Integrated Modeling and Assessment for Balancing Food Security, Conservation and Ecosystem Integrity in East Africa

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Narrative Summary

This project is developing an integrated modeling and assessment system (IMAS) that integrates computer modeling, geographic information systems, remote sensing, and field studies to provide the information and understanding necessary to conserve biodiversity, wildlife, and ecosystem integrity while increasing pastoral food security. The IMAS is based upon an existing spatial-dynamic ecosystem model called SAVANNA. The IMAS quantifies the impacts of land tenure, enterprise scale, and conservation policy on four objective functions: livestock production, pastoral welfare, wildlife, and ecosystem integrity. The system will enable alternative policy and management strategies to be objectively explored, debated, implemented, and reassessed. The IMAS is being implemented at Ngorongoro Conservation Area, Tanzania; Kajiado District, Kenya; and the Lake Mburo National Park in Uganda; Regional analyses are being conducted to identify areas of high and low conflicts between pastoralists and wildlife, the economic costs of conflicts and the benefits of their solutions, and appropriate policies for mitigating and preventing unfavorable pastoral-wildlife interactions in an era of rapid land use changes, human population growth, and modernization.

Ngorongoro Conservation Area (NCA) is a multiple use area where wildlife , Maasai pastoralists and their livestock herds reside under the conservation and land use policies of the Ngorongoro Conservation Area Authority. In Loliondo, Maasai, livestock and wildlife co-inhabit an area where land use is not restricted by local land use policies. The most important factors affecting land use include an increasing human population, conservation policies and disease interactions. The IMAS is being adapted to simulate historic and current patterns of land use by the Maasai and by the NCA, to represent the degree of competition between livestock and wildlife for forage and usable habitat. Long-term changes in livestock and wildlife abundances, fire, and human wood utilization will be simulated, along with their combined impacts on the vegetation and soil.

The implementation of the IMAS for the NCA is proceeding well, through field studies, data syntheses, and modeling. We are establishing working relationships with the Ngorongoro Conservation Area Authority (NCAA), as well as NCA pastoralists. Meetings have been held with NCAA and several local authorities, numerous local Maasai herdsmen, NGO representatives and other interested stakeholders.

Reconnaissance surveys of the NCA and Loliondo District were carried out to meet stakeholders and to get a general idea of the contrast in land use patterns and land use strategies between the two areas. We are collecting socioeconomic, health and nutritional data on Maasai pastoralists.

Research

Problem Statement and Approach

Pastoralism or extensive livestock herding is the most prevalent form of land use in East Africa in terms of land area utilized. These pastoral regions also support some of the largest and most viable wildlife populations in Africa. Traditional pastoral livestock production has been highly compatible with wildlife conservation, but this compatible interaction is showing signs of disintegration in many parts of East Africa. Livestock and wildlife are viewed as competitors for limiting forage. Livestock are seen as spreading disease into wildlife, and wildlife are seen as spreading disease into livestock. Spatial components of pastoral ecosystems have been disrupted by competing forms of land use, with negative implications for ecosystem persistence.

Our first of three intensive study sites is the Ngorongoro Conservation Area, Tanzania where land use pressures have been growing rapidly. Pastoralists in the NCA share grazing areas with Serengeti migratory wildebeest and zebra. Pastoral population densities in the NCA nearly tripled 1966-1988. Many have settled, and are cultivating small plots. Increases in agro-pastoral populations have led to increased poaching, unplanned fires, and illegal. There is increasing conversion of pastoral rangelands and associated wildlife grazing areas to large-scale cultivation. Massive increases in wildebeest numbers 1960-1980 diminished NCA Maasai grazing lands. Maasai herders state that the traditional migratory herding pattern of moving down to the Serengeti plains for the wet season has been disrupted by the wildebeest expansion. Maasai cattle are now unable to take advantage of the nutritious grazing resources of the lowlands, resulting in lowered production and weakened animals which are more prone to other livestock diseases. Wildebeest transmit the fatal malignant catarrhal fever (MCF) to cattle, and other diseases such as Rinderpest, canine distemper, and rift valley fever, pose additional problems for pastoral-wildlife coexistence.

