SUSTAINABLE REGIONAL DEVELOPMENT



GLOBAL ENGAGEMENT / DEAKIN INTERNATIONAL

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SUSTAINABLE REGIONAL DEVELOPMENT GROUP

Deakin University: Burwood | Geelong | Warrnambool | Australia Located in Melbourne, Geelong and Warrnambool, State of Victoria, Australia, Deakin University is a dynamic young university that has moved strongly into multiple leadingedge research fields, developing world-class facilities and a rapidly growing reputation for developing projects with positive societal impacts. Deakin has international offices in India, China, India, Europe, Brazil and Uruguay.

Deakin **Centre for Regional and Rural Futures** (CeRRF) advances and implements the latest scientific knowledge and relevant practice that ensures sustainable and holistic urban, regional and rural development as well as identifies the opportunities arising, in particular, from climate change effects in communities and industries.

In association with Deakin Faculty of Science, Engineering and Built Environment (SEBE), staff at the Centre have developed, and teaches in, the new *Master of Sustainability – Specialisation in Sustainable Regional Development* and supervise PhD students from Australia and overseas. The Master is a two years full-time (or 4-years part-time) study with two streams (i) a research path, and (ii) an industry path. The former requires the development of a major thesis, which can be developed in the country of origin of an international student. Over 60 students from 20 developed and developing countries are currently enrolled in the Master and PhD studies and are developing theses and dissertations on multiple sustainable development topics.

Professors Victor Sposito and Robert Faggian have also been appointed by Deakin Vice-Chancellor as *Senior Advisors, Latin America*. In this capacity, they work in the Global Engagement Division with Deputy-Vice Chancellor Professor Gary Smith and the Pro-Vice Chancellor (International) John Molony.

Sustainable Regional Development at Deakin

Globalisation, population growth, economic structural adjustments, climate change and extreme weather events are having major impacts on national, urban, regional and rural economies, environment, and communities around the world. This is cause for major concern, but through sound analysis and effective planning these changes can be harnessed to create new economic, social and environmental opportunities for urban, regional and rural communities – see list of some of the major projects undertaken by the Sustainable Regional Development Group.

The Sustainable Regional Development Group

The Group's researchers are working hard to advance smart cities' development, food security, water and green energy resources management, agriculture and forestry development, manufacturing and services industries, regional competitiveness, and sustainable urban, rural and regional development. To develop projects and initiatives

the Group closely collaborates with governments at all levels, industries, NGOs, and communities both in Australia and abroad.

CORE CAPABILITIES

- Strategic Planning and Management
- Project Development, Management and Implementation
- Urban, Regional, Rural and Environmental Planning and Modelling
- Climate Change Impacts, Adaptation Assessments and Policy formulation and Measures
- Socio-Cultural and Economic Analyses, including Job Generation and Innovative Green Clusters Development
- Environmental and Industrial Biotechnologies
- Sustainable Agriculture and Forestry Development
- Water Resources / Hydrological Modelling and Analysis
- Blue-Green Infrastructure Analysis and Design
- Green Energy Analysis and Biophysical Design
- Regional and Urban Land Suitability Analysis and Land Use Mapping
- Soils Science and Pedological Digital Mapping
- Remote Sensing Information from Satellites and Unmanned Aerial Vehicles (UAV or drones)
- Logistics and Transport Connectivity, Supply Chain Management and Global Product Value Chains
- Information and Communication Technologies (ITC), including Software Engineering, Intelligent Systems, Data Analytics and Artificial Intelligence (AI)
- Geographic Information Systems (GIS) and Visualisation
- Information, Planning and Decision Support Systems.

PARTNERS AND COLLABORATIVE PROJECTS

The Sustainable Development Group partners with National, State and Local Governments, Regional and Catchment Management Authorities, industry and Non-Government Organisations (NGOs) to develop and implement innovative projects, methodologies, methods and models in multiple areas of endeavour. In particular, our

models predict the impact of climate change on human settlements, natural resources (water, land, soils) and agricultural and forestry productivity in the present and the future (e.g. years 2030, 2050, 2070). Our development projects include practical initiatives to tackle current and future challenges and plan for better futures.

Our projects and research span the State of Victoria in Australia, and globally - Brazil, Chile, Mexico, Peru, Uruguay, Peru, Nepal, Sri Lanka, The Philippines, Vietnam and China (see Projects and Research, below).



PROJECTS AND RESEARCH | AUSTRALIA

RECENT AND CURRENT PROJECTS

Land Suitability Assessment in Melbourne's Green Wedges and Peri-Urban Areas – State of Victoria

This project - undertaken for the Victorian Department of Environment, Land, Water and Planning (DELWP) - informed the delivery of *Plan Melbourne* (Action 17) via the strategic analysis of biophysical 'Land Suitability'. This involved modelling the versatility of land for key crops according to climate change scenarios up to the year 2070. The modelling used detailed soil data from a complimentary land/soil study developed by Agriculture Victoria Research of DELWP. The project analysed, in particular, the likely impact of climate change on agriculture and forestry in a large region around Melbourne (within a 150km radius from its CBD). This analysis was combined with other relevant matters - such as proximity to environmental assets, water sources and distribution centres - to identify areas of strategic significance. This is essential for long-term planning and the resilience of green wedge and peri-urban agriculture and forestry, which, in turn, supports enhanced planning decision-making. **See: Figure 1.**

