MAURITIUS RESEARCH COUNCIL

Abstracts of projects approved under the AAP-MRC-MoESD collaboration

4/18/2012

Compilation of the abstracts of the projects approved by the MRC board for funding under the Unsolicited Research Grant Scheme using the grant money provided by the MoESD under the AAP.

1. Use of Compost by farmers as an adaptation strategy for climate change: Land application and simulation studies

Dr Geeta D Somaroo (Principal Investigator), Professor Romeela Mohee (Co-Investigator), Mr Ackmez Mudhoo (Co-Investigator)

Sustainable agricultural development is widely acknowledged as a critical component in a strategy to combat both poverty and environmental degradation. Soil degradation continues to be a key factor in unsustainable production systems, despite decades of research on soil conservation and other sustainable practices. A key component of many unsustainable agricultural systems is degradation of soils through loss of soil organic matter. Consequently, there is a potential to increase SOC in most cultivated soils. Due to the fact that farm households in degraded environments are some of the world's poorest people, incentive mechanisms for carbon sequestration by natural amendments in agricultural soils could simultaneously contribute to the goals of alleviating rural poverty, enhancing agricultural sustainability, and mitigating greenhouse gas (GHG) emissions. Despite the obvious connection between climate change adaptation and sustainable agriculture practices, such linkages have rather scantily been addressed explicitly in the agricultural sector in Mauritius. The methodology to be used in this research study shall comprise the following stages, sets of experiments and analyzes: (1) comprehensive (and critical) literature review on the essentials, research conducted so far on the application of composts on different types of soil, namely dry, peaty and sandy soils etc., as well as the impacts of composts application on the growth rate and quality of food crops, (2) setting up of different treatments namely: (a) soil only; (b) compost and Soil; (c) soil and chemical Fertilizers; (d) soil and manure, and (e) compost, soil and chemical fertilizers; for comparing their effects on changes in soil characteristics structure, and plant growth. The following experiments and analyzes will be conducted on the different treatments namely food crop yields, root systems network, bulk density, porosity, water holding capacity, analysis of runoff, mineralization of carbon and organic carbon contents. The environmental impacts associated with the use of compost and the gaseous and aqueous emissions that contribute significantly to climate change will be assessed and analyzed using SimaPro software; and also the carbon footprint of the compost treatments will be determined. It is expected that the pool of results of the proposed research shall constitute a comprehensive pool of novel contribution to the knowledge in the field. Also, depending on the quality and variability of the results, it is inherently felt that the community of farmers can adapt to climate change through the use of compost, in view of building and maintaining soil carbon under different land management system in different locations and on different soil types, using results of this study. This shall be a driving force of this proposed project: it shall acquire a major pool of data which may be processed and used in future works related to Sustainable Agricultural Practices. Hence, the overall major outcome of this proposed study resides in that the results shall be a major support in developing an adaptation strategy through a shift in behaviour and agricultural practice of farmers as regards a fresh and preferred use of composts over chemical fertilizers and/or manure. The proposed project shall be a stepping-stone in fostering Sustainable Agricultural Practices among the farmers' community in Mauritius.

2. ENERGY FUTURES OF MAURITIUS IN A CARBON CONSTRAINED WORLD

Prakash (Sanju) Deenapanray (PI)

Energy is a vital input in the production and delivery of goods and services. Mauritius, like it is in the rest of the world, relies heavily on the burning of fossil fuels to maintain its socio-economic activities. The historical and continuous accumulation of greenhouse gases (GHGs) is now known to perturb the climate system, and the impacts from these changes are constraining the future development of developing countries. Island states face unique vulnerabilities to climate change. The last two decades has witnessed efforts to curb the emission of GHGs, but the trends are not promising as far as avoiding irreversible climate change by the end of the century. Now more than ever, emission cuts by both developed and developing countries will be required on a wholesale scale by 2050 to avoid a climate regime wherein all countries will be 'losers'. The 'holy grail' of virtually all countries in the world is to adopt sustainable development as a new model. One key aspect of this new model is to shift towards a low-carbon society. The proposed research will investigate alternative emission pathways for Mauritius for different atmospheric GHG stabilization levels. System Dynamics modeling will be used to propose low-carbon emission scenarios over the 2050 time horizon. The basket of viable technologies will be proposed for the different low-emission scenarios, and the investment costs will be estimated. Further, the potential for 'green' job creation will be investigated for the low-emission pathways relative to the business-as-usual situation. As a case study, the applicability of the System Dynamics methodology to develop Nationally Appropriate Mitigation Actions (NAMAs) will be demonstrated for Mauritius, and a general framework for developing NAMAs will be proposed.

