Anglia Ruskin University

Global Sustainability Institute

Complex social-ecological systems and environmental shocks: a threat for international security

Dr Davide Natalini, Senior Research Fellow, Global Sustainability Institute

A bit about the speaker..

Name: Davide Natalini
Title: Senior Research Fellow
Interdisciplinary Environmental Social Scientist
Role: Co-lead Global Risk and Resilience research theme @ Global Sustainability Institute, ARU, UK

Research expertise/interests :

- Complex social-ecological systems
- Environmental security
- Participatory sustainable development
- …

Structure of the talk

1. Complex Social-Ecological Systems

2. Environmental security

3. Virus outbreaks as ecological shocks

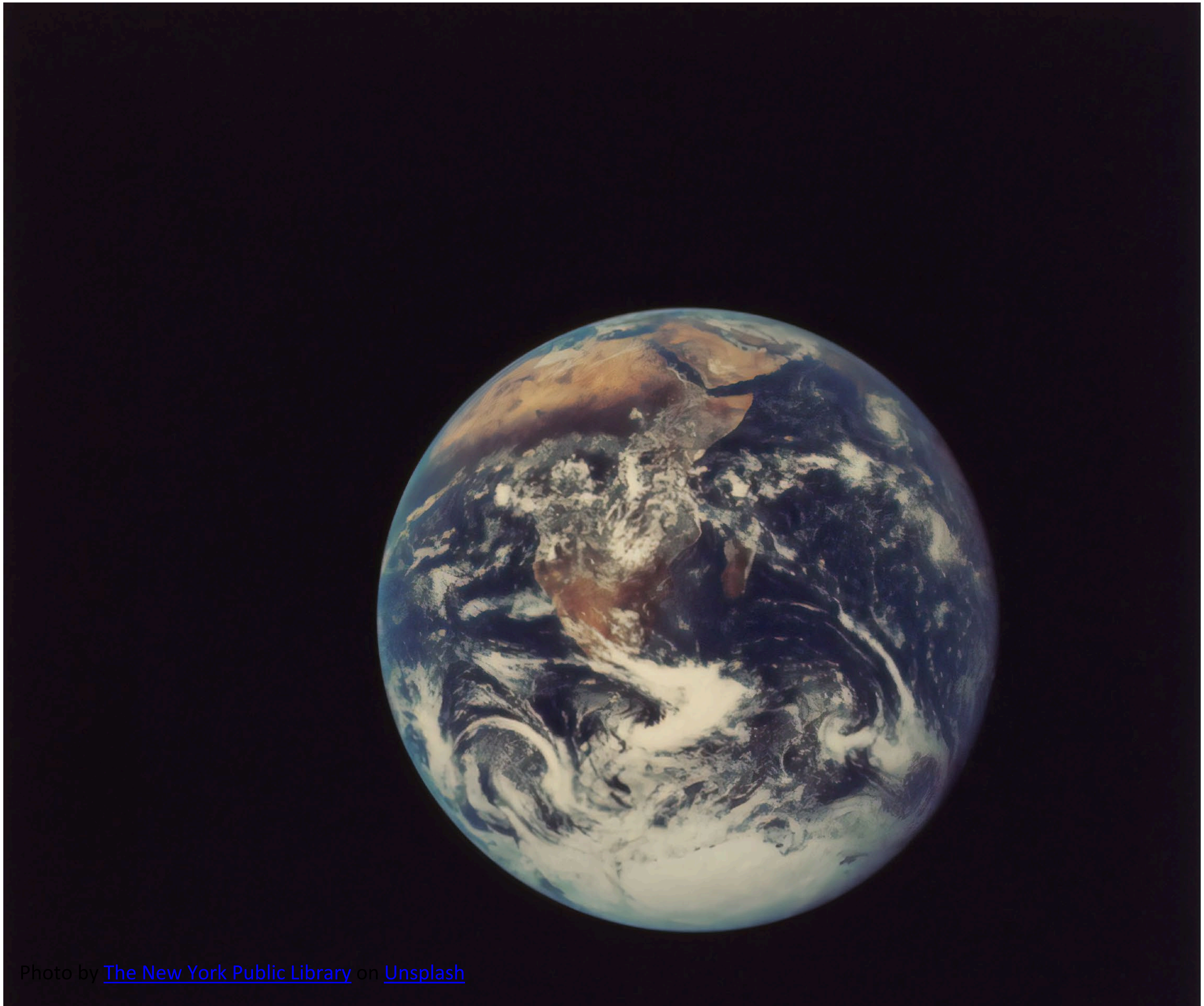
4. Cascading ecological shocks and networks