This project is addressing the different facets of the problem through the development and implementation of an integrated modeling and assessment system (IMAS). The IMAS will be used to improve prospects for establishing an appropriate and sustainable balance between food security and natural resource conservation in the pastoral regions of East Africa. The assessment system will integrate computer modeling, geographic information systems, remote sensing, and field studies. The core of the IMAS is a spatial ecosystems model called SAVANNA. The system will enable alternative policy and management strategies to be objectively explored, debated, implemented, and reassessed. The IMAS will include empirical and data-based assessment procedures, linked to computer-based procedures, and land-use analyses. Assessments will be made based upon modeling, and participatory involvement from stakeholders at the community level. The results of the assessment will then be used by land managers and policy analysts to develop environmentally and economically sustainable plans of resource utilization.

The results of ecological changes or developmental innovations are felt primarily and most directly at the household level, in terms of changes in income, food security and nutritional status. Impacts also have to be assessed at the community and regional levels, because landuse and other decisions are often made at these levels as well as at the individual household level. A human ecology and economics component of the IMAS is being developed to address processes at the household level.

A GIS-based disease submodel is being developed and will ultimately be linked to

SAVANNA. Employing a linked disease-SAVANNA model, we will predict the health consequences of alternative livestock and wildlife management strategies and disease control measures, and the relative trade-offs in terms of disease risk vs. loss of forage and animal productivity. Existing information for each disease will be evaluated to identify parameters for which data exist and those for which assumptions and estimates must be made.

Site-level studies are being conducted to assess changes in vegetation composition and abundance, and to develop a response database for ecological responses to resource utilization. Changes in herbaceous layer production and species composition are being studied in response to climate, grazing, fire, and soils.

A regional level component of the IMAS will be based upon GIS analyses. Cross-site comparisons are to be conducted among the study sites in 3 or 4 countries. More immediately, we are scaling-up to the region based upon our understanding of the varied situations in different countries and physical environments, and the distributions of such environments across the region. We are developing a regional-scale modeling initiative which will be designed to address broad-scale gradients and differences. Regional-scale GIS modeling will be used to identify areas of high and low conflicts between pastoralists and wildlife, in relation to policies which may be causes of, or which aim to resolve such conflicts.

Studies are being conducted to determine the policy environment at both the local and regional levels, to determine how the IMAS approach might be most effectively used to effect change.

Progress

The project includes modeling, GIS analysis, remote-sensing and field-based research in three east African countries: Tanzania, Kenya, Uganda. During 1998 we emphasized research in Tanzania but also carried out some preparatory studies and networking in Kenya and Uganda which will be the research foci in 1999 and 2000, respectively.

Tanzania

Modeling, GIS, remote-sensing

A vegetation map for the NCA was created by unsupervised classification of Landsat Thematic Mapper data. Preliminary vegetation types were assigned based upon existing maps. Several additional vegetation maps were acquired from cooperators, the US Geological Survey, and from digitizing published maps. These existing maps (n = 6) of the region were plotted at the same resolution and with similar color schemes for comparison and refinement. In October, an expert in the vegetation of the region reviewed the maps. We are now finalizing the vegetation map to be used in our study.

A long term remote-sensed NDVI data are being used to trace the dynamics of vegetation in the NCA, over a decadenal time period. We have developed a spatial-dynamic visualization tool to examine this data, which produces images and animations of vegetation greenness over time and space.