Sustainable Economic Development Strategy for Gippsland – State of Victoria This project formulated a Sustainable Regional Development Strategy for the Gippsland Region in Victoria to enable its industries and communities to adapt to climate change. It focused, in particular, on regional, industrial and infrastructure development, including agricultural industry transformation. It designed a *Strategic Spatial (or Territorial) Framework* that integrates three levels of analysis and planning: (i) Strategic, (ii) Sub-regional/*Production Areas* and (iii) industry/enterprises. Production Areas were defined as geographic areas (or territories) within rural regions that are selected for the intensive sustainable development of agriculture (including forestry, agro-forestry and bioenergy), their associated activities and supporting infrastructure. The holistic analyses included demographics - population and housing trends and projections, labour force trends and projections, the environment including biodiversity, and key "hard' and 'soft' infrastructure. **See figure 2.**

Macedon Ranges Future Jobs Blueprint – State of Victoria

This project involved complex socio-economic and biophysical analyses to determine the best future investment opportunities in the Macedon Shire Region in Victoria. It was a major input into the Shire's *Economic Development Strategy*. In particular, this project identified development pathways to maximise job creation and investment out to the year 2035. The project analysed relevant statistical data, in conjunction with data obtained from a comprehensive business and industry study and a matching residential survey, both focused on mid-term futures. A complementary assessment of the competitive advantage of the agricultural sector in the region was also undertaken using Land Suitability Analysis. See: **Figure** 3 and https://www.mrsc.vic.gov.au/About-Council/News/News/Jobs-for-the-Future-Blueprint-to-inform-economic-development-strategy

Future Landscapes: Looking at the Land - State of Victoria

This project developed a *Regional Agriculture and Biodiversity Climate Adaptation and Opportunities Plan* for the Central Highlands Region in Victoria. In particular, the project formulated specific Biodiversity Action and Strategy Plans for the five Local Government Authorities within the region, as well as carried out a rural land use (statutory) review for the Hepburn Shire. It also developed a *Strategic Framework* for coordinated and collaborative planning, decision making and action to respond to regional strategic priorities, risks and opportunities in order to maximise positive outcomes for the region. **See:** https://futurelandscapes.cultivate.org.au/

Climate Smart Agriculture Development in the Goulburn Broken Region (GBCSAD), State of Victoria

This project generated specific long-term data, information and strategic plans, which enable Local Government Authorities and the agriculture/forestry sector in the Goulburn Broken Region to adapt to climate change with a focus on regional development, infrastructure and agricultural industry transformation. It developed, in particular, practical resources to assist the agricultural sector and the community adapt to projected climatic changes and plan for the future, such as an interactive Spatial Tool for Local Government and CMA adaption planning. This novel tool allows planners and decision makers to view the progression of agricultural productivity over time, from the present to the future (year 2050), and make informed decisions on economic development, investment and land-use planning. See: http://www.gbga.com.au/climate-smart-agriculture-development.html

This project was awarded the *Planning Excellence Award* of the Planning Institute of Australia (PIA) in the category Industry and Community Engagement, and the 2017 *Deakin Vice-Chancellor's Award* for Outstanding Contribution to Partnerships.



Figure 1 – Strategic map of one of the multiple Land Suitability Analyses (LSA) undertaken in the Green Wedges and peri-urban areas of metropolitan Melbourne, Australia.



Figure 2 – Strategic map illustrating the main components of the Spatial (Territorial) Framework for the sustainable development of the Gippsland Region of fVictoria, based on Production Areas.



Figure 3 – Likely evolution of the profitability of beef production under a worst climate change scenario (RCP8.5) in the Macedon Region of the State of Victoria, Australia.

Agriculture Industry Transformation: Spatial Implications of a Changing Climate – Gippsland, Victoria

This project developed high resolution Gippsland-specific climate change and spatial information that is assisting the region, its community and industry to adapt to the potential climate change impacts and capitalise upon the economic, social and environmental opportunities for agriculture and forestry and associated industrial and service development across Gippsland.

Strategic Planning for Adaptation to Climate Change in Regional Systems – A Case Study: South West Victoria, Victoria

This project, developed for the Glenelg Hopkins Catchment Management Authority and Local Councils formulated multiple scenarios for the possible development of the South West Region of Victoria, based on extensive biophysical analysis.

This project was awarded The Excellence Award of the Planning Institute of Australia (PIA) – Victoria Division in the category Rural and Regional Planning.

RECENT AND CURRENT RESEARCH

Climate Change Implication for Regional Development - Robert Faggian

Likely impacts of climate change on agriculture and forestry at regional level, implications for regional development, and formulation and implementation of innovative instruments for mitigating negative impacts and capturing opportunities, including the development of innovative water management systems.

Systems, Strategic Thinking and Holistic Methodologies - Victor Sposito

Application of Systems Thinking (Systems Science) to the development of methodologies and methods for assessing the impacts of multiple drivers of change on cities, city-regions and regions; new approaches to sustainable regional development, including the development of innovative *Production Areas* (*Clusters*) underpinned by essential 'hard' and 'soft' infrastructure.

Use of Geospatial Decision-Support Tools to Transition the Agriculture Sector to a Climate Smart Future - **Madeleine Johnson**

This research investigates the role of geospatial decision-support tools in supporting adaptation to climate change in regional/rural communities in the agriculture sector. Using a case-study approach in the Goulburn Broken Region of Victoria, it is identifying, and mapping, regional strategies - particularly the sustainable intensification of agriculture - within a GIS environment. An important outcome of the project will to embed local realities into decision making processes, and determining priorities using a variety of survey and analysis methods.

Planning and Decision Support Systems for the Environment - **Hemayet Hossain** Development of holistic Information Systems leading to the construction of Planning and Decision Support Systems based on Geographical Information Systems (GIS); and application of new methodologies for assessing environmental matters, including biodiversity.

Optimising Urban and Regional Policy - Ray Wyatt

This research involves predicting which people will prefer what policy using innovative stakeholder workshops and optimization software. Practical applications are already being implemented.

