Leverhulme Doctoral Scholarships Programme for Interdisciplinary Resilience Studies (PIRS)
University of Southampton

RECRUITMENT CYCLE for studentships starting: October 2024

SUPERVISORY TEAM

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STUDENTSHIP PROJECT TITLE

Thinking in Systems to Enhance Ocean Resilience

OVERVIEW

Considering marine fish populations and the fishing communities they support, this project will investigate the cumulative effects of a series of shocks (e.g. Brexit, Covid-19, War in Ukraine) on resource resilience and sustainability. Interdisciplinary skills using innovative methodologies that combine machine learning, remote sensing, and social surveys will be developed.

SUMMARY

Global challenges are often complex and fail to fit neatly into any particular unidisciplinary domain; to solve them we must embrace interdisciplinarity. This project will advance sustainable marine fisheries management as part of initiatives to address the global biodiversity crisis while also protecting low-income fishing communities that depend on this primary resource for their livelihoods. We will adopt a systems-based approach to create more resilient ocean resources by taking a holistical perspective that acknowledges complexity and moves away from working in silos. As such, the successful applicant will work at the interdisciplinary interface and so develop a range of appropriate and highly sought after skills (e.g. in systems dynamics, remote sensing, AI and machine learning, and novel social survey techniques). Working with partners at Fishing into the Future https://www.fishingintothefuture.co.uk/ , Blue Marine Foundation https://www.bluemarinefoundation.com/, and Seafish https://www.seafish.org/ the successful applicant will investigate how the fishing industry responds to shocks, such as those created by new trading arrangements after Brexit, the inability to fish during the Covid-19 pandemic, and the dramatic increase in fuel prices due to the Russian invasion of Ukraine. The findings will have substantial impact by providing lessons on how natural resources, such as fisheries, can be better managed in the face of future global shocks, such as those associated with climate change and global food shortages. The PhD student will work as part of an interdisciplinary team that nurtures creativity within a cohort of other likeminded researchers who are motivated to "think outside the box".

PROJECT CONCEPT

Traditional views of sustainable development are based on three fundamental pillars that represent the social, economic and environmental domains. Likewise, the 17 UN Sustainable Development Goals (SDGs) focus on achieving key sustainability objectives, such as those related to ending poverty and inequality and protecting the planet. The weakness of such perspectives, however, is that they can give the impression that the elements of sustainability are independent of each other, and so disregard both the intricate and interconnected interactions between them and the dynamic nature of the systems in which they function. As a result, past approaches to sustainable development have been criticised for reinforcing silos and fragmenting sustainability governance[1], leading to failures to address complex challenges[2]. By adopting a systems-thinking based approach to sustainable development and natural resource management the potential to identify and capitalise on synergies that may exist between sectors, while minimising or even avoiding trade-offs that result in negative consequences, can be enhanced[3].

The overexploitation and mismanagement of many natural resources over millennia has rendered them poorly able to buffer, adapt and recover from further stresses and shocks, whether those are spatially and temporally acute (e.g. regional extreme weather events) or chronic (e.g. global climate

change), or due to natural (e.g. volcanism) or anthropogenic (e.g. overhunting) activities. As a consequence, many resources are not resilient. Marine fish stocks have been overexploited for decades, if not centuries, by ever more industrialised fishing[4]. Today, fish populations are further threatened by a range of other stresses, including climate change (and associated ocean acidification), traditional (e.g. nutrients from fertilisers, industrial chemicals, oil) and novel (e.g. microplastics, sound, artificial light at night, pharmaceuticals) pollutants, invasive species, and habitat loss due to infrastructure development and abstractive activities. Consequently, the fisheries and fishing communities the fish populations support are also imperilled and lack long-term resilience. Acknowledging that fisheries are social-ecological systems[5] in which the fish stocks themselves form the foundations on which economic prosperity and wellbeing of fishing communities and society more widely depends, future management should adopt a systems dynamics-based approach to enhance sustainability and resilience.

Focusing on marine fisheries, this interdisciplinary project will investigate how fishing communities responds to a series of shocks (e.g. Brexit, Covid-19, war in Ukraine) so that lessons may be learnt on how resilience of the resource and the people it supports may be reinforced. Should this application be successful, specific objectives will be co-created with the PhD student recruited, and may relate to:

(1) Creating a conceptual model of the marine fisheries system using causal loop and stocks and flows diagrams.
(2) Building a systems model to test assumptions of the conceptual model, using appropriate system dynamics software (e.g. Venosim and Stella architect).
(3) Quantifying fishing activity over time-scales that cover the period of the shock using the most appropriate approaches, e.g. Automated Identification Systems (AIS) that track fishing vessels and social media (e.g. for small recreational boats) or remote sensing satellite imagery (e.g. for vessels operating in other regions of the world).
(4) Investigating shifts in catch from available data on landings for specific species and vessel types (e.g. in the UK available from the Marine Management Organisation).
(5) Obtaining information related to the status of specific fish stocks available from ICES.
(6) Correlating measures of activity and catch / stock status with metrics that document the consequences of shocks (e.g. price of red diesel, tariffs on white fish from Russia, start of new trading arrangements, period of lock down).
(7) Documenting the lived experience of fishers using appropriate social surveying techniques (e.g. on-line questionnaires, independent interviews, focus groups).