Compiling geographic data layers for use in modeling the Ngorongoro Conservation Area ecosystem is progressing well. Other geographic layers (e.g., boundaries, elevation, NDVI ratios, soils, roads, bomas, water sources) were acquired from published sources or cooperators, and merged into the information system. Climatic

data are in place for Ngorongoro. We continue to refine the characteristics of the SAVANNA model for the NCA. Our plans are to model seven vegetation functional groups, tracking both palatable and unpalatable grasses and shrubs. Eight herbivore functional groups will be modeled, including grazers (e.g., cattle, wildebeest) and grazer-browsers (e.g., goats, giraffe). A ninth animal functional group ? predators ? may be modeled as well, removing a portion of their prey in a density dependent fashion. Finally, an early version of a user-friendly interface for SAVANNA has been created. Although creating the interface and ancillary programs is complex, our experience suggests that using Microsoft Visual Basic and ESRI's MapObjects to create the integrated management system is most efficient. In the coming weeks we will be continue estimation of the values of the parameters used in SAVANNA. Parameters controlling biomass accumulation, herbivore foraging behaviors, and soil nutrient transfer must be set, for example.

Socioeconomic submodel and linkages

This submodel will address the economic outcomes of management scenarios on the pastoral population. The design of the model is rulebased which is flexible enough to incorporate various levels of market activity. For the NCA we have chosen nine strata based on three wealth groups and three elevational groups for which distinct rules may be required in the building of different household models. The model will be run at two levels: the household and at the regional scale where we can assess courserlevel processes such as ecotourism. We hypothesize that there is a quantity, T, of total livestock units per person that characterizes pastoral systems. It is not clear what this value of T is, but the idea is that this increases to levels at which the operator becomes a commercial beef rancher and it decreases to the point where agropastoralism commences. The rules in the household model reflect the management decisions that are taken to aim at the target TLU per person, which may vary with wealth levels. If there are excess animals, these can be sold for cash. If there is a deficit, then animals can be bought, if there are resources to do so.

We also hypothesize a hierarchy of goals at the household level. Food requirement is first met. If there is a shortfall, then this is made up by recourse to various options, including the selling of an animal. Second, the household is assumed to manage for investment and disinvestment decisions regarding livestock. Third, there is discretionary consumption.

Human ecological field research

Research was conducted in the Ngorongoro Conservation Area (NCA), northern Tanzania and in adjacent parts of Loliondo District. A total of ten US, three Tanzanian and two Kenyan scientists and graduate students carried out field research during 1998. Some of these scientists were supported by other leveraged research programs but all contributed to the objectives of the IMAS-CRSP. Research topics included pastoralist nutrition and welfare; pastoral demography and health; land use patterns of Maasai pastoralists; livestock holdings and involvement in crop cultivation; laws, policies and customary relations that determine land use in the NCA; vegetation production and range condition; livestock condition and sales; and a survey of livestock disease patterns and prevalence. We can say that the field research program went as planned and we were able to address all objectives. However, some of our Tanzanian colleagues had difficulties getting into the field and therefore had less time in the field than we had hoped.

The majority of the field research continued into August or September of 1998 and as

of October 1st, two researchers remain in northern Tanzania, completing their work. Results from the summer's research are now being compiled, so specific results are not addressed in this report.

Some preliminary results from this year's fieldwork suggests that this El Nino year had a major impact on land use and livestock condition and wildlife movements. The El Nino rains detrimentally affected livestock and crop production of the Maasai. However, relative to the previous drought year of 199697, the 199798 El Nino impact was not so severe. This year there was a high incidence of livestock disease, especially East Coast fever and calf mortality was estimated as being between 60 and 90 percent. Wildlife, especially wildebeest lingered in the NCA much longer than "usual" due to good forage conditions. Crops rotted and were washed, but last year they never sprouted. Measures of nutritional status however were similar to those which we found during more "normal" years of the mid 1990s. This suggests that the Maasai are able to ameliorate climate variability on their food supply, at least in the short run. This does not suggest however, that the Maasai are in good nutritional condition; on the contrary we have found them to be chronically undernourished. The question for the IMAS is under what management conditions can the Maasai maintain a modicum of well-being while maintaining their environment and the wildlife who live there.