5. Lebanon as an illustration of cascading social-ecological shocks and conflict

6. Conclusions

Complex Social-Ecological Systems (SESs)

We live in a very complex world…



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Complex Systems - Key properties

- *Numerosity* – Several components
- *Non-linearity* – Presence of thresholds that can cause **regime shifts**
- *Interconnectedness* – **interaction** between components and sub-systems
- *Emergence* - characteristics or behaviours resulting from a complex system that could not be captured by merely studying its single components in isolation

Complex Social-Ecological Systems

Social-ecological systems are linked systems of people and nature, emphasising that **humans must be seen as a part of, not apart from, nature** (Berkes and Folke, 1998)

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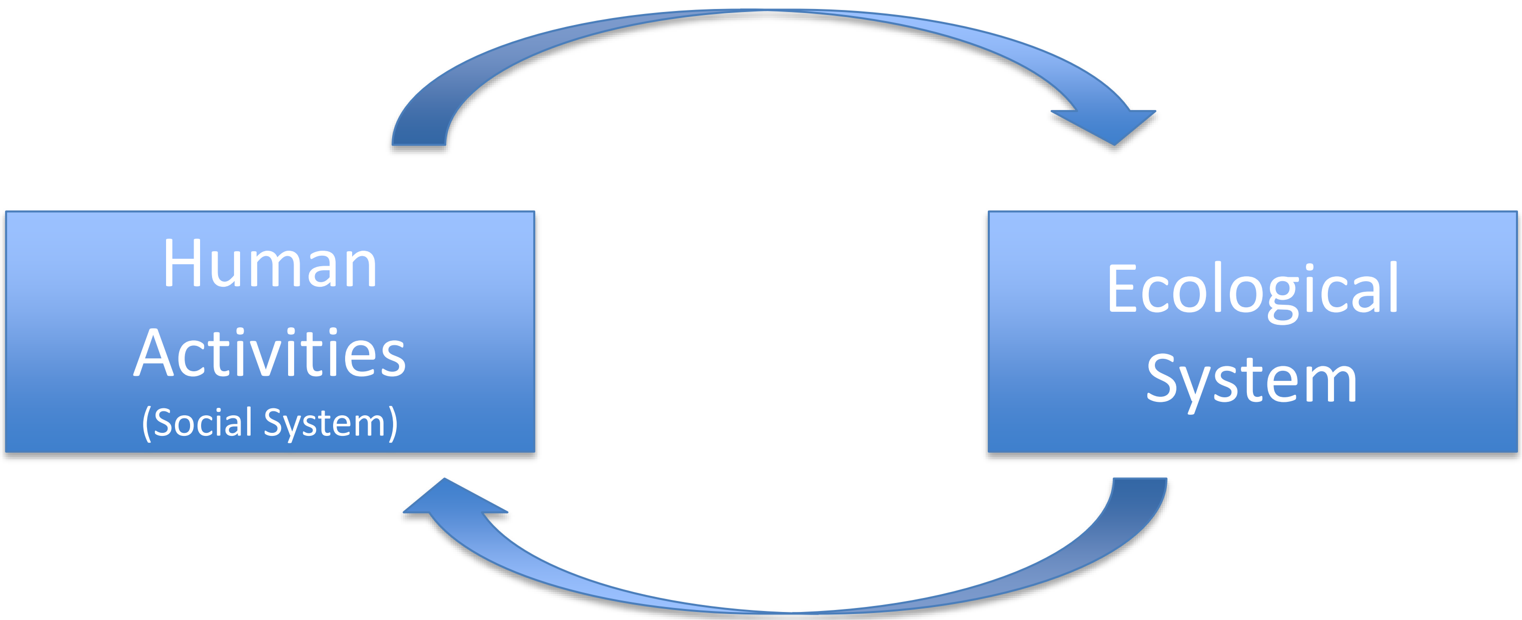
Complex Social-Ecological Systems

