National Oceanography Centre's submission to the House of Lords Science and Technology Committee's inquiry: Delivering a science and technology strategy

Introduction

The National Oceanography Centre (NOC) is one of the world's top oceanographic institutions with a remit to deliver research from the coast to the deep ocean. Its activities span numerous disciplines, from ocean physics to numerical modelling, marine biology, climate change, marine geophysics and technology innovation. We manage the UK national fleet of oceanographic Royal Research Ships, *RRS Discovery* and *RRS James Cook* and serve the needs of the greater UK marine science community through the National Marine Equipment Pool and the British Oceanographic Data Centre.

Summary

Ocean science is necessarily global in scope, and hence provides some useful illustrations of what is entailed in truly global science and what it means to be a global science superpower. The ambition to spend 2.4% of GDP on research, development and innovation (RDI) follows a decade of 'flat cash' funding resulting in serious erosion of basic science capabilities. It will be important to restore those capabilities that are critical to global science superpower status in order to provide a firm foundation on which to develop and enhance key areas.

The challenges facing ocean science in the UK are indicative of wider risks to its research and innovation landscape, whose current funding model prioritises delivery of project-based science undertaken by academics at universities. To secure our position as a science superpower, investments must be considered in decades rather than years, with longer-term funding models designed to support large-scale research and technological innovation outside of the higher education sector.

As a science superpower, we must also be a good global citizen in supporting the UK's share of globally distributed infrastructures like the Global Ocean Observing System (GOOS)[1] – especially its in-water component – which is the base of the continuous data and information value chain for investigating and managing solutions to important issues arising from global-scale environmental change and decadal variability.

Research institutes like the National Oceanography Centre are a vital part of the RDI landscape in big science areas like oceanography which depend on large infrastructures, long-lead-time technology innovation and a critical mass of scientific and technical capabilities which enable the ability of the whole UK ocean science base to participate. Every major oceanographic science superpower has such an institution in its RDI landscape. In the UK such institutes are particularly disadvantaged in the funding they receive, equivalent to just 80% of full economic costs due to a dual funding support model designed for a predominantly university-based model of delivery. Compared to other science superpowers, the UK has increasingly turned away from providing non-university research institutes with the stable, predictable funding required for effective collaboration with industry and international partners. This does raise questions about the governance of UK science and whether the voice of the institute mode of delivery is sufficiently represented or heard.

Meeting Sustainable Development Goal 14 requires continuous ocean observation as well as capacity building in ocean science, including through marine technology transfers. As a marine science superpower, the UK contributes to a wide range of global ocean and climate observing systems, and yet since 2017, less than half of UK Tide Gauge Network sensors reported data of sufficient quality to contribute to the Intergovernmental Oceanographic Commission's databank for long-term sea observations. A science power must be a good global citizen, and deferred

[1] https://www.goosocean.org/

investments to national critical infrastructure jeopardises our standing in the global scientific community.

NOC welcomes the promise of the new National and Science and Technology Council to restore the UK science community to full health by harnessing the world-class work of UK science to address global challenges along the four priority areas identified. We would be happy to follow this up with any further evidence that the Committee would find helpful.

Question 1: What would it mean for the UK to be a "science superpower?"

The UNESCO Global Ocean Science Report (2017)[2] shows the UK is already an ocean science superpower when it comes to research publication outputs and citations received, bibliometrics which demonstrate how ocean science knowledge is shared around the world. More generally, the UK punches above its weight in the global scientific landscape, considering its per capita investment in science is less than in many other developed countries. The UK has an innovative and flexible research, development and innovation landscape, and continues to attract the world's brightest minds to contribute to science and technology advancements across the public and private sector.

The UK's status as an ocean science superpower is inextricably linked to our position of global leadership in ocean conservation and governance efforts. Nearly 40% of our domestic waters are designated as Marine Protected Areas (MPA). With funding from NERC-UKRI, NOC provides the UK Delegation to the Intergovernmental Oceanographic Commission of UNESCO (IOC), the only United Nations body specializing in ocean science.[3] During its G7 Presidency in 2021, the UK announced the G7 Ocean Decade Navigation Plan and as host to COP26 that same year, championed the critical role that the ocean plays, both as a monitor and mitigator of climate change.