Blue-Green Infrastructure Development as a Response to Climate Change and Extreme Weather Events - Zahra Ghofrani

Water resources management is essential for sustainable development being critical to socio-economic progress, healthy ecosystems, and for human survival itself. Water is also at the heart of adaptation to climate change, serving as a crucial link between the climate system, the environment and human societies. This research developed, via case studies in Victoria, a sustainable environmental approach to tackle water-related crisis of flood, drought and pollution. We have termed the approach *Blue Green Infrastructure* (BGI). BGI is an interconnected regional network of natural and designed landscape components, including water bodies and green and open spaces, which provide multiple functions such as: (i) water storage for irrigation and industrial uses, (ii) flood control, (iii) wetland areas for wildlife habitat, and biodiversity corridors or water purification, among others.

Integrating Strategic Foresight into Sustainable Development of Catchment Land-use Under a Changing Climate – Glenelg Hopkins Region, Victoria -Jana Mrazova

This research project uses strategic foresight techniques to optimise land-use at a catchment/regional scale to achieve both environmental and economic benefits under a changing climate. It aims to determine the extent to which regional development strategies reflect the current and projected reality, using scenarios developed in cooperation with local experts. The output framework uses data generated by bio-physical and socio-economic analyses –population growth, economic development, climate change and land use transformations - with the foresight scenarios to formulate policy-informing, region-specific recommendations and implementation strategies.

Sustainable Economic Development in Peri-Urban Metropolitan Areas in the Context of Climate Change – City of Whittlesea, Metropolitan Melbourne, Victoria - Ana Spataru

This research project is developing a framework for sustainable development in periurban areas considering a wide range of socio-economic pressures. It focuses, in particular, on stimulating the local economy by metropolitan decentralisation in a polycentric approach. This approach has wide application in similar peri-urban situations.

Innovative Methodology for Evaluating Groundwater Resources for Sustainable Regional Development - Hanna Zydor

Agricultural and forestry development is underpinned by water. In the Victoria's Southwest Region - like in many regions around the world - groundwater is the dominant source of fresh water particularly for irrigated agriculture. For this region to sustainable intensify its agricultural activities and cater for the associated population growth in its cities and towns, a holistic understanding of the regional water balance under changing climate and socio-economic scenarios is required. In this context, this research is analysing the likely future water balance in the Victoria's southwest,

considering key biophysical, socio-economic and infrastructure-related factors. It will develop, in particular, widely applicable decision-support tools to enable water authorities to better allocate water under a range of development scenarios.

Regional Water and Wastewater System Optimisation Using Alternative Water Resources - Jason McGregor This research examined the challenges associated with water resource management in a future impacted by climate change, including the cause-and-effect relationship that exists between water systems and the world's climate. Specifically, the optimum mix of alternative sources of water in the Maryborough urban water and wastewater system, in Central Victoria, was assessed for its potential to reduce greenhouse gas emissions. Under a medium climate change scenario, yield, demand and quality were determined for the year 2040 in multiple traditional and alternative sources of water, including rainwater, stormwater and recycled water. A five-step novel methodology was developed and applied, including the analysis of six water resource scenarios to predict and optimise greenhouse gas emissions across individual elements of the water and wastewater system.

PROJECTS AND RESEARCH | GLOBAL

GLOBAL

Projected Changes in Wet-Bulb Global Temperature under Alternative Climate Scenarios – Don Gunasekera and David Newth

The increased levels of Greenhouse Gasses (GHGs) in the atmosphere will result in increased near-surface air temperature and absolute humidity. These two factors increasingly pose a risk of heat stress to humans. The Wet-Bulb Globe Temperature (WBGT) is a widely used and validated index for assessing the environmental heat stress. Using the output from the Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations of the four Representative Concentration Pathways (RCPs), we calculated the global and regional changes in WBGT. Globally, the WBGT is projected to increase by 0.6-1.7 °C for RCP 2.6 ('best' case scenario) and 2.37-4.4 C for RCP 8.5 ('worst' case scenario). At the regional scale, our analysis suggests a disproportionate increase in the WBGT over northern India, China, northern Australia, Africa, Central America and Southeast Asia. An increase in WBGT has consequences may be exacerbated in developing economies, which are less able to adapt to the changing environmental conditions.

LATIN AMERICA

BRAZIL

Projects in the State of Parana

Two major projects are being developed in the State of Parana sponsored by the State Government of Victoria, through the Department of Jobs, Precincts and Regions (International Education) and the State Government of Parana, through the Secretary of Education, Technology and Innovation (SETI).

Adaptation to Climate Change to Foster Economic Development in Parana Focusing on Agriculture, Water Resources and Soils

The purpose of this project is to promote economic development, sustainability and competitiveness in the Central, South and Central Campos Gerais Regions of Parana by: (i) assessing the impacts of climate change on agriculture and its utilization (inputs) of natural resources including water and soils; and (ii) generating knowledge and technical strategies for the conservation of natural resources, particularly the efficient use of water and the preservation of soils. It is being jointly developed by the Sustainable Development Group, the Universidade Estadual do Centro-Oeste (UNICENTRO) and the University of Ponta Grossa.

Climate Change Impacts on Water Resources in the Curitiba Region of Parana

The purpose of this project is to analyse the climate change impacts on water systems and land uses in the larger Curitiba city-region. Particular emphasis is being placed on the elimination of pollution, including chemical compounds such as steroids, in the water bodies of the region. This project is being jointly led by the Sustainable Development Group and the Pontificia Universidade Catolica do Parana (PUCPR).

Estimation of Agricultural Land suitability Potential for Maize and Wheat Production in Different Future Climate Scenarios in the Guarapuava Microregion of Parana – Lauro Ribas .