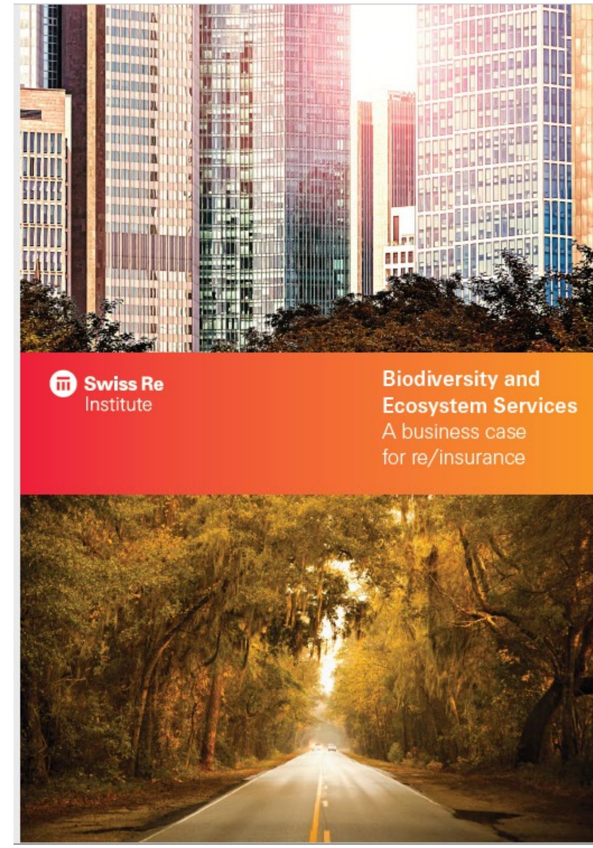
- Human activities have a profound impact on the ecological system
- The ecological system, in turn affects human activities
- This is a never-ending, unavoidable cycle



Mutual effects are **complex** and **difficult to predict**

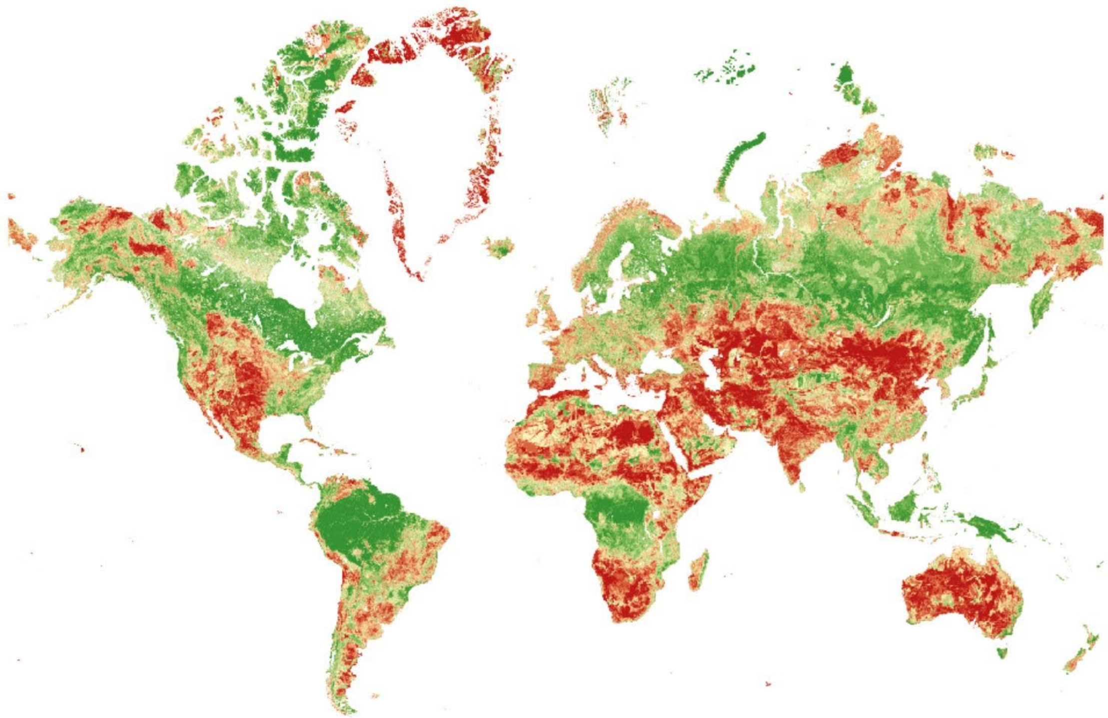
Biodiversity and connected Ecosystem Services continue to be destroyed (Swiss Re, 2020)

