

## **Research Assessment Exercise 2020**

### **Impact Overview Statement**

**University:** The University of Hong Kong

**Unit of Assessment (UoA):** 10 – earth sciences (incl. oceanography, meteorology) and other physical sciences (incl. environmental science)

**Total number of eligible staff of the university in the UoA:** 18

#### **(1) Context**

The Department of Earth Science (DES) was established in 1995 and has always conducted research with significant societal and industrial impact. The main foci of the department are closely aligned with fundamental scientific challenges of societal relevance. Blue skies work to understand Earth processes and planetary science is relevant to the discovery, utilization, management, and preservation of water, mineral, and energy resources in the context of sustainable development. It also informs the prediction and mitigation of natural hazards (volcanism, earthquakes, tsunamis, and landslides). DES's direct applied research focuses on geotechnical, engineering geology, and environmental problems, primarily in Hong Kong, but applicable regionally and globally, especially in densely populated coastal cities.

#### **(2) Approach to impact**

The department has an Advisory Board composed of expertise from government, the private sector, and academia, including alumni. Coordinated by the department's Outreach Committee, the board members meet annually to advise on the demands and expectations of stakeholders and end-users in the Hong Kong geoscience community, as well as identifying opportunities for societally relevant research. We have close relationships with Hong Kong government organizations such as the Geotechnical Engineering Office (GEO), Drainage Services Department (DSD), Water Services Department, Environmental Protection Department, and Agriculture, Fisheries, and Conservation Department, as well as with private companies such as AECOM Ltd, Black and Veatch Company Ltd and DiMap Ltd., plus environmental and geotechnical professional bodies (e.g., the International Mining Association of Hong Kong). Increasingly, links have been developed with government departments and agencies in Singapore, mainland China, and Sri Lanka. KE has always been a core principle of the department and has led to various societal, economic, environmental, and engineering impacts. A member of DES has been Assistant Dean for KE within the faculty. Members are actively participating in: (a) various consultation meetings organized by the government regarding major government projects; (b) communication with alumni working in the field of geosciences; (c) facilitation of interaction with the media; (d) public outreach and education; and (d) display of research findings in the Stephen Hui Geological Museum, Hong Kong Science Museum, and online media. The Geological Museum promotes DES research through attractive displays, as well as through its web and social media pages (e.g., the DES Facebook page, departmental website, and booklet). The museum hosts about 100 two-hour guided museum tours with more than 3,500 participants from schools, NGOs, and the general public annually, and welcomes about 60,000 individual visitors every year. School talks, international conferences with governmental and industrial attendees, and guided field tours are also essential parts of the DES's KE activities. In addition, the department hosts the Planetary Spectroscopy and Mineralogy Laboratory (PSML) and Geospatial Computing Facility (GCF), both of which play important roles in applied science projects. The GCF is used to support high-end processing of geospatial data (e.g., satellite data and airborne lidar data for Hong Kong and other locations). The PSML produces microscopic to macroscopic spectral imaging of rocks, minerals, plastics, and other pollutants. All of these activities result in impactful research and KE with agencies such as NASA, the European Space Agency and the Chinese National Space Agency on landing-site selection and the development of space-borne remote sensing technologies, as well as contract research and government projects in mineral exploration, plastics pollution, and environmental protection. The culture at HKU is that studies with societal impact are fully acknowledged and supported. Contributions through KE and impactful research are well recognized, and are considered when promoting existing and recruiting new academic staff.

### **(3) Strategy and plans**

The Advisory Board and Outreach Committee have been crucial in formulating strategy and plans for ensuring impact. The key element is to combine classical geological (field) methods and laboratory work to target many practical issues. Notable successes are the development of applied geophysical techniques for subsurface investigations. These studies have identified techniques to map subsurface voids and other conditions indicative of unstable slopes and retaining walls. The deliverables include more than 15 consultancy reports for various geotechnical firms or government departments in the assessment period. The department collaborates with GEO as part of a Government Expert Working Group, testing and developing standards and accreditation for the use of deep cement mixing, which is used in coastal urbanization globally. The DES works closely with the DSD in Hong Kong to study the impact of a huge cavern sewage treatment system on regional groundwater flow, and the possible environmental and engineering impact. The caverns will be about 2.0 million m<sup>3</sup> in volume, with a footprint of around 13 hectares. The best locations for installing wells to monitor long-term water level and potential leakage have been identified, and a monitoring system consisting of a series of wells in different locations and depths recommended. This research will lead to long-term collaboration with DSD. Through working with mining companies, new metallogenic models were proposed and have been used in different scales of exploration. The department's work has extended recently to rare earth element deposits in China, which dominate the world market. The investigation by DES of plastic pollution in this region has already led to publications and resulted in a significant shift in public opinion and governmental discussion in Hong Kong via the department's participation in panel discussions for corporations, the public, and schools. The first paper was widely covered in the local news, with more than 2.6 million readers. The department was then approached by the Environmental Protection Department to identify best practice in tackling plastic pollution. DES's study on greenhouse gas emissions helped Hong Kong to meet the 2015 Paris Agreement and was intensely reported on by the local media, with 1.5 million readers. The authors of the study were invited to join the think-tank, "CarbonCare InnoLab", partly funded by the Hong Kong Jockey Club. They improved the methodological design, metrics, and criteria used in the panel's "think tank Paris watch indicator", used to evaluate Hong Kong's performance against its targets. They also participated in public events funded by district councils. Looking forward, the department's challenge remains to develop innovative solutions to global and local environmental and geologically-related problems, maintaining its established leadership position in these fields while further strengthening its role in key areas including Urban Geology, Planetary Science, and Global Change. DES will ensure adequate succession planning in selected research fields with societal impact, improve its technical infrastructure to better deliver applied research and consultancy, and increase knowledge exchange and public outreach. These actions will diversify and grow the department's funding base while serving society.

### **(4) Relationship to case studies**

The two case studies are directly relevant to problems here in Hong Kong and are of vital importance considering its highly urbanized setting and associated geological problems. They arose through a combination of Prof. Jiao's research interests and local needs, identified by interaction with local geotechnical companies and government agencies, and were often facilitated by alumni and given urgency by well-briefed news media coverage. Particular problems were related to safe, economic, and environmentally sound development and utilization of land and untapped groundwater sources. The ultimate beneficiaries of the work outlined in the two case studies are the people and economy of Hong Kong through the prevention of loss of life and the avoidance of social disruption and economic loss associated with landslides. This work, while being based in Hong Kong, is also of relevance to other fast-growing urban areas constrained by the sea (e.g., Singapore) and with steeply sloping land (e.g., Brazil). A new model of confined groundwater in hillslopes resulted in reduced risks of deep-seated landslides (Case Study 1). Case Study 2 is about coastal groundwater and its various implications for the environment and water resources. They both demonstrate that engagement with local geotechnical engineers and government enables research that can achieve international reach via significant generalizable solutions beyond Hong Kong.