This project analysed the climate change impacts on wheat and maize crop productivity in the Guarapuava Micro-region, using climate modelling and local production database. In particular, the spatial and time variability of mean air temperature and mean rainfall, according to the IPCC climate scenarios RCP4.5 and RCP8.5, were used to calculate the Suitability Index of those crops. The results of this analysis were compared with the production indexes obtained in the field for the 2000, 2005 and 2010 harvests. The information enabled a detailed analysis of climate impacts on crop productivity in the study region. **See Figure 4**.

CHILE

The Impact of a Changing Climate on Snowmelt-Driven Catchments: Implications for Water Allocation Planning and Climate Change Adaptation in Agriculture: Comparison between Chile and Victoria – Edward Cornwell

Food security is one of the main worldwide challenges, even more so in view of water scarcity forecasts as a result of unfolding climate change and its impact over regional/rural areas. In regions fed by snowmelt, there is not a clear understanding about the role that snowpack dynamics could play to sustain downstream water requirements. Therefore, in this research project, a strategic assessment of agricultural land suitability is being undertaken in two particular mountain-valley regions in Chile and Victoria where competition for the water systems for irrigation and other uses is paramount. This research is thus addressing the definition of specific adaptation pathways in light of likely futures and the formulation of guidelines for decision-makers working in different domains. **See Figure 5.**

MEXICO

Eco-tourism for the Sustainable Development of Regional Areas -Paulina Gutierrez

Eco-tourism currently accounts for approximately 13% of global tourism and generates \$4.8 billion annually. It is predicted to grow to around 25% of the global travel demand by 2025. In this context, this research project focused on examining whether eco-tourism can be utilised as a tool to diversifying the economy of a region. Using qualitative and quantitative data supplemented by interviews and surveys of governments, industries and people, it compared the situation in the Janos Region, close to the Chihuahuan Desert, in Mexico with the Corangamite Region in the State of Victoria. It developed a Strategic Framework using strategic planning and evaluation indicators (criteria) of eco-tourism to sustainably develop the natural resources of a

region. The set of indicators include environmental assets (flora, fauna and hydrological resources), heritage and cultural places, relevant infrastructure, carrying capacity, and distance from existing urban settlements.

PERU

Spatially informed socio-economic study for the Moquegua Region in Peru – Lauro Ribas

This international project provided an integrated strategy to support multi-sectoral economic activity and employment; stimulate investment and growth in agriculture, forestry, fisheries, services, conservation and other economic sectors; as well as strengthening value chains. It included carrying out spatial analyses of sectoral opportunities, formulating agriculture and forestry (specific crop adequacy) models; determining livestock adequacy; the suitability for fishing, aquaculture and mariculture; and the region's capacity for industrial development. Designing and producing high quality production maps in a GIS system, and classifying land use coverage were also components of the work undertaken. This project was developed in 2019 by Lauro Ribas, acting as Consultant Senior GIS Specialist to the Ergo Strategy Group.

URUGUAY

Climate Change Effects on Surface Water Quality - Alejo Silvarrey

Eutrophication of lakes arising from nutrient-laden farm runoff is a serious problem in many countries which impacts on drinking water supplies and economic activities, such as tourism. The impacts will occur more often as the climate changes. In this context, the research is: (i) developing a novel method for monitoring the trophic state of surface water using remote sensing via satellite images and multispectral cameras mounted on Unmanned Aerial Vehicles (UAV) (or drones), and (ii) formulating a methodology to identify, through climate and land-suitability modelling, the most at-risk areas within catchments (or basins) over time to prioritise monitoring regimes. This will enable faster, cheaper and strategic monitoring of catchments and thus support land-use policies that limit the frequency and extent of eutrophication events. The overall approach is being tested in the Santa Lucia Basin in the south-east of Uruguay and lessons will be drawn for application in other contexts.

Urban Suitability Modelling and Analysis in Canelones, Uruguay – Lucia Bianchi This research project developed and applied a methodology – Urban Suitability Model (USM) - to determining the best areas for urban development in the Department of Canelones, Uruguay. Through relevant methods and associated GIS-based techniques, the USM set up a matrix of urban suitability across the study region and visualized the physical opportunities and constraints for urban growth. Although based on a case study in Uruguay, the USM can be easily adapted to different regions as well as consider different factors and land-uses. It can, for instance, analyse the potential of an agricultural commodity, or an industrial or touristic land-use. The approach can also be adjusted to include future projections regarding economic or demographic parameters, climate and so on.

Climate Change and Variability Impacts on Soybean Production in Uruguay – Magdalena Borges

This research project analysed the likely impacts of climate change and climate variability on soybean yields in Uruguay in the long-term to 2060. By considering

climatic factors, soil features and economic data, it specifically identified the most suitable areas to produce soybeans, now and in the future, increase the production output and reduce its volatility, while minimising the use of inputs (like fertilisers and agrochemicals) thus reducing the negative impacts on the environment. The two main stages of the innovative methodology are (i) the definition of a future 'baseline' scenario, using Land Suitability Analysis (LSA), for the soybean sector and (ii) the construction of risk scenarios. The impacts of climate variability on yields and profits were tested by means of a Monte Carlo analysis, which simulates hundreds of climate scenarios. The analysis was also complemented with information about significant environmental areas. Although based on a case study in Uruguay, the methodology can be extended for application in other regions and commodities. See: **Figure 6**.

Multi-criteria Catchment Suitability Modelling to Assess Buffer Zones Creation/Restoration in the Basin of the Santa Lucia River, Uruguay – Alfonsina Lopez

Anthropogenic impacts due to land use changes (urbanization, agriculture intensification, population growth) and poor management have led to the deterioration of land and freshwater ecosystems around the world. Buffer zones, such as wetlands and riparian forests, play a key role in filtering the inputs of components carried out into water bodies by runoff as well as controlling floods. These ecosystems are also characterized by hosting a great variety of species (hotspots of biodiversity). This project generated a tool to assess the most suitable areas for the creation or restoration of buffer zones in the Santa Lucía River Basin (SLRB), Uruguay. New insights were revealed to improve environmental planning and policies for increasing the overall system's health. In particular, the model's outcomes highlighted the importance of small water bodies and their riparian belts, which has wide application in practice in other land /freshwater ecosystems.