Range ecological research in the NCA

Vegetation and range reconnaissance, sampling, and data synthesis were conducted in the NCA. Range conditions were deemed good to excellent partly due to the El Nino year. Data from the Ngorongoro Ecological Monitoring Program are being synthesized, to characterize biomass, species composition over time in response to climate and grazing. The biomass data will be related to satellite greenness (NDVI) data for broader extrapolation.

Disease research and modeling

An investigative survey was conducted in the NCA to determine the primary livestock and wildlife disease problems, and their potential solutions. Numerous authorities and pastoralists were interviewed. Data were gathered which will be necessary for parameterization of the disease model. A report is being prepared.

Good progress has been made on the development of a disease submodel. The model is based upon a model that was developed earlier to simulate brucellosis in American bison. Preliminary model runs have been conducted. A survey instrument has been designed to provide better information to parameterize this model.

Kenya

Field Research

Field research in Kenya was limited to one graduate student project (U. of Nairobi) on vegetation dynamics in 1998 (J. Mworia, under J. Kinyamario).

The major objectives of this study are:

1) Study differences in vegetation structure, composition, production and associated soil physical and hydrologic status as influenced by the management approach, grazing pressure and cultivation,

2) Characterize the main factors critical to the spatial distribution and standing crop of the key forage species in the study area and the influence of land management options, and

3) Assess the potential for integrated production of livestock and wildlife under various managerial and land use conditions. The study is based in and around the National Range Research Centre (NRRC) in Kiboko.

The expected outputs of this study are:

1) Quantification of the effects of three land management strategies namely; group ranch, small scale ranch/farm and a reserve, in a semi-arid area of Kajiado on:

- a. Vegetation structure, composition and population; biomass production and spatial distribution, animal feed diversity, and some soil physical and hydrologic aspects critical for sustained productivity.

2) The potential of the three management approaches to support sustained integrated wildlife and livestock production. That is, the classes and numbers of livestock and wildlife herbivores that can be best supported under the prevailing vegetation and soil status.

Modeling, GIS, remote-sensing

Major efforts were conducted at ILRI to develop a comprehensive GIS data base for Kajiado District, the main area of research in 1998-99, and for the east African region in anticipation of more regional scale research in the future. This included digitization of thematic maps and portions of the atlas of Kajiado District. A GIS technician was hired and two computers acquired to facilitate these efforts. Also at ILRI, we have undertaken the development of a socio-economics sub-model for SAVANNA. The model will be a modification of a dynamic land use model, developed by P. Thornton, to meet IMAS objectives. Thornton traveled to NREL CSU in March to coordinate his efforts with those of the SAVANNA modeling team.

Other Activities

Planning meetings were held at ILRI among US, ILRI and Kenyan scientists from the University of Nairobi and DRSRS, (Department of Remote Sensing and Resource Surveys) to specify research objectives and methods for year II CRSP research. Several reconnaissance trips were made to Kajiado District, led by M. Rainy to familiarize project scientists with the region, to gain a perspective on local problems, to identify research sites and to make contacts with local stakeholders. In addition, Rainy has been very active in publicizing the research program with local stakeholder organizations and with individual land holders, Maasai group ranches and with the Kenya Wildlife Service, the Dutch ASAL program and with other local stakeholders.

Uganda

No research was actually conducted in Uganda during 1998 although a lot was accomplished in terms of developing local contacts and local interest in the CRSP project. This is in preparation for initiation of limited activities in 1999 and a major field effort in 2000. Dr. Jim Else, Ms. Joyce Acen and Mr. Arthur Mugishu, all of the Uganda Wildlife Authority, worked hard to get the CRSP project well integrated with

other ongoing NGO research efforts (conducted by AWF and GTZ, among others) in the Lake M'buro region. They also conducted reconnaissance visits for US-based CRSP scientists to the Lake M'buro area. During these visits by J. Ellis, R. Reid (ILRI) and K. Galvin, a workshop was held with local stakeholders, including ranchers, civic leaders, research and extension agency personnel, NGO representatives and Lake M'buro National Park staff. Objectives of the CRSP project and an introduction to the SAVANNA model were provided by the CRSP scientists. Local participants reviewed problems and perspectives on wildlife-livestock conflicts in the area. In addition to the workshop, CRSP scientists participated in site visits to the Kanyaryeru Resettlement Scheme (a section of land de-gazetted from Lake M'buro National Park for agricultural settlement); local Ranches including private ranches and a government Ankole cattle breeding ranch and local farms where wildlife conflicts recently occurred. Finally, the team visited staff at Lake M'buro National Park to see firsthand the situation in the park and to get staff perspectives on conflicts between wildlife and the surrounding communities.

