonstrated that differences in land uses, e.g., forest vs. bare soil, have different hydrological behavior, which can significantly affects water yields.

[Top]

Carlos Leon Perez

Economic Benefits from Soil and Water Conservation Techniques at the Farm Scale: The PAES Case, El Salvador

Soil and water conservation techniques are intended to reduce erosion, superficial runoff and improve water infiltration, however, there is little scientific evidence that these measures themselves could greatly improve farm income. This situation is of particular interest within small farmers who grow staple crops such us corn, beans and sorghum in many regions of Central America.

The biophysical conditions of El Salvador (A country wide 6 months dry season, heavy rains the other half) imposes natural constraints for these crops success, therefore yields are mostly for subsistence.
Bringing farmers to deliver soil and water conservation is not easy, basically because the planning horizon for most of them does not goes beyond the agriculture year, and the long term planning becomes an utopia.
The El Salvador Environmental Project (Joint IADB-Gov funded) hired three companies to deliver Soil and Water Conservation services to critical areas within the Rio Lempa Watershed, the most important to El Salvador (almost 50% of its territory).
An Abt Associates Inc and Winrock International consortium is one of these three companies, with and strategy to improve adoption through the following approach to improve the farm economy: Cost Reduction: 20% by adopting technologies such us IPM, Low input agriculture, soil protection and green fertilizers. The organizational model promoted makes farmers paying much less for inputs they will need or are used to:

1. Spatial Management: S & W conservation techniques are directed to enhance cropping areas trough better spacing and understanding on the most suitable areas for farming
2. Monitoring: this a Data Rich environment, and the project has developed a Data Base containing critical information on every farmer techniques, slopes, among others. GPS will bring spatial information to implement a GIS. The DB is intended to deliver information for project tracking and policy issues
3. Incentives: a common practice within this type of projects, the variation in this project consists in organizing “Community Funds” handled by the peasants. This measure is a key strategy for the project growth and economic sustainability.
4. Cash crops: as part of the AFS menu, medium term crops such as plantain, papaya or local crops as loroco will improve income within the first two years, while frits tress like oranges or lemons will deliver from year 5 on. Eucalyptus, Madreado (Glirycida sepium) and Teak are among the species used for intercropping or living fences.

[Top] [Global] [Country] [Region] [Microregion]