Brief Overview of Climate Change and Sustainability Research at the National University of Singapore (NUS)

Executive Summary

NUS conducts systems-level research in climate change and sustainability. Under the climate system, NUS expertise lies in downscaling global climate models to regional and local models to understand microclimate, including extremes in temperature, rainfall, humidity and drought and its urban heat island effect. Under the water system, NUS research comprises of coupling global atmospheric and ocean models with regional and local land-coastal inundation models, including sea level rise to present a wholistic assessment of coastal defence. Under the biological system, NUS conducts cutting-edge research on understanding relationships between ecosystems and society, including ecosystem services, coastal protection (green infrastructure) and biodiversity conversation to inform climate policies, strategies and actions. Under the social system, NUS expertise lies in understanding the impacts of climate change on society, including socio-economic impacts and suggesting effective public policy interventions to address these impacts together with enhancing public understanding of risk. Additionally, climate mitigation research focusses on green energy technologies, specifically solar energy technologies and platforms and CO_2 removal along with energy policy studies.

1. Climate System

1.1 Tropical Marine Science Institute (TMSI)

Tropical Marine Science Institute (TMSI) is a centre of excellence for research, development and consultancy in tropical marine and environmental science. With its multi-disciplinary research laboratories and active international links, it handles projects relevant to physical oceanography, acoustics, marine biology, marine mammals, biofuels, water resources and climate change. Within Climate change, TMSI focusses on climatology, regional climate modelling and sea level change.

https://www.tmsi.nus.edu.sg

1.2 School of Design and Environment

The School of Design and Environment has the range of expertise across disciplines that bridges different physical scales (**macro**: urban planning scale, **meso**: urban design scale, and **micro**: building scale) — DESIGN: architecture, landscape architecture, urban design, water-sensitive urban design, urban planning, computational and spatial modelling, etc.; SCIENCE & TECHNOLOGY: urban heat island, total building performance, ventilation, indoor air quality and health, energy efficiency, thermal and visual comfort, phase change materials and ECONOMICS: urban economics for viable solutions — necessary to conduct interdisciplinary research to mitigate the effects of climate change.
https://www.sde.nus.edu.sg

2. Water System

2.1 Coastal Engineering Research for Sea-level Rise

NUS is committed to the strengthening global efforts in assessing multiple interconnected strategies to mitigate climate change risks and developing coastal adaptation measures. The hydraulic laboratory within the Civil and Environmental Engineering Department and the deep-water basin facilities in the Technology Centre for Offshore and Marine Singapore (TCOMS) provide unique opportunities for exploring different coastal protection and adaptation designs. Currently, the hydraulic laboratory is conducting experimental and numerical studies for designing an eco-friendly seawall in Singapore and developing guidelines for seawall design with consideration of overtopping limits. In the future, the laboratory wave flumes and shallow-water and deep-water wave basins can be used to conduct physical modelling of alternative coastal protection designs and produce measurements for validating numerical models, which can be deployed to perform comprehensive analyses for a wider range of physical parameters.

https://www.eng.nus.edu.sg/cee/research/laboratories/hydraulic-engineering-laboratory/
https://www.eng.nus.edu.sg/core/

2.2 NUS Environmental Research Institute

NUS Environmental Research Institute (NERI) is a university-level research institute that focuses on the development of integrated sustainability solutions for the environment. It collaborates with government, industry, NGOs and leading academic partners to ensure that its research consistently addresses real-world issues. Research areas include environmental surveillance and treatment; environmental and human health; green chemistry and sustainable energy; impact of climate change on the environment and food, energy and water nexus in urban farming.

http://nus.edu.sg/neri/

3. Biological System

3.1 Centre for Nature-based Climate Solutions (newly established – to be operational by end of 2020)

The Centre for Nature-based Climate Solutions is a newly established research facility at NUS with an aim to empower governments and corporate leaders to respond decisively to climate change for the overarching goal of achieving a carbon-neutral economy and stable global climate. It aims to produce policy-relevant science on nature-based climate solutions – tackling climate change by protecting and better managing natural ecosystems – to address knowledge gaps, build capacity and deliver pragmatic solutions and innovations to inform climate policies, strategies and actions. The Centre is expected to be operational by the end of 2020.

https://www.straitstimes.com/singapore/environment/new-research-centre-on-nature-based-solutions-for-climate-change-to-open-in

4. Social System

4.1 The Institute of Water Policy (IWP)

The Institute of Water Policy (IWP) is a research institute at the Lee Kuan Yew School of Public Policy, at NUS. The institute houses a team of researchers and adjunct faculty who are internationally recognised for their high-impact research. IWP's mission is to help improve water policy and governance in Asia through research, training, thought leadership and consulting. The institute produces policy-relevant research that helps shape the discourse on water policy in Asia. Areas of research include water security, behavioural studies, water economics, water governance and water science and public policy.

