Sustainability Research Centre
University of the Sunshine Coast

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http://www.usc.edu.au/connect/research/research-concentrations/sustainability-research-centre/research-at-sustainability-research-centre

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Outline

University of the Sunshine Coast (USC) has grown rapidly since its inception in 1996, from 524 students to a current student enrolment of nearly 10,000. There are two Faculties – (1) Arts and Business, and (2) Science, Health, Education and Engineering. Overseas students currently comprise 11% of the student body with the majority of these international students coming from India, Germany, USA, Nepal, and Sweden. Currently there are about 300 full-time faculty members.

While USC was initially established as primarily a regional teaching university for undergraduates, it is now evolving into a targeted research university. The recent appointment of Professor Roland De Marco as USC's first Pro Vice-Chancellor of Research, underlined the university's commitment to supporting excellence in research. Three Research Centres now exist as focal points at USC: GeneCology Research Centre; Forest Industries Research Centre; and Sustainability Research Centre. Additionally, several other research clusters or themes have developed and new ones are emerging. Through these focal points, USC maintains research collaborations worldwide with a strong emphasis in the Asian-Pacific region. USC has recently enhanced its research profile through the recruitment of outstanding researchers and up-to-date infrastructure.

The Sustainability Research Centre (SRC) was formalised as one of the University of the Sunshine Coast's flagship research concentrations in September 2007. In 2012 the SRC was also designated as a Tier 1 Research Centre, one of only three in the university. Within the past year, the SRC has made two critical research-based hires in geosciences (Professors Patrick Nunn and Roy C. Sidle) to increase its visibility and profile in biophysical sciences to complement the strong faculty counterpart in social sciences. The SRC has the capacity to attract top-level Honours students from various faculties and support post graduate students as well as Research Fellows.

The SRC offer both undergraduate majors and minors in Sustainability and a Ph.D. by research in Sustainability. The core focus of the sustainability educational programs aligns with the social, behavioural, biophysical, and economic sciences. In addressing concerns of society and the environment, this important transdisciplinary research area offers a broad spectrum of opportunity.

Research Achievements and Challenges

RESEARCH ACHIEVEMENTS

One research niche of the Sustainability Research Centre (SRC) that related strongly to disaster risk reduction is societal adaptation – i.e., understanding the social dimensions of regional environmental change. Prior to the recent hires of Professors Dunne and Sidle, the key accomplishments in this sustainability research arena included:

- Resilience to climate change
- Adaptive capacity and social learning
- Adaptive management
- Natural resource governance

The SRC focus areas have been applied to a range of sustainability issues such as coastal management, climate change, and water management (recognised as significant at local through to international scales). Much of the research addresses real on-the-ground concerns of society and the environment.

With the expansion of this research program into the biophysical sciences, new areas of research that are emerging include:

- The role of climate change and natural disasters on early settlements in the South Pacific
- Effects of climate change-driven sea level rise on poorer island nations in the Asian-Pacific region.
- Understanding how oral traditions that allude to or encode memories of extreme events (e.g., volcanic eruptions, earthquakes, abrupt land submergence) might be used to improve adaptive strategies to future climate-driven environmental change.
- Effects of contemporary and past land management practices on sediment sources and discharge into the Great Barrier Reef and important receiving waters of Southeast Asia.
- Evaluating the role of forest conversion to pasture or agriculture on shallow and deeper landslide initiation.
- Understanding the impact of mountain road networks, particularly in developing countries, on sediment delivery (via landslides and surface erosion) to major streams and rivers.
- Coastal hazards in Queensland – flooding, sediment hazards, fire, including social consequences, avoidance measures, and adaptability.

The research conducted within the SRC encompasses a range of subject areas and is truly transdisciplinary.

RESEARCH CHALLENGES

The major research challenges related to disaster risk reduction that the Sustainability Research Centre at University of the Sunshine Coast will address in the future include the following general areas:

- Climate change and associated seal level rise: adaptation and social resilience
- Coastal hazards and mitigation/prevention measures
- Effects of contemporary and past land management on sediment and nutrient export from inland catchments to the Great Barrier Reef
- Complex interactions amongst land use, roads, and different landslide initiation mechanisms in the tropics
- Water governance issues related to sea level rise, coastal flooding, and development

Climate change and associated seal level rise: adaptation and social resilience

Most of Australia's residents, as well as those of many island nations of Asia, live within the boundaries of coastal zones. With projected increases in sea level rise that will occur regardless of contemporary regulations on fossil fuel emissions, it is mandatory that nations and local governments develop contingency adaptation plans to protect livelihoods and resources. A key aspect of this adaptation is social resilience – largely founded on education and understanding of past disaster occurrences. This research focuses on how societies and governments can implement adaptation measures through a combination of social resilience, land management and infrastructure changes, modifications of community planning and development, and structural measures to achieve more sustainable solutions to the projected sea level rise.

