

Critical Supply Chains & Environmental Security (CriSCES)

Notes from Scoping Workshop 3 July 2025

This report summarises an internal workshop held in Security Lancaster on 3 July 2025. The focus was on the scope of research to understand **long-term security and availability of critical resources** (i.e. supply chains for food, water, energy, communications) in the face of strategic threats from climate, environmental and ecological breakdown as well as (often coupled) geopolitical realignment and turbulence.

Participants:

Jessica Bridgen, Jessica Davies, Basil Germond, Anas Iftikhar, Rob Lamb, Colin McLaughlin, Luciana Mendes-Barbosa, Qiang Ni, Tom Notman (SWC), Bill Oxbury, Dan Prince, Kostas Selviaridis, Mark Stevenson

1. Context

Within Security Lancaster, CriSCES is proposed as a cross-disciplinary network of researchers across the management, social, environmental, mathematical and security sciences, to establish a centre of expertise on the challenges outlined below.

Can we:

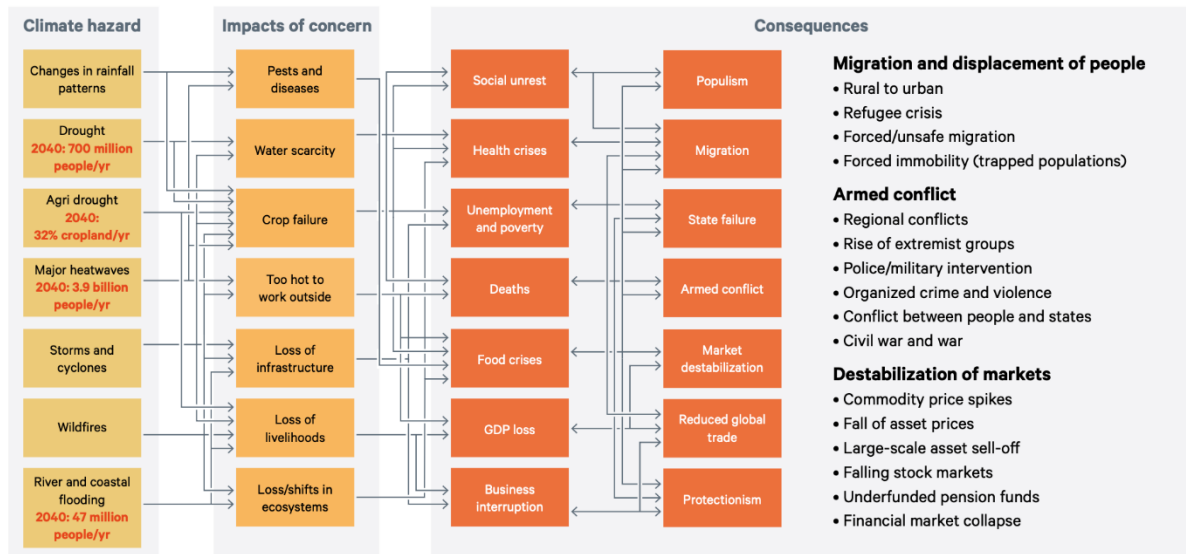
- Model regional and global supply chain networks in order to analyse vulnerabilities to systemic environmental effects?
- Build simulation platforms incorporating high-quality real-world data (socio-economic, geo-political, environmental, trade routes, supply networks) in order to test scenarios such as climate tipping points, pandemics and major conflicts, including cascading threats realised simultaneously?
- Understand resilience to malicious attacks (cyber or physical warfare, criminal, biohazard etc) under increasing systemic stress from climate, environmental and ecological factors?
- Inform and engage with public understanding of climate change and the environment as impacting on economic and physical security?

The purpose of this initial workshop was to scope the project's questions and boundaries; gauge feasibility and agree ways forward.

2. Participant contributions

The morning session of the workshop consisted of a series of talks from a range of academic backgrounds.

Bill Oxbury (School of Mathematical Sciences) reviewed the drivers and aims of the CriSCES theme, and in particular the risks to global and national security cascading from climate and wider environmental breakdown, as outlined in [1,2] and similar reports.