Merging Blue-Green Infrastructure and biotechnology: The case of glyphosate in Santa Lucia's sub-basin, Uruguay - Eliana Nervi

Rapid urbanisation and intensification of agriculture often result in severe problems including: a) habitat fragmentation and biodiversity loss, b) modification of hydrological systems, and c) increased water pollution particularly from agriculture water runoffs at diffuse sources. In Uruguay, pollution in water systems is largely caused by glyphosate herbicide - the most widely applied compound since the introduction of genetically modified crops with tolerance to it. Tackling the problems requires a holistic approach - termed in this project Blue-Green Infrastructure (BGI) that combines vegetation and hydrological features to create innovative environmental solutions. In confined runoff waters, microorganisms can be used as remediation agents for glyphosate, immobilizing them in inert matrices that allow their removal. Hydrological tools for targeting and designing glyphosate bioremediation was tested. In particular, SWAT (Soil Water Assessment Tool) was used to locate areas of interest where glyphosate was higher exported during a 12-year simulation period (2000-2012). At the same time, native glyphosate degrading bacteria (GBD) were isolated from soybean soils while using glyphosate as P and C source. Strains Ochrobactrum spp. 188 and Pseudomonas spp. 138 presented a versatile metabolism while may be using AMPA pathway. Acinetobacter spp. demonstrated to use glyphosate as the only P source at comparable growing rates. All these findings

constitute primary insights for the development of a *BGI-glyphosate-bioremediation strategy*. See: **Figure 7.**

Promoting Local Identity and Regional Development in the East of Uruguay **Educational** Strategiestrough Marcela Marques This research project focuses on educational strategies that can assist family farmers in to achieve endogenous and sustainable development. Using a case-study approach in the East of Uruguay, qualitative and quantitative methods will be combined for the collection and analysis of socio-economic data. To compile the qualitative data, special 'workshops' are being organised to promote collective awareness and diagnoses. A System Thinking approach will be employed, specifically Midgley's Systemic Intervention, formulated to tackle complex problems involving social aspects with unclear objectives. An expected outcome will be the empowerment and integration of farmers and local institutions, considered as fundamental for the promotion of sustainable regional development.

Suitability Analysis and Planning of Urban Green Infrastructure in Montevideo, Uruguay - Agustina Apud

This research project is developing a GIS-based methodology and model to identify priority areas for Green Infrastructure (GI) localization in metropolitan Montevideo. GI addresses a wide range of urban challenges, such as climate change, encroachment on agricultural and conservation areas, and, at the same time, provide different benefits and functions. localizations of GI should be in places where benefits are maximized and respond to different functions so that the value and role of green infrastructure are strengthened and its implementation is promoted within the region.

Climate Variability Impacts on Fisheries of Whitemouth Croaker and Striped Weakfish in Uruguay - Rafael Santana

This project is analysing how climate variability affects fisheries of the two most common species, which are commercially fished in the River Plate (Estuary) and the Uruguayan Ocean coast. It will developed important knowledge about the environmental effects on the species investigated and propose management measures related, in particular, to the regulation of fisheries in Uruguay. The methodological approach developed and applied in the project will be of relevance for the study of other fish species in similar over-fishing situations in other countries.

Determinants of the Relationship between Familiar Livestock Systems and the Implementation of Innovative Techniques: Co-innovation Approaches in Uruguay - Ines Soca

This research project focuses on the implementation of innovative techniques to raise the productivity of the resources associated with cattle meat production by 'familiar cattle producers', particularly the use of co-innovation approaches. These approaches combines complex systems theory, social learning and dynamic project monitoring and evaluation to stimulate the strategic reorientation of family farm systems.





Figure 4 – Agricultural suitability for wheat cultivation - Base scenario (1985), RCP4.5 and RCP8.5 (2050), Guarapuava Micro-region, State of Parana, Brazil.



Figure 5 – Methodological approach to the analysis of climate change impacts and adaptation agricultural systems in snowbelt driven basins – Comparison in Chile and Victoria, Australia,



Figure 6. Climate change and variability affect the main regions of soybean production in Uruguay – Land Suitability Index in future scenarios.



Figure 7. Merging Blue-Green Infrastructure (BGI) and Biotechnology - Water runoff collection design system for two BGI components (S1 vegetative swale, S2 cropping plot sub-catchment); all run off is directed to S1.

ASIA-PACIFIC AND MIDDLE WEST

Post-harvest loss reduction in Asia-Pacific Developing Economies – Don Gunasekera, Michael Smith and Hermione Parsons

This research reviewed the post-harvest loss experience of several Asia-Pacific economies (Indonesia, Papua New Guinea, the Philippines, Thailand and Vietnam) to analyse the potential impacts of reduction of such losses using a range of remedial measures. A conceptual framework was developed and then applied to a case study based on those Asia-Pacific economies to provide an empirical basis for the analysis. Limited access to vital farm inputs and credit, poor infrastructure and lack of technical and market information are some of the critical challenges confronting many small farmers in developing economies including those in the selected case-study countries. The estimated "food savings" are considerable if Asia-Pacific Economic Cooperation's pledge to reduce food losses and waste by 10 per cent by 2020, relative to the 2011-2012 levels is realised in the case-study economies.

Further work is however urgently required to collect more up-to-date data on food losses along the food supply chain, including post-harvest losses, in many economies across the world, including the Asia-Pacific region. The analysis of post-harvest losses will be underpinned by the conceptual framework developed and applied to several Asia-Pacific economies.