Coastal hazards and mitigation/prevention measures

The coastal areas of eastern Australia experience a variety of sometimes interrelated hazards that affect residents, businesses, agriculture, and infrastructure. Each year, coastal communities in parts of Queensland suffer major damages from flooding caused by landfall cyclones and rainstorms. In turn, these intense rainfall events cause coastal erosion, stream channel changes, and erosion and mass wasting in the uplands. Rather than taking the approach of repairing or 'cleaning up' after each episodic event, a more holistic approach to deal with coastal hazards is needed. This research examines possibilities for more sustainable solution to mitigate and even prevent damage caused by these hazards. Strategies include modifying infrastructure, land development, and community planning to reduce investment and populations in highly vulnerable areas. Additionally, certain land management and community development modifications can actually reduce the overall hazard vulnerability.

Effects of contemporary and past land management on sediment and nutrient export from inland catchments to the Great Barrier Reef

UNESCO is currently considering putting the Great Barrier Reef (GBR) World Heritage site on its endangered list. Much of the concern for the health of the GBR centers on the export of sediments and nutrients from inland catchments. To address this concern, a top research priority involves identifying erosion 'hot spots' in contributing catchments and assessing whether or not these sediments (and associated nutrients) are being transported into coastal waters. This research involves a complex assessment of historical sedimentation, current land use and road effects, sediment fingerprinting, hydrological routing, developing dynamic sediment budgets and sediment modeling. Once major sediment sources are articulated, remedial actions (e.g., changing land management practices, improving road specifications) can be recommended.

Complex interactions amongst land use, roads, and different landslide initiation mechanisms in the tropics

Geotechnical, geological, and geomorphic investigations into landslide disasters often focus on causes of individual mass movements or only natural causes of landslides in a given area. This research examines the complex interactions among land management practices, roads and trails, and the mechanisms that initiate both shallow and deeper landslides in the tropics. Most of the research on land use impacts on landslides has been conducted in temperate regions. One of the key differences in the tropics is the high level of year-round evapotranspiration, which affects soil moisture status. Such increases in soil moisture after forest conversion can promote creep which has potential feedbacks to both deep and shallow landslides. Research is planned in the Andes of Columbia and Southeast Asia.

Water governance issues related to sea level rise, water use, coastal flooding, and development

This research focuses on the regulatory controls at all levels (local to national) and how they will effectively be implemented with due regard to social and gender equality, water allocation, and water use efficiency in both coastal Australia and developing Asian Pacific nations. The research concentrates on how seal level rise and coastal development will affect flooding, as well as optimizing water use, particularly during periods of water stress. We also explore vulnerability, resilience and adaptation pathways, especially in regard to increasingly complex socio-ecological contexts.

Suggestions for the Disaster Research Roadmap

The following are some ideas of priority topics that could be included in the disaster research road map for the next decade:

- Learning from past histories of natural disasters to inform the risk of contemporary disasters – examining records of past landslides, debris flows, liquefaction, tectonic activity, fire, and flooding using archeological evidence, dating methods, and geophysical methods to provide information on contemporary hazard risk and sustainable development.
- Understanding the temporal connectivity of hillslope landsides with debris flows in steep upland channels to provide better real-time warnings. The research would focus on loading rates from landslides and channel attributes that facilitate the disconnection of hillslope landslides and in-channel debris flows. Particularly, why some landslides immediately continue down-channel as debris flows and why others are disconnected in time.
- Understanding how active soil creep promotes incipient landslides and eventually deep-seated landslides in cohesive regoliths, including the role of changes in soil moisture due to evapotranspiration reduction following tree removal in the tropics.
- Spatial distribution of landslides initiated by large earthquakes as affected by seismic characteristics, antecedent moisture, regolith properties and land use.
- Chronic sediment hazards (non-point pollution) related to spatially and temporally distributed land management in large catchments. These sediment inputs may initiate from gully erosion, landslides, and debris flows, all of which can be affected by land management. Determining spatially distributed sources and timing of sedimentation using sediment fingerprinting and dating methods.
- Interactions among regolith weathering, soil hydrology (both saturated and unsaturated), and spatially distributed geotechnical properties as they affect both shallow and deeper landslide initiation and distribution.
- Soil accretion and future susceptibility of landslides in geomorphic hollows that have been previously evacuated by landsides, with an emphasis on infilling processes and rates and soil development via weathering.
- Contributions of mountain road and trail systems to sediment fluxes into important receiving waters – via landslides, debris flows, ravel, and extreme surface erosion processes. This research would include the development of conceptual models for more sustainable mountain road development with emphasis in tropical and mountainous Southeast and East Asia.

- Developing low-cost and rapid field tests to ascertain approximate values for spatially distributed soil physical and geotechnical properties that can be used in landslide models.
- Improving knowledge of land use – landslide interactions in the both the wet and dry tropics, with emphasis on widespread land cover changes – e.g., forest conversion to pasture or agriculture, exotic plantation establishment, residential development on hillslopes.
- Examining the potential for realistic scenarios of climate change to either increase or decrease the potential for different types of landslides.
- The influence of preferential flow pathways on both shallow and deep-seated landslide initiation