This research proposes to investigate the implications of the development of Mauritius over the 2050 time horizon in a carbon constrained world. The innovativeness of the proposed project stems from the fact that neither systematic nor systemic applied research has been carried out in Mauritius to guide public policy on low-carbon development pathways to date. In order to bridge this gap, this proposal will use System Dynamics (SD) modelling as a planning tool to:

1. Develop a self-consistent and transparent SD model that integrates the complexities of Environment, Society and Economy, and which faithfully explains the historical development of Mauritius, including its GHG emissions;
2. Investigate the emission reduction potential of the actions and measures identified in the long-term (to 2025) energy strategy that is currently being updated;
3. Construct carbon intensity curves to 2050 based on different GHG stabilization scenarios, while taking into account the projected growths in the economy and population;
4. Identify the technologies and the investment costs for achieving low-carbon development. The financing opportunities through carbon credits, especially from Sectoral Crediting under dynamic baselines will be investigated; and
5. Use the previous steps to propose a framework for developing Nationally Appropriate Mitigation Actions (NAMAs).

3. The Use of System Dynamics Approach to Identify Integrated Coastal Zone Planning and Management Indicators for Mauritius: A Performance Evaluation Model.

Dr C. Bokhoree (PI) & Dr R Bhagooli

This project will relate towards developing a systemic model to support integrated coastal zone planning and management activities prevailing in Mauritius. As a small island, Mauritius has developed coastal areas that sustain the livelihoods of local inhabitants as well as the economy. There have been major developments in these areas as a result of the expansion of the fishing and tourism industries and other coastal activities. Mauritius is a Small Island Developing State (SIDS) and is highly vulnerable to negative climate change impacts on its natural and built coastal environment, thus endangering coastal activities which require coastal resources to be perennial. Consequently, the island is affected by complex coastal zone management challenges associated with an attempt to achieve economic growth without destroying the ecological systems that support human existence. Poorly planned coastal land use including residential, agricultural and leisure activities also generate aftermaths on climate change while exacerbating coastal vulnerability. These circumstances justify an integrated coastal zone management (ICZM) whereby coastal land use planning as one of its key constituents would also combine climate mitigation and adaptation measures. Mauritius host a range of activities related to tourism, recreation and fishing impacting both positively and negatively on the socio-economic environment of the coastal zones. Though these activities are sources of sustenance for the inhabitants, they irreversibly damage the marine and land based ecosystems depleting biodiversity and natural resources. Moreover, this situation already aggravated by climate change is likely to deteriorate if appropriate mitigation and adaptation measures are not taken. There is therefore an increasing need to initiate an ICZM process in order to ensure balanced management and sustainable development of these zones.

The objectives will be:
- to have a clear picture of the coastal zone and the issues arising,
- to find out whether a systems approach may be used to address coastal zone issues,
- to develop a performance based model to identify a set of indicators which best describes the coastal zone to be used for evaluation and monitoring of ICZM,
- to carry out scenario planning for specific demo sites using the model.

Flic-en-Flac demo site will be considered for this project. Data profiling and site characterization by means of a survey will be carried out to determine relevant variables. A system dynamics approach using causal loop diagram and stock and flow diagrams will be applied to illustrate the possible relationships between the variables to generate specific indicators. These indicators will in turn be used for scenario planning of the demo site. Scenario planning will help in identifying trends of the site and the implications if the simulation is forecasted on low, medium or high probabilities. The indicators obtained will be useful to assess an ICZM performance evaluation framework if put in place within a coastal area. Thee simulations may be useful for scenario planning which consists of exploring the future and to assess potential circumstances on one to ten year time span. The results of the study may be used as a basis not only for evaluation in this particular site but may also for other coastal zones of Mauritius. Furthermore, the successful implementation of such a model will eventually result towards supporting key ICZM initiatives undertaken in Mauritius by the relevant stakeholders (Example: Ministry of the Environment and sustainable development and NGOs).

4. Development of a wind resource map for onshore and offshore Mauritius

Mr K. Kathapermall and Mr V. Chuttur, Dr A. Suddhoo.

The project will involve the collection and analysis of wind data with a view to estimating the wind density power in the regions of Mauritius, both land-based and offshore. Wind measuring instruments will be located in strategic areas and the data thereby collected will be used in conjunction with available meteorological data from the Mauritius Meteorological Services to define a web based digital wind atlas for Mauritius. It is also anticipated that satellite wind data will also be made use of. The goal is to undertake a comparative exercise of land based wind energy versus near offshore based wind energy.