Gender

The end users of the IMAS include pastoralists, both male and female, as well as other stakeholders in East African pastoral/wildlife systems. A measurable impact of the IMAS is increased food security for humans, including women and children. Although pastoral women do not own livestock they do have control over food acquisition and distribution. Thus, they are an integral component of our project. As baseline data for the socioeconomic submodel we interviewed Maasai women about household food security. Information on agricultural food production and livestock production, women's diet intake and health status was collected. All household members were assessed for nutritional status. This information will be used in the IMAS system to project the effect of changes in policy, management, economic or ecological conditions. For example, if policy or management decisions are contemplated that suggest an increase or decrease in the flow of income or food energy, we can, based on the current nutritional status indicators, suggest the impact of these decisions on human welfare and food security by sex and age.

There are several women involved in the project. The coPI is a woman and there are two other USbased women researchers involved in the project. In addition, we have a woman team member who is working in Kenya and another who is our sitecoordinator for Tanzania. (Our graduate students funded on other projects, but working in Tanzania are all female). And finally, a team member and future Ph.D. graduate student from Uganda is a woman.

Policy

Work done on policy in 1998 included an assessment of the laws, policies and customary relations that determine the use of land and wildlife resources in the NCA. Interviews were conducted in Arusha and Dar es Salaam; pertinent documents were collected and reviewed. We are considering holding a one-day workshop to review policy issues impinging on east African pastoralists. This workshop will involve personnel from the CSU and Utah State CRSP projects. It will most likely take place in early 1999.

Outreach

Our outreach target for our first site, the NCA, are all the stakeholders we have previously identified. We intend to have a workshop which will demonstrate the model, show results of model output based on stakeholder problems and how to use a version of a userfriendly model. Computers and the model will be left in Tanzania for stakeholder use. The stakeholders include Ngorongoro Conservation Area Authority staff such as A. Kijasi, V. Runyoro and E. Chausi, K. Hirji and F. ole Kashe; representatives from NGOs such as AWF, WWF, and Maasai NGOs such as Inyuaat Maa and the Sanjan Development Association. Other stakeholders from the University of Dar es Salaam include I. Kikula and A. Nikundiwe. USAID officer R. Ruybal and other AID mission folks are interested in this process for possible work in other areas of Tanzania. Tanzania National Park people and Serengeti Wildlife Research Institute are other potential endusers.

Development Impact

Environmental Impact & Relevance

We are developing an integrated modeling and assessment system (IMAS) that will integrate computer modeling, geographic information systems, remote sensing, and field studies to provide the information and understanding necessary to conserve biodiversity, wildlife, and ecosystem integrity while increasing pastoral food security. Livestock based agriculture cannot be developed in East Africa without careful consideration of environmental impacts. Since ecotourism is a primary source of revenue for the region, and ecotourism depends on the continued viability of savanna ecosystems and the wildlife they harbor, any threat to savanna ecosystem viability would constitute a grave threat to the economic viability of the region.

Agricultural Sustainability

Livestock based agriculture, including extensive and intensive pastoralism, is highly dependent upon the natural ecosystem processes. East African rangelands are largely native ecosystems, and they have coevolved with ungulate herbivores for millennia, and with pastoral man for centuries. The continued viability of livestock based agriculture depends upon the continued sustenance of these well-adapted ecosystems over the long-term. The requisite ecological characteristics of intact pastoral ecosystems, such as ability to move over large areas and access key seasonal grazing areas must be fully recognized, and either conserved or emulated for successful combined use. Pastoralism was a sustainable land use under free access to grazing lands, but the reality is that now, land use is constrained.

