SOUTH AFRICA PARTNERSHIPS PROGRAM

Evaluation of Soil Quality for Improving Food Security and Sustainability of Irrigated Agroecosystems in Africa

Submitted by
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Statement of Accomplishments

The objectives of the project were:

1. To survey the major causes for soil degradation in South African irrigated systems and the effects these practices are having on soil quality for crop production.

2. To test and develop a low-cost kit for use by farmers or agricultural professionals in the region to assess soil quality in irrigated systems.

3. To provide workshops and short courses for graduate students and possible agricultural professionals on soil quality and methods for its assessment (with the participation of Stellenbosch University, University of the Western Cape, the Agricultural Research Council, Department of Agriculture and other stakeholders).

4. To develop sufficient research data and information to submit a larger proposal on assessment of soil quality in irrigated agroecosystems in South Africa.

During the grant period, the researchers realized that the focus of the larger research proposal should be on the effects of climate change on ecosystem resilience and sustainability in the Limpopo River Basin and developing countries in the South African region which are in the Limpopo River Basin should be included in the proposal. Therefore, Motavalli worked with scientific collaborators from Mozambique to expand the scope of the proposed research.

Between March 22–29, 2012, Dr. Peter Motavalli (Professor, Department of Soil, Environmental and Atmospheric Sciences, MU) visited Cape Town, South Africa to work with Dr. Nebo Jovanovic (Principal Researcher, Council for Scientific and Industrial Research (CSIR)) to:

- Conduct a two-day (March 24-25) graduate workshop on soil quality and soil quality assessment methods at the University of the Western Cape (UWC) with the collaboration of Dr. Dominic Mazvimavi, Professor of Water & Environmental Science in the Department of Earth Sciences, and Director for the Institute for Water Studies at UWC.
• Develop a research grant proposal for the National Science Foundation (NSF) Partnerships for International Research and Education (PIRE) with South African and Mozambican partners to support a multi-country (i.e., United States, South Africa and Mozambique) research project focusing on the effects of climate change on ecosystem resilience and sustainability through species diversity in the Limpopo River Basin. This effort also included a linked proposal from the South African and Mozambican partners to the U.S. Agency for International Development Partnerships for Enhanced Engagement in Research (PEER) program.

A. Graduate Workshop on Soil Quality and Soil Quality Assessment Methods

Drs. Motavalli and Jovanovic gave a two-day workshop to approximately 15 graduate students at UWC on soil quality and soil quality assessment methods. This workshop included lectures and discussion on an Introduction to Soil Quality, Soil Quality Indicators, Soil Quality Indices, and Management of Soil Quality. The objectives of the workshop were to: 1) discuss soil quality and its importance, 2) identify possible soil indicators and soil indices that would be relevant for South Africa and the region, especially in irrigated agroecosystems, and 3) become familiar with some assessment methods for soil quality and discuss their appropriateness for South African agriculture.

Laboratory exercises were conducted in the teaching laboratory of the Department of Earth Science at UWC each day of the course. These hands-on laboratory exercises introduced students to field and laboratory-based assessment methods for soil quality indicators. The methods covered included: 1) measuring active soil organic carbon with potassium permanganate, 2) determination of particulate organic matter carbon, 3) measurement of soil water-stable aggregates, and 4) measuring soil strength with a soil cone penetrometer. Detailed laboratory exercises including a description and an annotated step-by-step procedure for each method. Laboratory kits and materials that were purchased through this project were left with the UWC faculty to use in their teaching program. Dr. Jovanovic also provided soil samples that were taken from irrigated research sites in the Limpopo River Basin with contrasting soil quality for the laboratory exercises.

B. Develop a Research Grant Proposal for the National Science Foundation (NSF) Partnerships for International Research and Education (PIRE)

Dr. Motavalli met with several potential research collaborators and administrators from universities and national research agencies in South Africa and Mozambique to discuss submission of a NSF PIRE proposal and an accompanying proposal for the U.S. AID Partnerships for Enhanced Engagement in Research (PEER) program. He travelled to Maputo, Mozambique on March 29 – 31 to meet with Dr. Sebastião Famba, Faculty of Agronomy and Forestry, Eduardo Mondlane University, and Dr. Carvalho Ecole, Agricultural Research Program, National Inst. for Agronomic Research, Mozambique. He then travelled to the irrigated agricultural area north of Maputo to identify possible research sites on the Limpopo River. He also made a seminar presentation to the Mozambican National Inst. for Agronomic Research and worked on logistics for future students including housing and laboratory space and facilities. The list of research and educational collaborators included the following:
The title for the proposal which was submitted in May, 2012 was “Climate Change Impacts on Flood and Drought in River Valley Systems: Increasing Ecosystem Resilience and Sustainability through Species Diversity” and the total funds requested for the 5-year project was $5,839,392. A brief summary of the project is provided:

The flood plains and surrounding areas in the semi-arid river valley regions of Mozambique and South Africa are vulnerable to frequent flooding and drought events that cause large losses of property, land degradation and famines, resulting in human suffering. Owing to trends in climate change, it is predicted that extreme weather events, including increases in droughts and floods, will put more stress on water resources and food security in this region. The primary focus of this research proposal is to evaluate the resiliency of different land use management systems in order to assist in the mitigation of the expected impacts of future climate change induced droughts and floods. Investigators and students will examine soil, plant, and ecosystem parameters and unravel the impact of species diversity and management practices on ecosystem resiliency on both field and watershed scales. The PIRE investigators from the U.S., South Africa and Mozambique bring proven expertise and experience in atmospheric and hydrologic modeling, soil physics, plant ecology, biochemistry, molecular microbiology, soil science, and environmental studies to successfully accomplish this project. Specifically, we will compare land use systems of different management intensity including an intensive irrigated vegetable production system, tree-based multispecies system, grain-fallow or intercropping system, to native bushveld vegetation. We will use replicated field locations in Giyani, South
Africa and Chokwé Irrigation Scheme, Mozambique to monitor changes in ecosystem processes, such as runoff and erosion, carbon and nutrient inventory, primary productivity, and aboveground and belowground functional diversity to quantify ecosystem resilience with these different land use systems. These sites in South Africa and Mozambique provide a unique opportunity to examine the effects of differences of elevation, climate, soils, vegetation, and management on climate change and ecosystem resiliency across political boundaries and within the same river basin.

We have designed an educational program that will actively recruit and mentor underserved students and build cross-cultural experience and exchange of knowledge between U.S. and international participants. Our objectives are 1) to provide hands on international research learning experience for a total of 75 U.S. undergraduate students in Africa; 2) to train 10 U.S. Ph.D. students in collaborative international research; and 3) to mentor two post doctoral/early career researchers to be successful in networking and collaborative research. A total of 25 undergraduates will be recruited from Lincoln University, a historically black university in the U.S. The PIRE URP will consist of three sequential components: a 3-credit spring semester MU course, a 4 week field experience in Africa, and a follow up 2-credit fall course at MU. This type of interdisciplinary experience, skill development and collaboration with international scientists enables young scientists to be able to address critical environmental issues as well as other future environmental challenges that cross national boundaries.

An accompanying PEER proposal was submitted in May, 2012, by the South African and Mozambican partners led by Dr. Jovanovic entitled “Increasing Farm Sustainability in the Semi-Arid Limpopo River Basin through Improved Soil Water and Soil Fertility Management with Multispecies Cropping Systems”.

After extensive review by NSF and U.S. AID, both the PIRE and PEER proposals were not funded, but the collaborators are working on finding other possible funding sources, such as the SANREM CRSP of U.S. AID, during its next cycle of competitive grants.

C. Visit by Dr. Nebo Jovanovic to the University of Missouri

Dr. Jovanovic visited the University of Missouri campus in Columbia, Missouri from October 31st to November 3rd, 2012 to meet with MU faculty and students and scientists from the U.S. Agricultural Research Service to discuss possible research collaboration with CSIR and with his specific research program. He presented a lecture on environmental issues in South Africa in an undergraduate course taught by Dr. Motavalli and gave a seminar on his research to the School of natural Resources on Nov. 1st. He also went on a tour of the MU agroforestry research facilities, including the flood laboratory, at the Horticulture and Agroforestry Research Center (HARC) on Nov. 2nd. Dr. Motavalli discussed specific research projects that they could collaborate on and are in communication to develop those proposals. In addition, Dr. Motavalli and Dr. Jose are working with Dr. Jimmy Adegoke at the University of Missouri-Kansas City and who was a former research director with CSIR to develop additional opportunities with South Africa and in Missouri.