NEPAL

Land Suitability Analysis of Large Cardamom and Ginger in Nepal in projected climate change to 2050 – Anita Shrestha

This project is analysing the change in the suitability of land to produce large Cardamom and Ginger (two of the major export products of Nepal) in the verge of future projected climate change - Representative Concentration Paths (RCPs) best case RCP2.6 and worst case RCP8.5 - through the extensive application of GIS. In particular, an expert-based modelling approach is being used which considers climatic, soil and landscape parameters to map expected land suitability in the country. Actions to enable the increased of production of the two studied commodities in Nepal will also be considered.

SRI LANKA

Vulnerability and Adaptive Capacity of Smallholder Farmers to Climate Change in Sri Lanka – Wethige Varunika Fernando

According to FAO, there are 500 million smallholder farmers in the world, who produce 80% of the developing countries' food. Smallholder farmers are those (a) with few resources relative to other farmers in their sector and (b) farmers that own small plots of land where they produce mostly subsistence crops and some cash crops, and who rely almost entirely on family labour. They also represent about half the world's population classified as hungry. Smallholder farmers are heavily exposed to climate

change impacts and any decline in their production of food will have negative effects in their livelihoods, health and well-being. In this context, this research project is analysing the situation in Sri Lanka - a tropical, developing country where agriculture is one of the most important sectors of the national economy. The major crops cultivated - rice, tea and coconut (both as plantation crops and non-plantation) - are highly sensitive to variation in climate. The project focuses on a large rural region of Sri Lanka where top-down climate adaptation measures have been ineffective due to the predominance of smallholders. The project is assessing, in particular, the adaptive capacity of smallholder farmers to climate change and use of information to develop feasible and implementable on-farm adaptation actions and more effective adaptation policies at regional and national level.

Sustainability of Irrigation Projects in Distressed River Basins – Comparison between Sri Lanka and Australia – Lelanga Dissanayake

Approximately one third of the Sri Lanka is a dry region and the main livelihood of the people living in it is agriculture. Rainfall in this region is confined to the months from November to January and hence the main crop, rice, cannot be cultivated unless water-gathering devices exist. Since immemorial times, first stage of evolution, farmers constructed small irrigation reservoirs – called 'tanks. A second stage in the evolution of water use for agriculture was dominated by engineers with slight regard to the environment. As a consequence, many river basins in Sri Lanka are now in a critical condition in terms of the quantity and quality of water resources. In this context, the research is analysing the evolution of the use of water resources in the Deduru Oya River Basin focusing on the policies and irrigation schemes implemented over the years. These will be contrasted with irrigation policies and schemes in the Goulburn-Broken Region of Victoria, Australia.

PHILIPPINES

Development and Application of Architectural Green Design Principles in the Development of Rural Areas: Case Study in The Philippines – Thea Aganon

This research is developing a set of green design principles based on three primary concepts – sustainable rural development, Architectural (Systemic) Interventions in planning and designing rural areas. An important approach informing green urbanism is *Biophilic Design*, which is based on the use of natural methods in planning and designing new, and redesigning existing, built environments. It is thus a premise of this research that there are important relationships between *biophilia*, urban sustainability and resilience. The defined green design principles will be tested in a case study in The Philippines.

CHINA

Climate Change Impacts and Adaptation in Rural China: Shiyang River Basin Region and Hexi Corridor Silk Road - Dr Jizong Jiao

This project examined climate change impacts on agriculture and natural resources, specially water, at present and in the long-term future (i.e., by 2050) in the Shiyang River Basin Region and Hexi Corridor Silk Road.. The core methodology consisted in the

spatio-temporal simulation analysis of the performance of various agricultural commodities, now and in the future, on account of projected climatic changes including extreme weather events (such as droughts and heat waves). Emphasis was placed on better understanding the relationships between human activities and climate change through the simulation analysis. This involved the analyses of likely water shortages for domestic, industrial and agricultural uses as well as possible land and ecological degradation as a consequence of climate change. Of particular interest was the application of advance Geographic Information Systems (GIS) and Remote Sensing (RS).

A/Professor Dr Jizong Jiao, College of Earth and Environmental Sciences, Lanzhou University, Gansu developed this project with members of the Sustainable Development Group during yearlong secondment to Deakin University. Dr Jiao has worked in the topics researched in the project in Rural China. He is also an expert of advance GIS and Remote Sensing and has published two books and numerous articles in those topics.

TEAM PROFILE

Deakin Regional Sustainable Development Group comprises planners, strategic analysts, environmental and agronomic engineers, economists, geographers and GIS/remote sensing staff, modellers, programmers and software developers with a high level of expertise in socio-economic and resource analyses, decision-making, and information and support systems. The Group has worked and published widely in these areas, developing datasets, information and innovative methodologies, methods and tools for application at a local, regional, state and national levels.

Team Members

Robert Faggian - PhD (RMIT University, 2002); BAppSci (First Class Honours, RMIT University); DipBus (Frontline Management, Box Hill Institute) is A/Professor of Climate Change Adaptation at Deakin University, holding a joint appointment with the Centre for Regional and Rural Futures (CeRRF) and the School of Life and Environmental Sciences (LES). He also holds honorary positions at the University of Melbourne (Melbourne School of Engineering and Faculty of Veterinary and Agricultural Sciences) and is an Affiliate of the Centre for Disaster Management and Public Safety and the Melbourne Sustainable Society Institute. Faggian has an interdisciplinary research background with an emphasis on systems-related issues (climate change, regional development, water resource management, food and fibre production). His recent research (at both Deakin University and the University of Melbourne) has focused on determining the potential impacts of climate change on agriculture at the regional level, the implications for sustainable regional development and the use of strategic planning approaches to build adaptive capacity and resilience to climate change in regional/rural communities. Previously, he was also a Senior Research Scientist in Agricultural Systems with the (former) Victorian Department of Primary Industries (DPI), and the Centre Leader of DPI's Parkville Research Centre. He has led state-wide research projects on irrigation efficiency and regional development, national research projects on recycled water, and international research projects on biosecurity and plant pathology. Faggian has a strong track record of i) building collaborative links, ii) engaging with stakeholders and the community, and iii) attracting industry funding. He has secured more than AUD 7m from government and industry sources since 2001 and maintains strong ties with several international research groups. Faggian also lectures in climate change adaptation, regional development, systems and strategic thinking, plant pathology, plant physiology, plant biochemistry, plantgenetics and molecular biology.