Source: reference [1]

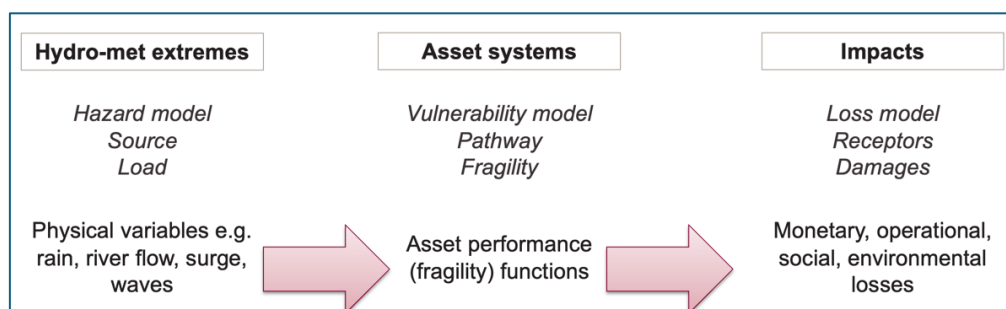
Anas Iftikhar and **Kostas Selviaridis** (Management School) gave a view from the Supply Chain (SC) management and SC risk community. This area focuses on resilience to (and ability to recover from) sudden disruptions more than to long-term threats and systemic attrition. SC vulnerabilities are not accidental but result from system design, which optimises for cost efficiency. They observed that SCs are not just physical systems but are socio-technical, with human factors and decision-making playing a key role.

The core research gap is seen as moving beyond *descriptive* analytics (what risk is) to *predictive* and *adaptive*, to find best response and model its impact.

They cited as current related work, the RESPOND-OR project (disaster preparedness and response in Indonesia and Sudan); and the MIA project – Measures for Improved Availability of medicines and vaccines.

Rob Lamb (Chief Scientist, JBA) talked about risk estimation where a complex network of assets, each entailing an economic cost under failure, is vulnerable to hazards which may be extreme probability events. He described a case study for bridge failures, under extreme flooding events, in the UK rail network.

The methodology involves decoupling the problem into a hazard model (e.g. for a flooding event), a vulnerability model (for bridge collapse) and a loss model (for economic or social cost of asset failure):

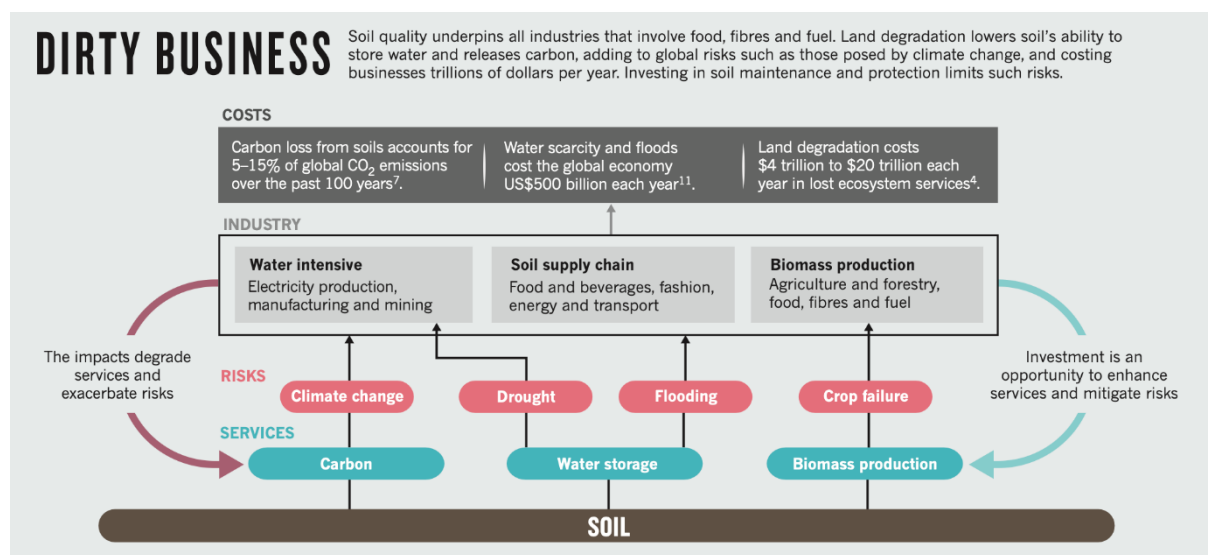


Source: reference [17]

He discussed the computational challenges of applying this framework to a network of assets (e.g. assessing financial risk across the entire UK rail network). See [17].

We can note the formal similarity between the two diagrams above: the case study exactly illustrates the challenge of modelling cascading risk through a causal chain, under uncertainty at each link in the chain. While there are mature modelling platforms for natural catastrophe risk assessment (“cat” models – see [18]) that adopt this structure for insurance portfolio risk management, where losses are aggregated from individual assets, nevertheless these typically do not allow for network or interdependency issues. See [19].