The Government's commitment to increasing public research and development funding, with a long-term target of 3% of GDP invested in UK science and technology, has the potential to solidify our existing reputation as a global marine science superpower in the decades to come. The four priority areas identified by the National Science and Technology Council provide a welcome focus to secure the UK's leadership in the global scientific community, and ocean science contributes to them all. We agree with the Government Office for Science's assessment that "the UK should develop a more strategic position, with clear priorities, with regards to its marine interests."[4]

To maintain our status as a global science superpower, the UK must overcome the temptation for short-term, transactional engagement with international partners when contributing to the science and technology solutions required for the global challenges of our time. It is crucial that the UK is seen as a good global citizen and long-term partner, particularly when it comes to capacity development efforts with countries across the Commonwealth and beyond. Ocean science is necessarily global in scope, and investment in shared physical as well as digital infrastructure becomes increasingly critical as rapid technological advances extend the frontiers of how we study the ocean.

As a global science superpower, the UK's science and technology strategy demands a broader, longer-term approach to research funding and infrastructure investment than a shorter-term research grant model for individual projects supports. Ocean science requires sustained global sensing infrastructure as well as research ships which are fit for purpose. The problems facing the

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[2] *Global Ocean Science Report: The Current Status of Ocean Science around the World* (UNESCO 2017, pg 28): https://en.unesco.org/gosr2017

[3] https://projects.noc.ac.uk/uk-ioc/

[4] *Foresight Future of the Sea: A Report from the Government Chief Scientific Adviser* (Government for Science 2018, pg 9): *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/706956/foresight-future-of-the-sea-report.pdf*

ocean are too big to be tackled by one nation alone, and long-term commitments are required to generate the shared, globally accessible data needed to answer such critical questions as the future capacity of the ocean to continue absorbing heat and carbon.

Question 2: Are the right structures in place in Government to implement a science and technology strategy?

The UK would benefit from having a Minister for the Ocean responsible for developing an integrated ocean strategy mirroring what has been achieved by having a space strategy. A Minister for the Ocean would represent the unique requirements of ocean science – including long-term investments in digital and physical infrastructure – and the role it plays within a science and technology strategy focused on environmental, health and security priorities. The integrated security, defence and foreign policy review sets out the desire to support a resilient ocean that is "effectively governed, clean, healthy, safe, productive and biologically diverse" by 2030, combining work on "maritime security, the environment and trade."[5] Research institutes such as NOC are ideally positioned to deliver the scope of research and sustain the breath of partnerships required to deliver these objectives.

A Minister for the Ocean would provide a single focus for marine science, allowing the UK to produce, as noted by the UN Decade of Ocean Science for Sustainable Development, "The Science We need for the Ocean We Want."[6] A single Minister could also drive forward the technology and infrastructure requirements of ocean science, linking up the needs of shipping, renewable energy and science with developments multiple stakeholders across the marine and maritime sector.

Question 4: Is the UK realizing the potential of its research investment?

The UK's research investment potential is diminished by the current short-term and project-based approach to science and technology funding. Whilst this model may serve the higher education sector well, a diversity of research delivery modes is needed to tackle the current scale of global challenges. Meaningful advances in ocean science require a greater appetite for risk and investment in long-term national capabilities than current funding models support, particularly given the scale of infrastructure required. There is untapped potential to maximise the impact and increase the pace of technological innovations in such areas as Marine Autonomous and Robotics Systems.[7]

Public and non-profit research organisations such as the National Oceanography Centre are well positioned to deliver interdisciplinary research and innovation, but are funded only at 80% of full economic costs (FEC) because the system is designed for universities where shortfalls are offset by quality-related (QR) funding. Consequently, Public Sector Research Establishments (PSREs) and Independent Research Organisations (IROs) struggle to secure funds needed to recruit and develop talent and miss opportunities to support the UK in advancing global-scale science and technology developments.

The Royal Society notes that "there are an unusually low number of public and non-profit research organisations in the UK compared to some other countries and there remain significant challenges with regard to their long-term financial stability."[8] As an ocean science superpower, the UK cannot

[5] *Global Britain in a competitive age: The Integrated Review of Security, Defence, Development and Foreign Policy* (HM Government 2021, pg 92): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975077/Global_Britain_in_a_Competitive_Age-_the_Integrated_Review_of_Security__Defence__Development_and_Foreign_Policy.pdf

[6] https://www.oceandecade.org/

[7] https://noc.ac.uk/technology/technology-development/marine-autonomous-robotic-systems

[8] *The Role of Public and Non-Profit Research Organisations in the UK* (The Royal Society 2020, pg 1): https://royalsociety.org/-/media/policy/Publications/2020/2020-09-the-role-of-public-and-non-profit-research-organisations-explainer.pdf

afford to let activities such as sustained ocean observations fall to sub-critical levels due to shifts away from longer-term core funding and insufficient investment in new technology.

As an IRO, NOC welcomed the creation of the Advanced Research and Innovation Agency (ARIA) and the National Science and Technology Council, and hopes this signals a renewal of support for ambitious, interdisciplinary research in such fields as ocean science that contribute to multiple environmental, health and security priorities. With sustained investments in areas of national strategic importance such as ocean science, research institutes are ideally situated to conduct long-term, high-risk and large-scale science and develop new technologies to enable this work.