https://lkyspp.nus.edu.sg/iwp/about-us

4.2 The Lloyd's Register Foundation Institute for the Public Understanding of Risk (IPUR)

The Lloyd's Register Foundation Institute for the Public Understanding of Risk (IPUR) at the NUS was launched in 2017. Established through funding from the Lloyd's Register Foundation and the NUS, IPUR is the first international research and public outreach institution of its kind in Asia. IPUR seeks to narrow the gap between people's perceptions and real-world risks by undertaking research on the scientific understanding of risk and its practical application through a multi-disciplinary approach. Bringing together science, engineering, social sciences, and humanities, our current research efforts span across three areas: Data and Technology, Environment and Climate, as well as Health and Food Safety.

https://ipur.nus.edu.sg/about/

5. Climate Mitigation Research

5.1 Solar Energy Technologies and Platforms: Solar Energy Research Institute of Singapore (SERIS)

The Solar Energy Research Institute of Singapore (SERIS) at NUS is Singapore's national institute for applied solar energy research. SERIS conducts research, development, testing and consulting on solar energy technologies and their integration into power systems and buildings. Research areas include silicon solar cells and modules; PV modules; solar energy systems and novel PV concepts. SERIS designed and operates the world's largest floating PV testbed in Singapore, which was commissioned by the Public Utility Board (Singapore's National Water Agency) and the Economic Development Board, Singapore.

http://www.seris.nus.edu.sg/index.html

5.2 NUS Sembcorp Corporate Laboratory

The NUS Sembcorp Corporate Laboratory for Sustainable Energy, Water and Waste-to-resource Generation is a tripartite research collaboration between Sembcorp Industries, NUS and the National Research Foundation of Singapore. The Corporate Lab focusses on developing cost effective, cutting edge technologies in the areas of power generation, industrial wastewater treatment and reuse and waste-to-resource conversion. Research activities include development of predictive maintenance systems that will optimise and enhance the efficiency of energy generation operations, while reducing emissions and waste residue; development of cost-effective solutions to meet stringent chemical oxygen demand (COD) discharge standards; as well as comprehensive biological models to optimise plant performance and reduce liquid discharge and conversion of solid residue from power plants and incineration facilities into useful and high-value products; and utilisation of combustion ash and solid residue to produce ultra-light composites for modular construction.

https://sembcorp-nus.nus.edu.sg

5.3 NUS Green Energy Programme

The NUS Green Energy programme is a joint program with the Agency of Science, Technology and Research, Singapore and Nanyang Technological University. It aims to develop massively scalable efficient technologies that convert sunlight, CO_2 and water into stable, affordable, energy dense liquid fuels that are storable, transportable, and distributable adapting existing supply chain, with the goal of replacing fossil fuels. Objective is to build one of the world's leading programmes for providing ecologically-balanced solutions that simultaneously address global climate change and energy challenges to transform Singapore as one of the major green technology hubs for the development and application of viable solutions for CO_2 mitigation, energy security, sustainable development, and contributing to the creation of a new industry sector.

5.4 Energy Studies Institute

The Energy Studies Institute at NUS conducts research on energy policies and their national, regional and global implications and promotes discussion and advance collective understanding on issues related to energy policy development. Research areas include energy efficiency and conservation; energy and climate change; energy for power generation; energy for transport; energy geopolitics and energy and competitiveness.
https://esi.nus.edu.sg

5.5 Singapore Energy Centre (SgEC)

The Singapore Energy Centre (SgEC) is a consortium founded by NUS, Nanyang Technological University (NTU) and Exxon Mobil, USA. The Centre aims to create a framework for long-term partnership between academia and industry on technological and socioeconomic issues within sustainable energy development. It builds upon the reputation of Singapore as a living laboratory to explore scalable near-term and long-term solutions of global and regional significance. Examples of SgEC research projects include: Design of novel mixed matrix membranes and thin-film composite membranes; Enhancing the energy efficiency of refining and chemical sectors via a next-generation framework; Low-Cost robust self-supported catalyst beads for methane cracking; Novel integrated process for CO2 capture, storage and utilization with wastes; Seawater (Photo)-Electrolysis for renewable hydrogen production and surface modification of MOF adsorbents with Ultrathin Hydrophobic layers for moisture-resistant CO_2 capture.

http://www.sgec.sg/aboutus/Pages/default.aspx

5.6 Centre for Energy Research and Technology (CERT)

CERT provides technology solutions for a sustainable energy future in the domain of energy storage, smart grids, energy efficiency and natural gas technologies in collaboration with industry partners and Singapore government agencies.

https://www.eng.nus.edu.sg/research/research-centres-and-institutes/centre-for-energy-research-and-technology/