Leverhulme Doctoral Scholarships Programme for Interdisciplinary Resilience Studies (PIRS)

University of Southampton

RECRUITMENT CYCLE for studentships starting: October 2025 (Cohort 2)

SUPERVISORY TEAM

Primary Supervisor	Dr Eli Lazarus
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Co-Supervisor	Dr Vanissa Wanick
School & Faculty:	Winchester School of Art (FAH)
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STUDENTSHIP PROJECT TITLE

Reimagining complex adaptive systems as "serious games" for dynamical insight

OVERVIEW

This project will explore and examine dynamics of resilience by creating and developing deliberately simplified models of complex adaptive systems, constructed as "serious games". Combining geography, game theory, creative design, and complexity science, these "serious games" will pursue a new method of gaining dynamical insight into classical resilience problems.

SUMMARY

Resilience is a dynamic that describes both elasticity and brittleness in response to disruption. Although resilience is intrinsic to a vast array of systems, mechanisms of elasticity and brittleness in any particular system are often poorly understood. To make resilience problems more tractable, researchers use theory and techniques from the science of complex systems, constructing deliberately simplified or "toy" models to explore nonlinear dynamics observed in real systems. An especially challenging set of resilience problems involve complex adaptive systems, in which critical functions and feedbacks depend on behaviours such as iterative decision making, learning, and strategy evolution. But capturing adaptive dynamics in models of complex adaptive systems has challenged resilience researchers for decades.

This project will advance insight into dynamics of resilience by reimagining complex adaptive systems as "serious games" – deliberately simplified "human in the loop" computer models in which mechanisms of adaptation are handled by a participatory player. This studentship will involve the creation, design, development, and examination of one or more "serious games" inspired by key examples from the resilience literature (e.g., natural hazards in built environments, asymmetry in common-pool resources). Game-play data and player experience will be collected and analysed as a "design material". The project will widen participation in resilience studies by involving a diversity of players in participatory research, and through engagement and impact with project outputs (including the games themselves).

This studentship will build technical and transferrable skills across a broad spectrum, including: systems thinking, game theory, creative design, code development, data visualisation, writing and presentation for specialist and general audiences, participatory research methods, and activities for engagement and impact.

Applicants with experience writing Python code are encouraged to apply.

PROJECT CONCEPT

Resilience is a dynamic that describes both elasticity and brittleness in response to disruption. Although resilience is intrinsic to a vast array of systems, mechanisms of elasticity and brittleness in any particular system are often poorly understood, requiring pluralistic ways of investigating and informing the dynamics of resilience in its many dimensions.

To make resilience problems more tractable, researchers use theory and techniques from the science of complex systems, constructing deliberately simplified or "toy" models to explore nonlinear dynamics observed in real systems. An especially obdurate subset of resilience problems involve complex adaptive systems, in which critical functions depend on behaviours such as iterative decision making, learning, and strategy evolution. But capturing adaptive dynamics, especially in toy models, has challenged resilience researchers for decades.

To address that gap, this project **aims** to pursue a transformative means of exploring the dynamics of resilience through deliberately simplified models of complex adaptive systems constructed as "serious games".

In this project, the student will create, design, develop, and examine one or more deliberately simplified "human in the loop" computer models of complex adaptive systems as games, in which mechanisms of adaptation are handled by a participatory player. These toy models will derive from key examples in the resilience literature (e.g., natural hazards in built environments, asymmetry in common-pool resources). Ceding control of specific model mechanics to diverse human players will yield system dynamics that are neither deterministic nor stochastic, and analysis of collective player decisions and utility in game-play data will reveal emergent patterns of adaptive strategy.

"Serious games" blend creative design with concepts from the natural, physical, and social sciences. This project combines physical and social science from geography, complexity and game theory from mathematics, and behavioural insights from creative design and data visualisation. Using game data and player experience as a "design material", this project will engage with quantitative and qualitative analytical methods, and will help widen participation in resilience studies by involving a diversity of players in participatory research.

This project will be supported by an interdisciplinary team of three experienced supervisors (Lazarus [Geography], Wanick [Arts], Stallwood [Maths]). Collectively, the project team will have the necessary expertise to examine core research questions that address our project aim, such as: What can "human in the loop" models of complex adaptive systems reveal about resilient states, decision-making, and uncertainty estimation? How do diverse players converge on common strategies? How do participants respond to exploring complex dynamics in a game context, and how does game design inform their experience?

The student will address the project aim and research questions through three linked **Objectives**:

➔ Objective 1 – "Serious games" for select complex adaptive systems
The student will create, design, and develop one or more "human-in-the-loop" numerical models derived from examples of complex adaptive systems in the resilience literature. Model systems might include fires at the wildland-urban interface, leveed rivers, sand mining, beach nourishment, or climate-proofing vulnerable coastal transportation networks. Games will be open source and open access (i.e., written in Python, versioned on Github).

➔ Objective 2 – Analysis of resilient states, emergent strategy, and uncertainty estimation
The student will gather quantitative game-play and qualitative interview data from a diversity of players (i.e., researchers, practitioners, students, publics, generative AI) and, drawing on Activity Theory, analyse them collectively for resilient dynamical states, user preferences, expected utility, uncertainty estimation, and emergent strategy. Player responses to game events will illuminate features of cooperation (trust, implicit communication) vital to complex adaptive systems.

➔ Objective 3 – Legacy beyond the studentship
The student and supervisory team will collaborate with the University's Center for Higher Education Practice (CHEP), Sustainability and Resilience Institute (SRI), and other networked partners to convert project outputs (e.g., open-source games, analytical tools) into materials for interdisciplinary sandpits, science roadshows, exhibitions, training tools, classrooms, and public engagement, amplifying the student's professional profile for career development. These outputs will come in addition to fundamental academic contributions, including articles for esteemed peer-review publications with broad readerships.

This studentship will build technical and transferrable skills across a broad spectrum, including: systems thinking, game theory, creative design, code development, data visualisation, writing and presentation for specialist and general audiences, participatory research methods, and activities for engagement and impact.

Contribution to interdisciplinary resilience studies:

Through "serious games" – or a "human in the loop" architecture for toy models – this project opens a new avenue into exploring the dynamics of complex adaptive systems, in which critical functions depend on behaviours such as iterative decision making, learning, and strategy evolution. Capturing adaptive dynamics, especially in toy systems models, has challenged resilience researchers for decades. Ceding control of specific model mechanics to diverse human players will yield system dynamics that are neither deterministic nor stochastic, and analysis of collective player decisions and utility in game-play data will reveal emergent patterns of adaptive strategy. Combining geography, game theory, creative design, and complexity science, these "serious games" will pursue a new method of gaining dynamical insight into classical resilience problems.

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.*

The student recruited for this project will need to have demonstrated technical skill (e.g., examples of open code on Github) in writing Python code.