Jessica Davies (Sustainable Soils Group, LEC) talked about soil health as supporting the base of many critical supply chains (food, feed, fibres, fuel):



Source: reference [4]

How good are we at predicting the impact of soil depletion on supply chains? Some case studies were discussed: loss of agricultural productivity in the EU; nutrient depletion and maize in the US; impacts on the value of listed companies; scenario analysis in the Brazilian Cerrado.

Attention was drawn to a BBSRC call in 2024 around cascading risks in the UK food system. At present, soil is not well represented in food supply chain risks; soil degradation and its impacts can be hard to predict.

Luciana Mendes-Barbosa (Sociology of Climate Change) gave a sociological perspective on CriSCES and called for a deeper integration of social justice and equity into SC resilience frameworks. She drew attention to some key gaps: social tipping points (where and how SC stress turns into social unrest, riots etc); local vs global SC reliance; discourse and narratives (media framing and public response).

The emphasis of social justice and tipping points resonated not only for ethical reasons but for the CriSCES aim of understanding societal stability and security. The Arab Spring of 2011 had already been cited as an example (of food insecurity contributing to a social tipping point) in the workshop introduction.

Key questions for CriSCES: who decides supply chain priorities, and who is excluded? How do we model attritional crises (e.g. soil erosion) alongside acute shocks (e.g. hurricanes)? Can resilience indicators account for racial/class disparities? How do we centre grassroots knowledge in modelling?

Tom Notman (CEO, Small World Consulting) focussed on carbon accounting and on supply chain emissions. Global SCs are embedded in everything we do, and the bulk of any business's emissions are 'Scope 3' – that is, are in its supply chain. So every time a business spends money on SCs, it implicitly makes a sustainability choice. The procurement profession shapes market demand and therefore has immense agency. The talk stimulated thinking about how the demand side shapes incentives for supply security and the need, from a security perspective, to rethinking procurement systems and principles.

A challenge, as elsewhere in the workshop discussions, is in acquiring *data* on which to base SC calculations. In this talk a case study was shown from work with BT. While the focus of the workshop is SC vulnerability rather than SC emissions, the core SC disclosure data is needed in both cases.

A very striking graphic from the SWC talk is shown below: it shows at a coarse level how the global human population is distributed around the planet's land surface. It gives a powerful indication of the vulnerability of the global South, especially in Africa and Asia, to climate impacts – and therefore of global security as a consequence.



How 8 billion people are distributed around the world. Source: Small World Consulting

3. Research discussions

The afternoon consisted of discussions on directions for cross-disciplinary research and potential bids for research funding. The ideas that came out of this cluster as follows.

1. Data. A key challenge highlighted several times is access to data. Data for SC market portfolios is necessarily commercially sensitive and therefore difficult to acquire.

Sector-specific SCs were discussed (e.g. medicines, food). This offers simplifications for modelling, but especially advantages for customer engagement. Agreements with relevant government departments or industry leaders can enable data sharing, as discussed in some of the talks.

Data honest brokers and secure data sharing were discussed; these offer standard approaches to trusted data sharing between collaborating partners.

Open-source databases such as [ENCORE](#) (used in reference [5]) will also have some utility. Both banking [5] and insurance [7] sectors are key stakeholders in this area.

2. Quantitative modelling. Assuming suitable data access, a core ambition of the programme is to model SCs quantitatively so that environmental impacts can be explored and better understood – for example if a breadbasket region fails, or a trade route becomes unavailable, how will UK markets respond to that, how will competition between nations play out, and with what expected inflationary effects and so on?

A desirable approach is to build Digital Twin models – that is, models that couple to real-time data in order to mirror as accurately as possible the structure and dynamics of the real SC network. It was well noted during the workshop that economic, environmental and social factors all introduce uncertainties into such a model. Statistics is the science of modelling uncertainty, and statistics is a strength of Lancaster University. The problem is complex but not intractable (much like climate modelling).

The *National Digital Twin (DT) programme* was mentioned as something CriSCES could engage with. In particular, CriSCES may need to explore interoperability of DTs modelling different subsystems (e.g. sector-wise SCs, national SC networks etc).

Soil was seen as CNI and at the base of various SCs, most notably food. Through Jess Davies' work we have models of soil health that may offer good case studies for CriSCES.

The challenge was raised of coherence across different levels of resolution – coarse vs fine resolution. Where fine resolution is intractable, can one gain useful information from modelling at coarser levels?

Rob Lamb's talk had highlighted *risk estimation* as an intractable high-dimensional computation that in principle has to sum over values of many variables. This was highlighted for the UK rail network case study but is equally applicable for estimating risks under impacts propagating across an SC network. It is also a familiar problem in Bayesian inference, and we have techniques which it would be worth exploring on the rail network scenario initially.