- One-fifth of the world's countries are at risk of their ecosystems collapsing because of the destruction of wildlife and their habitats
- More than half of global GDP – $42tn (£32tn) – depends on high-functioning biodiversity, according to the report



Social-Ecological Tipping Points

Global SRI BES Index map at 1 km² resolution



Biodiversity & Ecosystem Services (BES) Index

- Very Low (<15)
- Low (15–30)
- Moderate (30–45)
- Moderate (45–60)
- Moderate (60–75)
- High (75–90)
- Very High (>90)

Source: Swiss Re Institute and multiple data sources

Complex social-ecological systems are characterised by tipping points and we don’t know where these are placed

Real-life examples of how social-ecological-social dynamics work – The Amazon Rainforest

Photo by sippakorn yamkasikorn on Unsplash

Real-life examples of how social-ecological-social dynamics work – Loss of insects

Photo by Maxime Gilbert on Unsplash

Real-life examples of how social-ecological-social dynamics work – Eutrophication

Photo by Tholaal Mohamed on Unsplash

Real-life examples of how social-ecological-social dynamics work – food and fuel riots

Photo by Hasan Almasi on Unsplash

Real-life examples of how social-ecological-social dynamics work – Virus outbreaks

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Environmental Security

Pathways from availability of resources to conflict (Vesco et al. 2020)