The IMAS which we are developing will explicitly consider the ecosystem processes which are vital for livestock based agriculture, as well as wildlife. The IMAS is aimed at the identification of effective strategies for conserving the natural resource base that is the core of livestock-based agricultural sustainability.

Contributions to US Agriculture

The issues of livestock-wildlife and livestock-environment interactions are not unique to East Africa. Indeed many of the same issues occur in the U.S., particularly in the grazing lands of the Western U.S. We expect that the IMAS approach we are developing for E. Africa will be directly useful for livestock based agricultural systems in the U.S. The SAVANNA modeling projects of Coughenour, funded by USGS BRD

and NPS have many of the same objectives as the work proposed here, particularly development and use of the same model for the purpose of managing ecosystems dominated by large herbivores. SAVANNA is being used to assess wildlife-livestock conflicts with respect to brucellosis in Grand Teton N.P., the National Elk Refuge, and Yellowstone N.P. The model is being used to assess carrying capacity for wild horses, and interactions between wild horses and bighorn sheep in the Pryor Mountains, Montana.

Contributions to Host Country

The results of this project have the potential to have a large impact on wildlifepastoral interactions in that judicious and sustainable management decisions for pastoral ecosystems could be made with use of the IMAS. In Tanzania, for instance, the Ngorongoro Conservation Area Authority is very interested in using the IMAS as an integral part of their management planning. Serengeti Wildlife Research Institute director sees the IMAS as having great potential for their domain of interest. This project, should it be successfully used by stakeholders in the NCA, could be used by several other protected areas in Tanzania such as Tarangire National Park where USAIDTanzania has management interest. In Kenya, we established an MOU with the Kenya Wildlife Service, who is interested in collaborating on the use of the SAVANNA model to improve ecosystem management and the viability of savanna ecosystems.

Linkages and Networking

This project is linked to other projects as described below. We are networking with a wide array of institutions, projects, and initiatives as evidenced elsewhere in this report.

Collaboration with IARCS and other CRSPs

The International Livestock Research Institute is a full partner in this research.

Other Contributions

Support for Free Markets and Broad-based Economic Growth

Free markets and economic growth can be enhanced by improving the balance between livestock-based agriculture and ecotourism. Neither livestock based agriculture nor ecotourism, can prosper without considering the sustainability of this balance. These two forms of market enterprise are intertwined, and codependent, in that pastoral economies do, or at least could derive necessary income from both sources. Ecotourism must be protected as a free-market enterprise in East Africa, because it generates a large amount of foreign income. Touristic expenditures are undoubtedly recycled many times in the regional and local economies.

Contributions to and Compliance with Mission Objectives

This project is concordant with Strategic Objective 2, of Country Missions of Tanzania, Uganda, and Kenya, which aims to promote agricultural productivity while conserving natural resources.

Concern for Individuals

We are working with land users and land holders, mostly pastoralists, whose livelihood depends upon their continued ability to utilize the grazing ecosystem. We are eliciting input from these stakeholders about their concerns. We are also concerned with the wants and needs of people who place a high value on having wildlife populations and a healthy environment.

Support for Democracy

Our work supports democracy by increasing food security, by striving for compatibility in different forms of land use, and perhaps most importantly, by providing an objective source of information to any stakeholders, and to the public. Democracy cannot thrive, corruption and graft are more prevalent, and tyrants are more likely to wield power, in environments where people are in strife, where there is mistrust, and where there is an advantage for those able to spread propaganda.

Humanitarian Assistance

We provide humanitarian assistance when we can and when there is a great need, on an incidental basis while working in the field. However, we are not funded to provide humanitarian assistance on this project.

Leveraged funds and linked projects

Several other research projects have direct or indirect linkages to the GL-CRSP/IMAS. These fall into two categories. Some projects provide direct inputs of information and/or methodological advances to the GL-CRSP/IMAS; others are spin-offs or applications of the GL-CRSP/IMAS methodology, adapted to other ecosystems and/or other problems of a similar nature.