3. Scenario analysis and uncertainty. The central aim of CriSCES is scenario analysis, both *quantitative* (through data analysis and mathematical modelling) and *qualitative* (through expert elicitation, social and behavioural science). The two approaches are both necessary and mutually informing.

The objects of study are ultimately causal chains (and networks) hazard → vulnerability → material loss (as framed in Rob Lamb's talk) but also augmented with → social instability. The hypothesis of CriSCES is that where *environmental impacts* are likely to induce *social instability* it is via their effect on critical resources.

Uncertainty permeates any such analysis – uncertainty about the future, about sparsity and reliability of data, uncertainty inherent in stochastic effects and so on. Uncertainty needs to be identified, reduced where possible, quantified and represented in research outputs. As pointed out by many recent authors e.g. [2,7], uncertainty is not a reason for inaction. The actuarial authors of [7] point out the need for policy focus on worst-case scenarios rather than only high-probability scenarios.

It was urged that models be *co-designed* with grass-roots stakeholders as well as SC owner and policy makers.

There was discussion of *stress testing* (of SCs, of critical resource availability, of social stability) – which can be taken to mean worst case scenario analysis. It can also mean stress testing of models to ensure maximum robustness and fidelity.

4. SC design and SC sustainability. There was much discussion of SC harms, for example environmental (carbon emissions, land degradation) and social (e.g. mining in Brazil). This is an important observation given the dominant role of SCs as a proportion of global economic activity.

The focus of CriSCES is not on the full SC network but on SCs that underpin critical resources and so underpin social health and stability. These SCs by no means exclude SC harms! In fact, it would be valuable to restrict a 'harms analysis' to those SCs we might deem 'critical' (under some suitable interpretation).

How vulnerable is the healthy functioning of SCs – of the stable provision of needed resources – to any *reforms that would remove social and environmental harms*? (The movement from industrial agriculture to sustainable or regenerative farming is a case in point.)

We see that questions of *SC design* – raised in the talk of Anas Iftikhar and Kostas Selviaridis, for the context of 'lean' SC designed for cost efficiency versus 'redundant' SC designed for resilience – are actually closely coupled to questions of *SC sustainability*. Sustainability feels like a third axis relative to resilience and cost efficiency.

So we can frame a very general research question: how can (critical resource) SCs be designed for resilience, while ensuring cost efficiency and sustainability? Does 'cost' in this setting include long-term, environmental security, costs? Who bears those costs? And on what timescale?

Can SCs be designed to be *adaptive* to environmental pressures?

5. Social stability. Understanding *social tipping points* (as raised in the talk of Luciana Mendes-Barbosa) should be a core contribution of CriSCES. The hypothesis is that resource scarcity can be a trigger for social unrest and conflict. (The example of the Arab Spring in 2011, at least partly driven by food price spikes driven by drought, was discussed in the morning session.) Inequality is also a key factor here, quite apart from being an important ethical issue. Availability requires affordability; and affordability depends on who you are and your level of wealth.

The points at which environmental supply chain crises become unmanageable are the points at which these social tipping points emerge. Understanding their mechanisms and dynamics is important.

6. Cyber and Soil. There has been some call to classify soil as a critical (national) infrastructure (food security) – this is likely to increase. In parallel, there has been growing research on soil vulnerability not just to malign activities targeting the physicality of soil but also on the vulnerability to cyber attacks. See references [4,11-16].

4. Next steps

Based on the discussion at this workshop we will be planning a conference on the topic, inviting wider expert participation. This will take place in early 2026.

For CriSCES to be a substantive research theme under Security Lancaster, it needs to be centred on one or more funded research projects focussing on the challenges discussed above. There may be some natural subthemes (mapping to the discussions above – the numbers refer to the headings in section 3):

Subtheme
Food security (UK production) [1,3,6] - agriculture as CNI - soil security - adversarial vulnerabilities - ecological vulnerabilities
Food security (SCs) [1,2,3,4] - UK dependence on overseas SCs - global threats to UK food SCs - food price inflation factors - SC vulnerabilities
Threat cascades [1,2] - identifying network threats - modelling network threats ('beyond cat models') - UK rail bridge case study and its extension to SC networks - global climate tipping points
Adaptive SCs [1,4] - analysis of whether NSRA adequately captures critical SC risks - SC design trade-offs (cost vs resilience vs sustainability) - SC resilience strategies: AI-enabled adaptability and response to disruption - UK agri-food sector as a case study - UK medicines SC as a case study (DHSC) - SC policy and implementation barriers - procurement as lever to incentivise SC security
Social & behavioural security [1,5] - social tipping points - public awareness - global comparisons

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