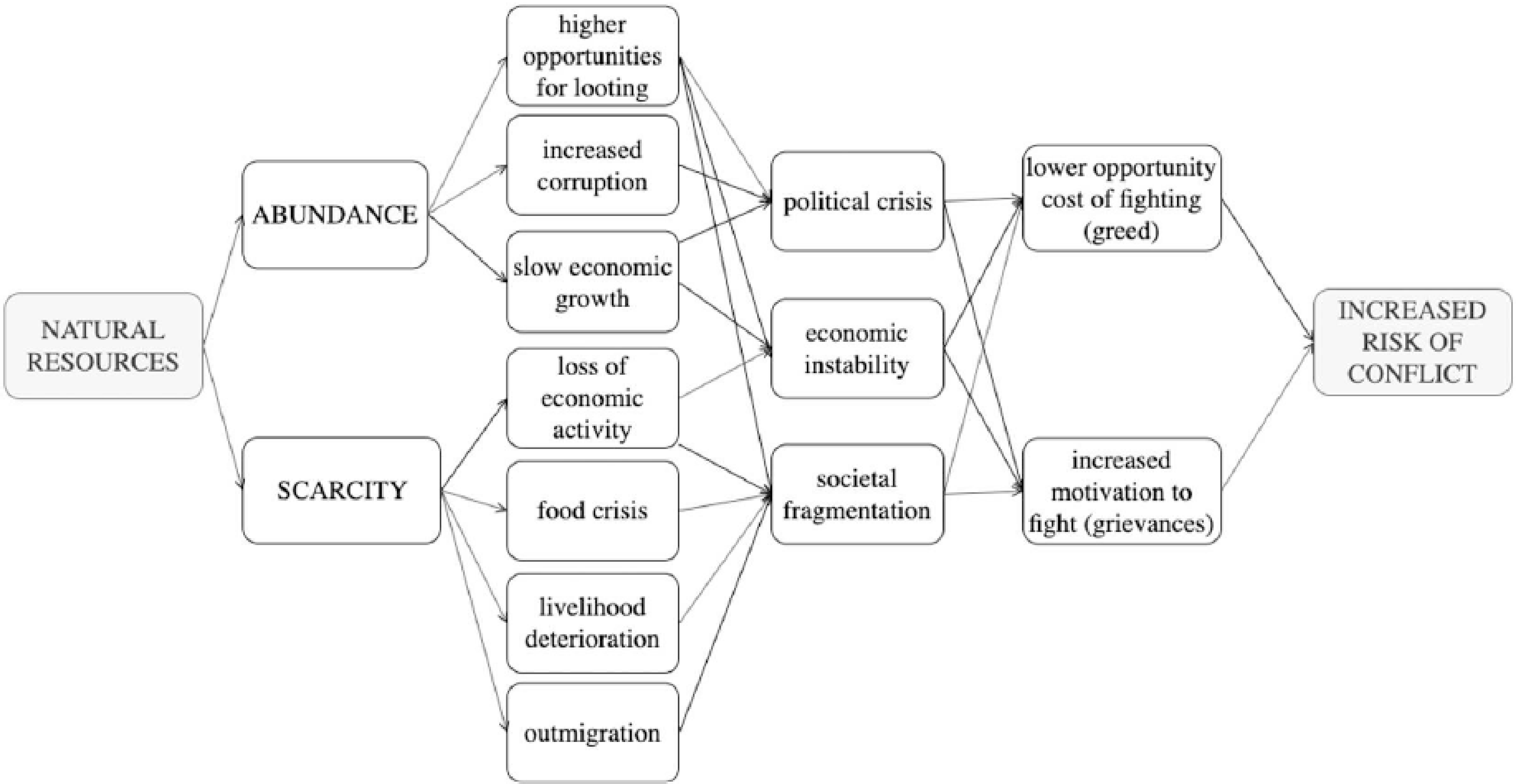
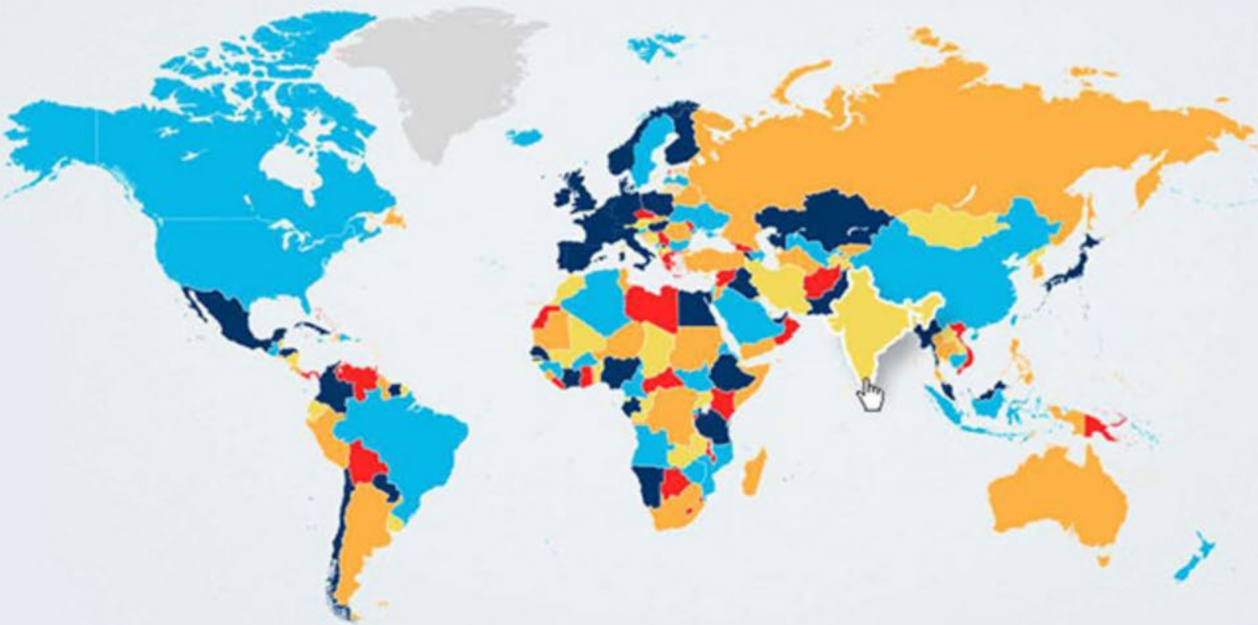


Fig. 1. Main pathways connecting natural resources to conflict risk.

Global Chaos Map Project – access to resources and conflict

Global Chaos Map Project

In a world where natural resources such as food, fuel and water are less accessible for millions of people, the potential for violent social unrest is ever present. The Global Chaos Map Project gives us valuable insights into patterns of unrest and global trends. Project outputs include an interactive map (under development) and a freely available database.