Victor A. Sposito - MPhil Regional Planning and Urban Design (Edinburgh), MSc Civil Engineering (Texas) and Civil Engineer (Uruguay), is currently A/Professor in Strategic Spatial Planning in both the Centre for Regional and Rural Futures (CeRRF) and the Faculty of Science, Engineering and Built Environment (SEBE), in Deakin. Over the years, he has alternated his professional and academic work between Australia and Uruguay. In Uruguay, he was Chief and Programming Engineer in ANCAP Paysandú Industrial Complex (Refinery, Distillery and Portland Cement) and Consultant to the National Ministry of Territorial Planning, Environment and Housing. In Australia, Sposito was Principal Research Scientist and Project Director in the Government of Victoria - Department of Primary Industries (DPI). He also held positions of Executive Director/Director of Strategic Regional and Metropolitan Planning in the (then)

Ministry for Planning and Environment. Sposito is a Fulbright Scholar and the former recipient of a British Government Scholarship to study planning in the UK. He has led major projects in national, urban, regional/rural, and organizational development and planning in Australia and abroad, and has an international and national reputation for leading-edge initiatives in sustainable economic development. He has written and published extensively in those fields, and has lectured and researched in various universities in South America, Australia and Europe. Sposito has won multiple Australian and international awards in the fields of urban, regional and environmental planning. He was conferred in 2003 the title of *Fellow* of the Planning Institute of Australia. Recently, Sposito was also conferred the title of *Academic* by PIA and appointed as a member of the Academy of Engineering in Uruguay.

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Madeleine Johnson - BEng (Hons) & BA (Hons) RMIT, GDip (Sustainable Regional Development) Deakin University, Johnson is a Research Fellow – Spatial Analysis and Modelling in Deakin CeRRF whose principal role is focused upon the delivery of agricultural development projects, investigating climate change impacts and agricultural production as well as likely regional responses to projected changes in future climate scenarios at a regional and community level. She specifically looks at identifying, and mapping, regional strategies for implementing alternative agricultural management systems, in particular sustainable intensification of agriculture. Johnson is also an Associate Lecturer, responsible for developing and delivering lecturers in three units, in both Bachelor and Master levels, at Deakin University.

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Hemayet Hossain - Doctor of Environmental Design (Texas A&M University, USA), M.Sc. Geography (Dhaka University, Bangladesh) is a Senior Fellow at the Centre for Regional and Rural Futures (CeRRF), Deakin University. Hossain has more than 30 years experience in Spatial Analysis and modelling and the use of GIS and Remote Sensing in Decision Support Systems for the planning and management of human-made and natural resources. Hossain has worked in the State Government of Victoria (Australia) - Department of Primary Industries as a Senior Research Scientist, addressing urban and rural land-use planning and management issues for State Government's instrumentalities and Local Governments. He has also worked for many years as Land Specialist for the UN-HABITAT HQ in Nairobi, Kenya and was also involved in land planning and management challenges in several developing countries. Hossain has taught and researched on natural and built environment planning at several Universities in Australia, Bangladesh, USA, and Thailand and has presented and published research findings in many international conferences and journals. He is now teaching Regional Development Modelling methods and supporting advanced research at Deakin University.

Lauro Ribas - Cartographic Engineer (UFPR), Doctor at the Mid-west University (UNICENTRO, State of Parana, Brazil. He has extensive research experience focused on plant production and Geosciences and in remote sensing projects applying GIS. Master's Program (USP), with experience in geology and geophysics areas working with airborne gravity and magnetic surveys on Brazilian territory and Southern Argentina. CAPES Scholarship - Sandwich Doctorate in the research group of the CERRF

at Deakin University, developing studies in the field of Climate change and adaptation methodologies to Land Sustainability and future scenarios applied to the crops of wheat and maize. Currently Geosciences consultant, professor of Geology and Geosciences at University Center Campo Real and Founder and Partner - AGROMENSURA Surveys and Consultants in Brazil.

Ray Wyatt – Doctor of Planning, UK. is a Senior Fellow at the Centre for Regional and Rural Futures (CeRRF), Deakin University. Wyatt has over 30 years' experience on planning matters working both in academia, at the University of Melbourne, and as a consultant.

Edward Cornwell - BEng. Civil Engineering (University of Chile, Chile), specialisation in hydraulics, environment and sanitary; MSc. Water Resources and the Environment (University of Chile, Chile). Cornwell has worked as a Project Engineer at the Advanced Mining Technology Center (University of Chile, 2012-2016). Cornwell has participated in international conferences, published peer-reviewed articles, produced several technical reports, and lecturing. Currently, Cornwell is undertaking PhD studies at Deakin University being awarded a Deakin University Postgraduate Research Scholarship (DUPRS). His research project is investigating cross-regional agricultural adaptation in the context of regional/rural strategic planning for both the Australian Alps and the Chilean Dry Andes.