Background

Wind power is currently one of the most developed and cost-effective renewable electricity technologies. The advantages of wind power include:
•   Free source of renewable energy
•   Better wind capture with recent development in wind turbine technology
•   Generate no greenhouse gas
•   Occupy relatively less space than the average power station
•   Great way of producing energy in remote locations.

Rationale

Energy demand due to the rapid economic growth has made energy issue become a priority in the governmental agenda in Mauritius. The energy supply in Mauritius relies heavily on fossil fuels, especially heavy petroleum oils. However, due to issues of pollution, sustainability and climate change related to the consumption of fossil fuels, the Mauritian government is trying its best to divert its energy supply from conventional energy resources to new renewable energy resources such as wind energy. Also, land availability being a serious issue for an island like Mauritius, wind energy offers huge potentials in terms of offshore installations, where the wind is stronger as well as steadier.
Thorough analysis of wind data over a wide period together with wind turbine performance is essential to evaluate the econometric of any proposed wind farm in Mauritius. However, while onshore wind data may be available through the Mauritius Meteorological Services, on-site marine meteorological data are sparse for evaluation of oceanic wind power.
This study aims to draw on both land-based meteorological stations and satellite data, and both theoretical and practical measures of wind turbine performance to produce an interactive wind resource map for Mauritius. This map would be highly useful to any potential investor in the wind energy sector.
Methodology and Outcomes
•   Retrieval of meteorological wind data for onshore and satellite ocean wind data for offshore
•   Mathematical and computational modelling of wind resource for Mauritius
•   Validation of data and modelling
•   Visualisation based on ARCGIS

Outcomes

•   Generate a visual map display wind power resource for both onshore and offshore in Mauritius
•   Comparison between onshore and offshore wind power for Mauritius
•   Identification of potential locations for wind farm installation in Mauritius
•   Study the econometric of offshore wind farms in Mauritius and wind turbine performance

5. Socio-economic Implications of the gradual depletion of the fishery stock in the Rodriguan Lagoon: A case study of the Piqueuse-Ourites.

Dr H. Neeliah & Mr A. Peedoly

This research project seeks to investigate the socio-economic impacts and changing livelihood strategies of the 'piqueses-ourites' of Rodrigues, in a context marked by a depletion of the fishery stock in the lagoon allegedly as a result of the compounded effects of over-fishing, inefficient resource management and climate change, among others. The study will mainly adopt a quantitative approach using the survey method but complemented with Focus Group Discussions, in-depth interviews and cases studies to describe and enrich the lived experiences, coping strategies and expectations of the piqueuses-ourites. A key outcome of this study will be in terms of the identification of alternative livelihood systems, particularly alternative jobs within their indigenous knowledge base, as well as relevant support structures to assist this social group.

It is widely acknowledged that the Rodriguan lagoon has been affected by a gradual depletion of its fishery stock (See e.g. IFAD, 2008). The quantification and the reasons for this gradual depletion have yet to be systematically studied although key informants believe that a range of interrelated factors including over-fishing, inefficient resource management and climate change have all contributed to this problem. As traditionally the lagoon has been central to the livelihoods system of a significant number of fishers, it is clear that this gradual depletion has been setting in motion a number of socio-economic transformations which are impacting on the latter and their households.

Against this backdrop, this research project seeks to investigate the socio-economic impacts and changing livelihood strategies of fishers, focusing more specifically on the 'piqueses-ourites'. The main research questions which will frame this study will therefore be:

- To locate traditional lagoon-based fishing in the present context of fishery stock depletion
- To identify the socio-economic profile of the 'piqueuses-ourites'.
- To understand how this gradual depletion is leading to changes in the ways the latter earn their living i.e. what are their coping strategies?
- To explore how are these affecting them and their family at the level of the household-economy

In terms of methodological approach, this study will use a mix of research techniques in order to achieve as complete a picture of the realities of the Rodriguan 'piqueues ourites' as possible. It will adopt a quantitative approach using the survey method of some 100 'piqueuses-ourites' and this data-set will be complemented with Focus Group Discussions, in-depth interviews and cases studies to describe and enrich the lived experiences, coping strategies and expectations of the 'piqueuses-ourites'. Semi-directed interviews with key informants and experts in fisheries in Rodrigues will also be performed. In addition, the study will also rely on secondary sources of data for context-setting.

A key outcome of this study will be in terms of the identification of alternative livelihood systems, particularly alternative jobs within their indigenous knowledge base, as well as relevant support structures to assist the 'piqueuses-ourites'. Given the strong gender-bearing of this study, the findings of this study will inform gender-sensitive solutions for the empowerment of this social group.