Projects Providing Inputs to GL-CRSP/IMAS

1996-1998. Integrated Assessment of the Effects of Climate and Land Use Change on Ecosystem Dynamics, Stability and Resilience on the Mongolian Steppe. U.S. National Science Foundation. $400,000 for 3 years. J. Ellis, M.B. Coughenour, K. Galvin, K. Price, Principal Investigators.

1997-1999. Land Use Change in East African Savannas: A Case Study in Northern Tanzania. U.S. National Science Foundation, Anthropology Program. $200,000 for two years. K. Galvin and J. Ellis, Principal Investigators.

1997-2000. Integrated Assessment of African Savannas through Spatial-Dynamic Vegetation and Land Use Modeling. U.S. National Science Foundation. $450,000 for three years. M.B. Coughenour and J. Ellis, Principal Investigators.

Applications of the GL-CRSP/IMAS Methodology (Indirect Contributions)

1998-2001. Responses to Climate Variability and the Utility of Climate Forecast Information for the Livestock Sector in the Arid and Semi-arid Zone, South Africa. NOAA Climate and Global Change Program. $336,000 for 3 years. K. Galvin, J. Ellis and C. Vogel, Principal Investigators.

1999. Integrated Modeling and Assessment for Balancing Food Security and Ecosystem Integrity in the Mara-Serengeti Ecosystem: Transboundary Ecosystem Management. $250,000 for three years. USAID/REDSO (Nairobi Office) M. Coughenour, J. Ellis, K. Galvin, R.Reid et al., Principal Investigators.

1999-2000. Living with Uncertainty: Northern Great Plains Agroecosystems in the 21st Century. USDA. $120,000 for one year. D.Watt, J. Dodd, J. Ellis, and K. Galvin, Principal Investigators.

1995-1999. Large Mammalian Herbivores, Plant Interactions and Ecosystem Processes in Five National Parks. U.S.G.S. Biological Resources Division. Francis Singer, P.I. $683,000.

1995-1999. Landscape-Scale Gap Analysis: A Complementary Geographic Approach for Land Managers. U.S.G.S. Biological Resources Division. T.J. Stohlgren, P.I. $765,000.

1995-1998. Integrated Assessment of the Effects of Climate and Land Use Change on Ecosystem Dynamics, Stability and Resilience on the Mongolian Steppe. National Science Foundation. J.E. Ellis, PI. $400,000.

1998-2202. Spatial Modeling of Yellowstone Bison and their Environments. U.S.G.S. B.R.D. $113,000. M.B. Coughenour, P.I.

1998-2001. Ecological Studies of the Jackson Bison and Elk Herds. U.S.G.S. B.R.D. $293,500. F. Singer and M.B. Coughenour, P.I.s

1998. Assessing Carrying Capacity for Elk and Other Native Ungulates, and Cattle in the Owl Mountain Habitat Partnership Program Area of Northern Colorado. $50,000. N.T. Hobbs, M. Coughenour, J. Ellis P.I.s

Training

In progress

Randy Boone, Postdoctoral Research Associate, Colorado State University - full support.

Jeff Worden, Ph.D. candidate 1, Colorado State University - full support.

John Mworia, under Prof. Kinyamario,

M.Sc. candidate 2, University of Nairobi, Botany - support for field studies.

Yusufu A. Ndyamkama, under Prof. Nikundiwe, M.Sc. candidate 2, University of Dar es Salaam, Architecture and Lands - support for field studies.

M.S. Maskini, under Prof. Kindunda, M.Sc. candidate 3, Sokoine University, Animal Sciences - support for field studies.

Mr. Onyango, GIS/modeling trainee 2, ILRI - salary.

Peter Weisberg, Postdoctoral Research Associate, CSU - partial support.