Question 6: What more should be done to encourage private-sector investment in research and development in the UK?

Independent Research Organisations such as NOC are ecosystems of innovation that incentivise collaborations between academics and industry. Since 2016, UK marine scientists at NOC have been providing new autonomous capabilities with innovative vehicle, autonomy, data and sensing solutions in collaboration with commercial marine technology users as part of Oceanids, a £16m Marine Autonomous Systems (MAS) programme funded by the government. We estimate that to invest in Oceanids II would cost £6.15m over the next three years, but offer a wealth of opportunities to scientists and industry to lead the world in these technologies.

Collaboration with commercial shipping can also enhance ocean observation science needed to monitor the health of the ocean, as their vessels and platforms can be fitted with sensors that feed into emerging digital ocean infrastructure.

Public sector procurement can be used to innovate the supply chain via sub-contracting some requirements for design solutions for scientific purposes and working in partnership to develop working models and prototypes and then taking them to test. This has the potential for useful side effects to emerge, such as making replacement parts more accessible and potentially cheaper. These kind of industry partnerships will be important in light of the Maritime 2050 strategy, which sets an ambition for the UK to "be seen as a global exemplar in green maritime issues" and "a leading supplier for zero (and low) emission shipping technology."[9]

The same innovation partnerships required for oceanographic research vessels capable of deploying large and energy intensive equipment to become net zero will benefit the private-sector maritime industry, and this alignment of interests can be harnessed to encourage private-sector investment into prototypes which may then become resilient products for both scientific and industry use. A research and development landscape that supports long-term, large-scale and high-risk science encourages private-sector investment in science and technology and in turn benefits national science and industrial capability.

Question 7: How well does the UK collaborate on research with international partners and what can it learn from other countries?

One area where the UK could learn from other countries, when it comes to science and technology investments, is to observe how they fund research institutes conducting science of strategic importance, separately from the funding streams allocated to academic research in universities.

For example, Germany's "Pact for Research and Innovation" was initially adopted in 2005 and provided annual funding increases per year for non-university research institutions. It been

[9] *Maritime 2050: Navigating the Future* (Department for Transport 2019, pg 151): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/872194/Maritime_2050_Report.pdf

renewed several times, most recently in 2019 for the years 2021 to 2030.[10] This has provided a stable planning environment for Germany's four major non-university research organization categories, including 90+ institutions as part of the Leibniz Association, 80+ Max Plank Institutes and 70+ Fraunhofer Society institutes.

In the US, Australia and France, there are separate sources of funding for applied strategic science which supports the public good and "pure" or "blue sky" science. A healthy national science ecosystem will enable both kinds of science, and research institutes, such as the National Oceanography Centre, deliver both. However, the UK could learn from other countries who fund different kinds of science from different funding streams, with more stable guarantees made for large-scale, long-term programmes which deliver on strategic priorities in the national interest. This kind of funding environment for applied science would also incentivise greater investment from commercial partners.

The UK actively collaborates on research with international partners, and our duties as a global citizen compel us to share data and infrastructure with other countries in order to advance ocean science.

In 1991, the Intergovernmental Oceanographic Commission of UNESCO (IOC) formed the Global Ocean Observing System (GOOS)[11] to better understand how society and all life on Earth is affected by climate change. The UK's national interests are served directly by our membership given threats to coastal areas due to rising sea levels and more intense weather events. These cannot be fully understood without access to internationally pooled data assets, facilities and infrastructure and yet, our credibility as a global partner in ocean science is threatened by years of flat cash funding and inadequate investments to critical infrastructure such as tide gauge systems, which are falling below international standards and hampering our own ability to forecast coastal hazards.

Our contribution to GOOS would be improved with greater public investment in the new marine technologies needed to support long-term, global-scale ocean observations such as autonomous vehicles, instruments and sensor and the next generation of electronics, software and communications technology required for real-time data gathering and analysis.

Conclusion

How science is funded is crucial to the UK's science superpower status. It must be long term, sustained and matched against the best performing countries globally. And researchers must not be penalized for where they undertake research – funding models should not discriminate over different types of settings in favour of the traditional higher education model. To drive forward marine science in particular, adopting an ocean-wide approach could be the most effective, driven by a single Minister for the Ocean.

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[10] https://www.gwk-bonn.de/themen/foerderung-von-ausseruniversitaeren-wissenschaftseinrichtungen/pakt-fuer-forschung-und-innovation/

[11] https://ioc.unesco.org/our-work/global-ocean-observing-system-goos