The project will be interdisciplinary in that it requires the integration of fisheries, computer, and social science. Fisheries science will involve the use of historic and current data (e.g. related to catch, landings, and stock status)

to validate the systemic responses predicted by the models. Computer science will likely involve the use of machine learning to automate the interrogation of images obtained from social media and / or remote sensing (particularly satellite imagery) to help quantify fishing activity and species targeted. Social science techniques will provide greater insight of fisher response to challenges faced, and why the actions identified were adopted. The successful candidate will be supported by the supervisory team who have experience in collaborating on interdisciplinary projects, and will be trained in the techniques and methods selected. The PhD student will receive training on research ethics and the use of social survey data obtained from active participants.

The study will provide important understanding of how those dependent on a primary resource, in this case marine fisheries to supply food, respond and adapt in the face of systemic shocks, enabling complex feedback loops to be evaluated and trade-offs, synergies and unintended consequences to be identified. In particular, the study will be novel because it will enable greater insight on the cumulative consequences of experiencing multiple successive shocks rather than the response to any one in isolation. Lessons will be learned on how to enhance the resilience of primary resources and the communities that depend on them in the face of ongoing existential threats, such as climate change. This study will help identify current biases and gaps in understanding on which to recommend future research directions.

[1]Bogers, M., Biermann, F., Kalfagianni, A., Kim, R. E., Treep, J. and Vos, M. G.. 2022. The impact of the Sustainable Development Goals on a network of 276 international organizations. Global Environmental Change 76, DOI: 10.1016/j.gloenvcha.2022.102567.
[2]UN 2023. Halfway to 2030, world 'nowhere near' reaching Global Goals, UN warns https://news.un.org/en/story/2023/07/1138777
[3]Kemp, P. S., Acuto, M., Larcom, S., Lumbroso, D. and Owen, M. 2022. Exorcising Malthusian ghosts: Vaccinating the nexus to advance integrated water, energy and food resource resilience. Current Research in Environmental Sustainability, 4, [100108]. DOI:10.1016/j.crsust.2021.100108).
[4]Thurstan, R., Brockington, S. & Roberts, C. The effects of 118 years of industrial fishing on UK bottom trawl fisheries. Nat Commun 1, 15 (2010). https://doi.org/10.1038/ncomms1013
[5]Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. Science 325, 5939, 419-422. DOI: 10.1126/science.1172133

Contribution to interdisciplinary resilience studies:

This project integrates environmental, computer and social sciences to investigate how complex socio-ecological systems (in this case fisheries) respond to a series of shocks to improve understanding of how resilience of the systems may be enhanced. Our research meets the Leverhulme remit to "transcend disciplinary boundaries" and aligns well with the PIRS aspirations

to develop graduates that are equipped with a highly employable combination of transferable investigative techniques, analytical skills, discipline-specific expertise, and interdisciplinary flexibility. Involving staff representative from three schools (two faculties), our project addresses a global challenge, primarily within the context of natural resource scarcity and sustainability. Furthermore, secondary links relate to food insecurity and systemic shocks (including extreme weather events, political upheaval, economic downturns, and pandemics) with the view that resilience can be built through learning lessons from past experience, potentially enabling adaptation to other shocks, such as climate change. Systems thinking is at the heart of this project, enabling a holistic nexus approach to be adopted to better visualise and address complexity. With the support of the supervisory team, the successful candidate with join a cohort of other PIRS students to form a cadre of PIRS ambassadors who will form the next generation of researchers equipped with skills needed to address complex social-ecological challenges. These skills not only include the technical capabilities to work effectively at the interdisciplinary interface, but also the broader skills of being able to collaborate as part of interdisciplinary teams. As such, the proposed study will provide a well-placed and a timely addition to the suite of projects offered by the PIRS programme in interdisciplinary resilience studies.

Please list and describe any specific/additional technical training or support to undertake and successfully deliver this project. *Note that students recruited into this programme will undertake a bespoke training curriculum. Students and their supervisory teams will also identify generic skills gaps to address through training courses offered by the University's Doctoral College.*

Training needs will be identified through a skills gaps analysis related to the student based on their background. However, it is expected that additional training may be required in one or more of the following areas:

(a) Survey methods used by social scientists.
(b) Machine learning and AI.
(c) Remote sensing (e.g. GIS and use of satellite data).
(d) System Dynamics modelling (e.g. the use of Venosim or Stella architect).

Appropriate expertise and relevant modules for a, b and c are currently available within the University. Likewise, practitioners that use d are also available within the University, work with the supervisory team, and will be accessed via the new Sustainability and Resilience Institute (SRI).