Alejo Silvarrey - MSc in science in IHE (Delft/The Netherlands); second-year PhD student in Sustainable Development at Deakin University (Melbourne/Australia). His research at Deakin is focused, in particular, on the use of remote sensing for monitoring surface water quality. He is also examining the use of environmental science to improve communication among scientists, industries and policymakers on climate change and eutrophication. After graduating in the MSc, Silvarrey was a research fellow at the Catholic University of Uruguay where he conducted several innovation projects. At the same time, he started his own company focused on developing comprehensive sustainable solutions, design and development services to reduce the environmental impacts of different types of industries and process.

Zahra Ghofrani – Research Fellow and PhD candidate at the Faculty of Science, Engineering and Built Environment, Centre for Regional and Rural Future (CeRRF), Deakin University. Ghofrani received her BSc in Geomatics Engineering and MSc in Remote Sensing and Photogrammetry form Iran. Her research interests include water management, sustainable development, climate change, and remote sensing sensors.

Anita Shrestha - Masters in Environment Management (2016) SchEMS, Pokhara University, Nepal; Bachelor of Science (2009), Trichandra College, Tribhuwan University (2006). Shrestha is currently finishing a Masters by Research in Sustainable Regional Development at Deakin University. Her research is investigating the impacts of climate change on agricultural commodities in Nepal and policies and actions to improve the likely situations in this country in the period 2020 – 2050. Shrestha has worked as a Secondary Teacher at Pathshala Nepal Foundation, Mid Baneshwor, Kathmandu, Nepal. (2012-2017).

Matias Sellanes – Bachelor of Accounting (Honours) and Bachelor of Business Administration (Honours), ORT University, Uruguay. Sellanes is currently studying in the Master of Sustainability – Specialisation in Environmental Management, Industry Stream, at Deakin. He has also Certificates from the University of California and Philanthropy University, USA. Professionally he has occupy several positions as a Senior Management Consultant in Strategy & Operations and Business Process Solutions, in Deloitte, Uruguay.

Associates

Dr Iman Avazpour - BEng, Meng, PhD Swinburne University of Technology, Australia Avazpour is a Lecturer in Software Engineering and Coordinator of Emergent International Collaborations at the School of IT, Deakin University. He has previously worked as post-doctoral fellow in Information Visualization, and before that as post-doctoral fellow in Data Engineering. Avazpour received his PhD in Information and Communication Technology from Swinburne University of Technology, Melbourne Australia in 2014. His PhD research was on interactive approaches for model and data transformations. He also has a Master of Science in Intelligence Systems and Robotics Engineering from the University Putra Malaysia, were he worked on intelligent approaches to improve medical diagnosis of cancer patients. Avazpour's main area of research is user-centric software engineering, and he has also been actively working on software testing, model driven engineering, data analytics, interactive visualisations, and embedded systems.

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Dr Jim Rookes - PhD (Deakin University). Rookes is a Senior Lecturer within the School of Life and Environmental Sciences (LES) and Director of the Master of Biotechnology and Bioinformatics Course at Deakin University. With a broad interest in plant science-related research, Rookes has been involved in a range of projects related to plant pathology, cell biology, physiology, molecular biology and biotechnology. A major focus of this research over the last decade has been towards understanding plant interactions with the soil borne pathogen *Phytophthora cinnamomi*, which is a major threat to the biodiversity of natural ecosystems across Australia. He has also been involved in Industry projects related to agriculture. Currently, he is actively supervising multiple postgraduate students, including a number of students hosted at the TERI-Deakin Nanobiotechnology Centre in Gurgaon, India.

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Michael Smith - Master of Business Administration, MBA, (Operations and Supply Chain Management) Bradford University, School of Management, U.K.; Grad Cert (Industrial Management) Staffordshire University, U.K; BSc (Psychology) Queens University, Belfast, Northern Ireland, U.K. In 2017 Michael was awarded a Commonwealth funded Research Training Scheme (RTS) Scholarship towards achieving a higher degree by research (Doctor of Philosophy).

Michael has over 20 years' experience working and conducting research in transport and logistics connectivity, supply chain management and global product value chains in Europe, APEC, the Association of South East Nations (ASEAN) and the broader AsiaPacific region. In particular, Smith headed the development and implementation of education and capability building programs as a part of a 'Supply Chain and Logistics Connectivity Knowledge Building Program' for ASEAN Member States. This research project involved the ten Member States and 150 program participants from government and industry, organised in the Philippines and funded by the ASEAN Secretariat in Jakarta, Indonesia. Delivered in-country technical assistance for ASEAN Member States government agencies and officials, designed to advance awareness, skills and capability building, specifically relating to expanding government's current knowledge and understanding of relevant global leading policy and regulatory practices, for the logistics services sector.

Smith is currently the Deputy Director, Centre for Supply Chain and Logistics, Deakin University. Melbourne. Principal Research Fellow, Institute for Supply Chain and logistics, Victoria University, Melbourne.

Don Gunasekera - PhD (Economics), Australian National University; Senior Managers in Government Program, Harvard University.

Gunasekera has had wide experience in the Australian Public Service working at the Australian Bureau of Agricultural and Resource Economics; CSIRO; Productivity Commission; National Competition Council; Department of Environment and Heritage; and the Australian Bureau of Meteorology. He was the Chief Economist at the Australian Bureau of Agricultural and Resource Economics (ABARE 2006-2009). In 2008, Gunasekera led ABARE's climate change modelling work for the Garnaut Climate Change Review. In 2007, he was a member of an independent working group for the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) that prepared a report on Climate Change in Australia: Regional Impacts and Adaptation.

Gunasekera's research, policy and analytical expertise covers a wide range of areas, including: economics of supply change management; agriculture and energy industry analysis; sustainability and natural resource management; food, nutrition and energy security; natural disaster analysis and management; domestic, regional and international trade; economics of pandemics and bio security threats; economy-wide analysis of domestic policy and global changes; climate change adaptation.