6. Assessing the impacts of climate change on the phenology of native Mauritian plants

Mrs P. Tatayah

Plant Phenology is the scientific study of periodic biological phenomena, such as flowering, fruiting and budding in relation to climatic and edaphic conditions. The main factors influencing Plant Phenology are temperature, rainfall, humidity, photoperiod, soil quality, water stress, seed predation and dispersal, pollination and herbivory.

Global climate change and its associated impacts on ecosystems, species and populations are in the forefront of current ecological research. Phenology studies worldwide are revealing that climate change is having a significant effect on wildlife. However, there is paucity of information about the influence of climate change on our native forests. Anecdotal evidence indicates that climatic changes are impacting on our biodiversity but detailed studies are required to demonstrate the extent of these impacts on native flora and fauna in order to increase our understanding of the phenomenon.

For the current study, a list of 48 native and 16 exotic plant species consumed by Pink Pigeons and Echo Parakeets have been identified. The species are monitored at five study sites, namely Plaine Lièvre, Pigeon Wood, Bel Ombre, Combo within the Black River Gorges National Park, and Ile aux Aigrettes. Each of these five sites differs in altitudes, forest type and species composition, soil and rainfall. Up to 20 individuals of each key food plant species at each site have been tagged on a selected track. The number of selected plant species may vary between sites depending on the abundance of the individuals of the species at a given site. Selected trees are monitored monthly by the field scientists for presence or absence of flowers, fruit, flower buds and leaves. The presence of a certain parameter is recorded as '1' and absence as '0'. The binary method has been adopted for ease of data collection and analysis. The field data are entered in a database for analysis.

A key component of this project is the finer assessment of seasonal variations on phenology, using the meteorological equipment to be acquired through this funding. Rain gauges and thermometers will be placed at the five sites. The climatic data will be collected on a daily basis by field staff. The data will be initially analyzed to assess the correlation between rainfall and temperature at the study sites and the presence or absence of floral features or onset of different biological parameters under study.

The expected outcomes of the study will include an updated database of the timing of recurrent biological events of selected native and exotic food plants, a phenology calendar for the flowering and fruiting periods of native species and a report containing recommendations to increase resilience of native forests to climate change. The project will also have a post-funding sustainability through the phenology manual, trained staff, database and meteorological equipment. The project will also support to the formulation of national strategies to adapt to global climate change.

7. MODELING THE EFFECT OF LARGE-SCALE CIRCULATION PATTERNS AND OTHER FACTORS ON WATER LEVEL IN RESERVOIRS IN MAURITIUS: A HYDROINFORMATICS APPROACH

Mr P Khedun, K. Gopal & A. Sohun

Mauritius is slowly emerging from one of the harshest drought the country has faced. In 1998-1999 the island faced a similar drought which resulted in a decrease of 40% in sugar production and a drop of about MUR 2 billion in GDP. On the social level, the occasional water deficit the country faces and the resulting reduction in supply to domestic consumers has led to riots in several regions.

Climate variability patterns such as El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) have been attributed as potential causes of these droughts. ENSO is the most dominant climatic variability pattern and affects the hydrological cycle around the globe. It is a coupled ocean-atmosphere phenomenon related to sea surface temperature (SST) anomalies in the central and eastern equatorial Pacific; two sentences and associated sea-level pressure difference known as the Southern Oscillation. ENSO has a recurrence pattern of $3 - 6$ years and every event normally lasts for around a year. El Niño events are often (but not always) followed by La Niña events. IOD is an ENSO-like phenomenon in the Indian Ocean basin. It is characterized by SST anomaly between the tropical western Indian Ocean (50°E-70°E, 10°S-10°N) and the tropical south-eastern Indian Ocean (90°E-110°E, 10°S-Equator). The IOD is short-lived; it usually peaks in October and quickly recedes. Empirical orthogonal analysis of gridded SST showed that 12% of SST anomaly in the Indian Ocean is associated with the dipole mode. The dipole is independent of ENSO and strong dipole modes have been seen to coincide with different phases of ENSO (neutral, positive, or negative).

The underlying hypothesis for this study is that there exist a statistically significant relationship between these large scale circulation patterns and local hydrological conditions, especially precipitation, which determines water level in the reservoirs. Tools within the realm of hydroinformatics (e.g. statistical analysis, artificial neural network, support vector machines, etc.) can be used to develop a model linking climatic and meteorological data to precipitation and hence reservoir levels.

The proposed study will provide a more accurate picture of how water levels in selected major reservoirs vary. Furthermore, given that the state of ENSO and IOD can be projected a few months before they occur, the predictive capabilities of the proposed model can be used as a warning tool, thus giving water planners enough time to prepare and implement appropriate mitigating plans. The results of this study can also help in developing sustainable long-term water plans to better manage the limited water resources of the island.