Beginning in 1998

Joyce Acen, Ph.D. candidate 2, Ugandan, at Colorado State University, Ecology - full support.

Frank Atieno, under Prof. Njoka, M.Sc. candidate 5. University of Nariobi, Range Science - partial support.

A. Kijazi from NCAA to attend, Shortcourse on GIS and ecological modeling - ILRI.

Kris Metzger, Ph.D. candidate, Colorado State University, partial support for field work only.

Comments

We believe there is widespread interest in furthering the objectives of this approach, and we have seen it expressed by government agencies, donors, and various branches of USAID. We are encouraged also by the potential synergism that exists with other research and development efforts, and the high level of willingness of other parties to collaborate. We are hopeful that the initiative will grow through increased collaboration with other agencies, particularly with other branches of USAID. We will need a broader base of funding and other support for this effort to be ultimately successful. Early signs indicate that the collaborative approach is working, towards providing the necessary base.

Most of us, including the PI, other senior investigators, and researchers at ILRI, are full or part-time soft money research scientists, or faculty with 4.5-9 month appointments. The current limitation of a maximum of 10% of budget to be spent on PI salaries is, at best, marginally workable. This project is subsidized by other research projects or by personal time if the actual time we put into this project exceeds our income from it. We will require a significant increase in salary support in order to expand our efforts any further, into additional linked projects. The other grave problem is the large matching contribution that is expected of our university. We are likely at our maximum possible contribution, meaning we cannot take on additional funding from AID at the same matching rate. In all likelihood we will simply be unable to take responsibility for additional projects without increased salary support and a waiver of further matching fund contributions from AID. This seems unfortunate, and ironic, given the potential demand for our services.

Collaborating Personnel

United States

Dennis Child, Department Chair, Professor, Colorado State Univ., Rangeland Ecosystem Science Dept.

Michael Coughenour, Senior Research Scientist, Associate Professor (Affiliate), Advising Faculty Colorado State Univ., Natural Resource Ecology Lab., Rangeland Ecosystem Science Dept., Graduate Degree in Ecology.

Robert Davis, Senior Associate Univ. of Colorado, Institute of Behavioral Science.

James DeMartini, Professor Colorado State Univ., Pathology Dept.

James Ellis, Senior Research Scientist, Associate Professor (Affiliate), Advising Faculty, Colorado State Univ., Natural Resource Ecology Lab., Rangeland Ecosystem Science Dept., Graduate Degree in Ecology.

Kathleen Galvin, Senior Research Scientist, Assistant Professor, Advising Faculty Colorado State Univ., Natural Resource Ecology Lab., Anthropology Dept., Graduate Degree Program in Ecology.

Rodney Howe, Research Scientist. USDA-APHIS, Fort Collins. CO.

Ann Magennis, Associate Professor, Colorado State Univ., Anthropology Dept.

Terrence McCabe, Assistant Professor, Associate Director, Univ., of Colorado, Anthropology Dept., Institute of Behavioral Science.

Larry Rittenhouse, Professor, Colorado State Univ., Rangeland Ecosystem Science Dept.

Kenya

Dr. H.K. Cheruiyot, Assistant Director, Range Research. Kenya Agricultural Research Institute.

Jan Grootenhuis, Veterinarian Consultant.

Jenesio Kinyamario, University of Nairobi, Dept. of Botany.

Russell Kruska, International Livestock Research Institute.

Stephen Mbogoh, Univ. of Nairobi, Agricultural Economics Dept.

Michael Rainy, Explore Mara Ltd., Consultant. Representative, Ololepo Hills Grazing Assoc.

Robin Reid, Senior Ecologist. International Livestock Research Institute.

Paul Rwambo, Veterinarian.

Mohammed Said, Department of Resources, Surveys and Remote Sensing.

Philip Thornton, Agricultural Systems, International Livestock Research Institute.

David Western, Former Director, Kenya Wildlife Service.

Tanzania

Feetham Banyikwa, Adjunct Faculty, Research Associate . Univ. of Dar es Salaam, Syracuse University.

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