Download data ›

Database and Map https://aru.ac.uk/global-sustainability-institute-gsi/research/global-risk-and-resilience/global-chaos-map-project

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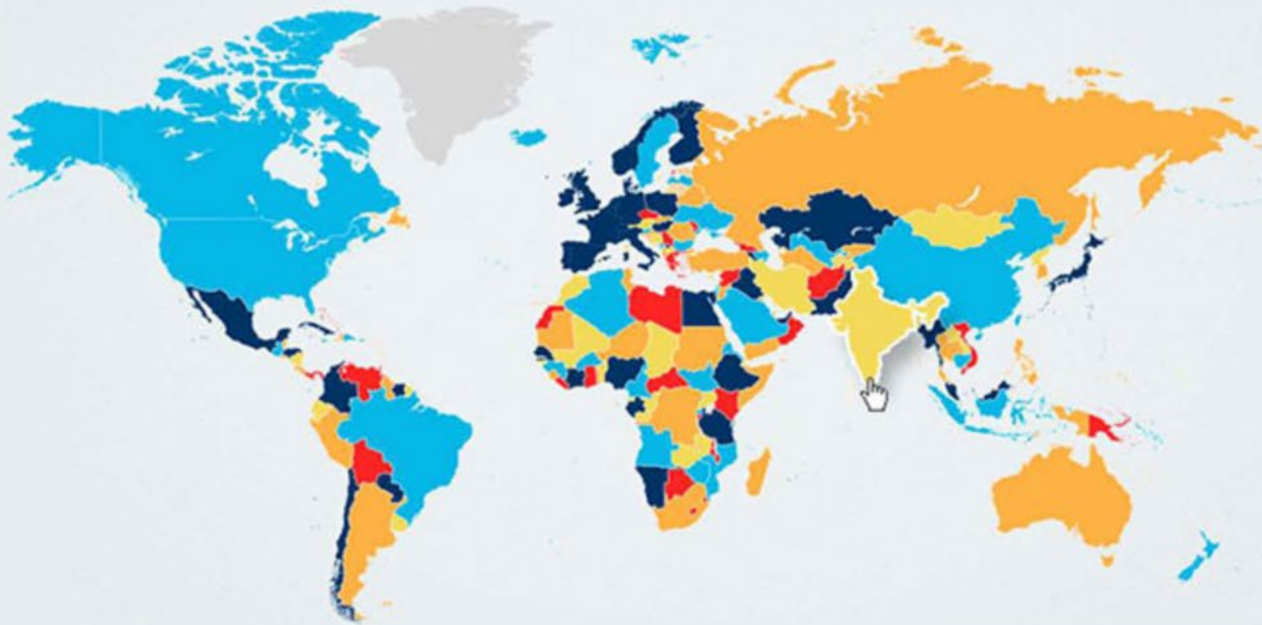


Environmental dynamics act as further stressors, which can lead to conflict

Research on Fuel Riots (Natalini et al. 2020)

	MODEL		
	1	2	3
INTERCEPT	−4.808***	−5.195***	−4.862***
	(0.363)	(0.403)	(0.460)
FUEL PRICE	0.756***	0.711***	0.748***
	(0.198)	(0.192)	(0.200)
POLITICAL STABILITY (REVERSED)	0.765***		
	(0.200)		
NET FUEL EXPORTS	−0.405*	−0.494*	−0.737**
	(0.173)	(0.201)	(0.242)
NET FUEL EXPORTS × POLITICAL STABILITY (REVERSED)	−0.365		
	(0.247)		
POLITY IV	0.119		−0.057
	(0.216)		(0.242)
GOVERNMENT EFFECTIVENESS (REVERSED)		0.595*	
		(0.239)	
PER CAPITA GDP			−0.680*
			(0.307)
POPULATION GROWTH			0.033
			(0.162)
NET FUEL EXPORTS × PER CAPITA GDP			0.369
			(0.221)
N. OF OBSERVATIONS	1769	2132	1714
LOG LIKELIHOOD	−195.5	−211.6	−193.4
AKAIKE INF. CRIT.	405.1	433.2	402.8
BAYESIAN INF. CRIT.	443.4	461.5	446.4
CONDITIONAL R^2	0.425	0.509	0.455
MARGINAL R^2	0.213	0.135	0.180