8. Evaluation of the Vulnerability of Coastal Communities to Climate Change in the Island economies – The Case of the Republic of Mauritius

Prof S. Sobhee, University of Mauritius

This project will shed more light on the socio-economic consequences of climate change in the context of Mauritius. It will particularly focus on the coastal communities who are very much at risk when it comes to extreme atmospheric/climatological conditions. While it is well known that climate change is a very slow process and its impacts may not be felt within a very short lapse of time, nevertheless, it is possible to track certain short run episodes of extreme weather conditions that comprise this long run pattern. Episodes of droughts, floods, sea-level rise, and an increase in the frequency and intensity of tropical cyclones provide enough indication of what could be expected to happen eventually. All in all, it is imperative to analyze the preparedness of populations that are easily threatened and that could become an easy prey to natural hazards. Mauritius being in the tropics lies in a zone which makes it highly vulnerable to such hazards. Recent years have shown quite a few episodes of extreme weather situations that have led to loss of lives, lost of economic output, social concerns, inflation and higher public as well as private spending to address natural hazards despite being short-lived. Given limited funding, the proposed research will focus on the mainland of the Republic; in particular, selected coastal villages that could be highly vulnerable to changing patterns of the global climate. The focus as mentioned earlier is to track the socio-economic aspects from identified hazards that certain coastal communities may be subjected to. It is intended to address the degree of preparedness of different communities, fishers, agriculturists, farmers, economically-disadvantaged people, and the homeless, amongst others. In addition, it is proposed to analyse how, and to what extent, could the surveyed communities resist to loss of lives and income, damages to habitats and public infrastructure, water shortages, land and landslides and health hazards. Moreover, the project will investigate into the potential adaptability and mitigation scenarios. The implications of our findings will be discussed through potential policy formulation by the central government as well as local authorities (district council).Our proposed methodology stretches from existing documentation and uses of secondary data, for instance uses of GIS maps, interviews with several key informants from the various ministries concerned and NGOs, through focus groups, to primary data collection. The latter will be done through a well-crafted questionnaire that will track demographic elements, socio-economic variables, people's perceptions and preparedness. The data generated will be used for more profound quantitative analyses (regression equations) to ensure the scientific rigour all along. In addition, there will be workshops/seminars that would be conducted by the team of researchers to disseminate, discuss, evaluate and validate the findings at different stages. The latter will be an important component in drafting policy implications. Needless to add, the findings of this research will be very useful to the local and central governments, private promoters and builders, fishing and agricultural as well as farming communities, people in general and the academic community. It is intended that the report will thereafter, subject to the approval of funding agencies, be published for a greater outreach.

9. **Assessing the Potential of Using Coal Ash & Bagasse ash as Inorganic amendment in the Composting process of Municipal Solid Wastes: Improvements in Compost Quality for Agronomic Application**

Prof R Mohee

Summary of the project

The objective of this project is to investigate the feasibility of co-composting coal and bagasse ash with sorted municipal solid wastes to produce enhanced quality compost as a soil-amendment material, as well as to optimize the proportion of coal ash and bagasse ash to be mixed with these waste streams to obtain best quality compost for agricultural use. The variations of physical and chemical process parameters during the composting processes will be monitored, together with an assessment of the final composts produced.

10. **Safe and Sustainable Utilisation of Coal/Bagasse Ash in Agroecosystems as Soil Amendment and for Crop Protection**
Dr Bhannooduth Lalljee

Summary of the project

The objective of this project is to evaluate the agronomic and environmental characteristics of ash, which is a waste product generated during energy production from coal and ash. This project aims at finding a potential use for this waste and revalorising it as a valuable resource as a good soil amendment and pest control product, and for improved plant growth. Scientific data from the experimental work, and economic data through surveys and established sources, will be statistically analysed to develop predictive economic models on the use of ash.

11. **Assessing the Potential of Using Coal Ash & Bagasse ash as Inorganic amendment in the Composting process of Municipal Solid Wastes: Improvements in Compost Quality for Agronomic Application**

Prof R Mohee

Summary of the project

The objective of this project is to investigate the feasibility of co-composting coal and bagasse ash with sorted municipal solid wastes to produce enhanced quality compost as a soil-amendment material, as well as to optimize the proportion of coal ash and bagasse ash to be mixed with these waste streams to obtain best quality compost for agricultural use. The variations of physical and chemical process parameters during the composting processes will be monitored, together with an assessment of the final composts produced. The project is phased in four key stages, involving the University of Mauritius and Solid Waste Recycling Ltd.