Research on Food Riots (Natalini et al. 2019; 2015)

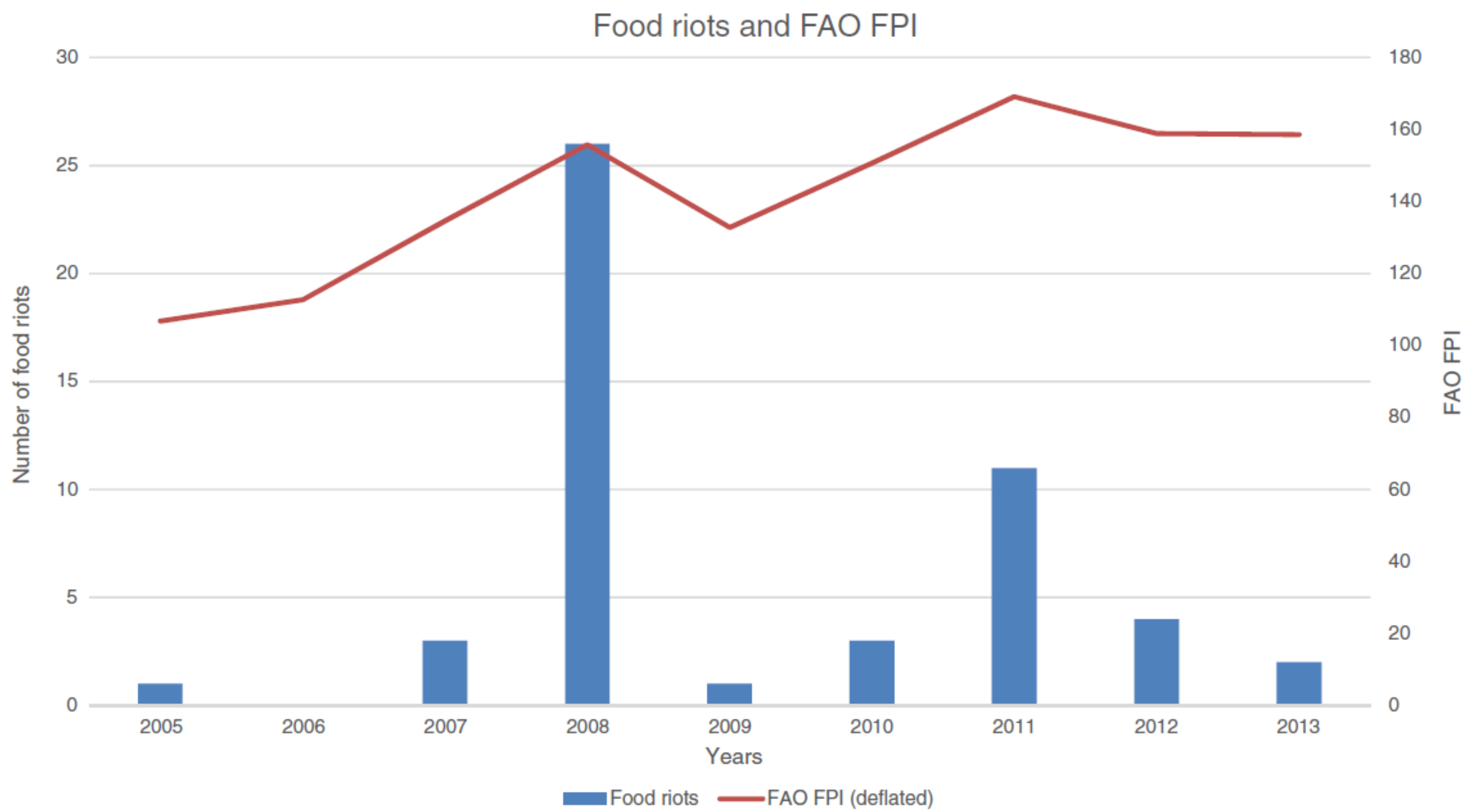
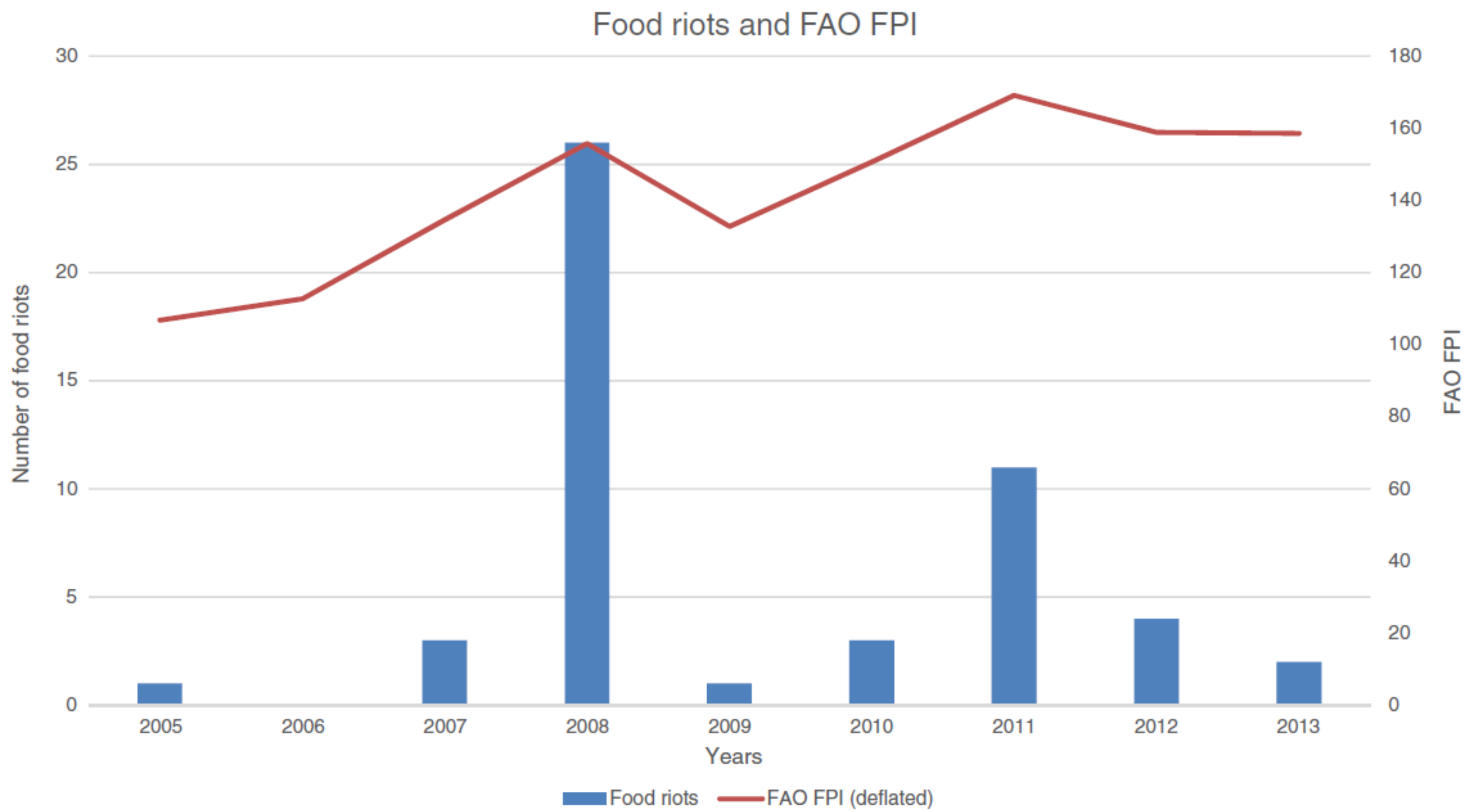


Fig. 2 Plot of the frequency of food riots per year (*columns*) and of the deflated version of the FAO FPI (*red line*) for the period 2005–2013

Research on Food Riots (Natalini et al. 2019; 2015)



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Environmental shocks can tip over the edge situations that are already politically and economically fragile

Research on Fuel Riots (Natalini et al. TBC)

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Action for Empowerment and Accountability (A4EA) Research Programme, led by @JohnGaventa @IDS_UK. Photo credit: G Ibrahim

Drivers of virus outbreaks

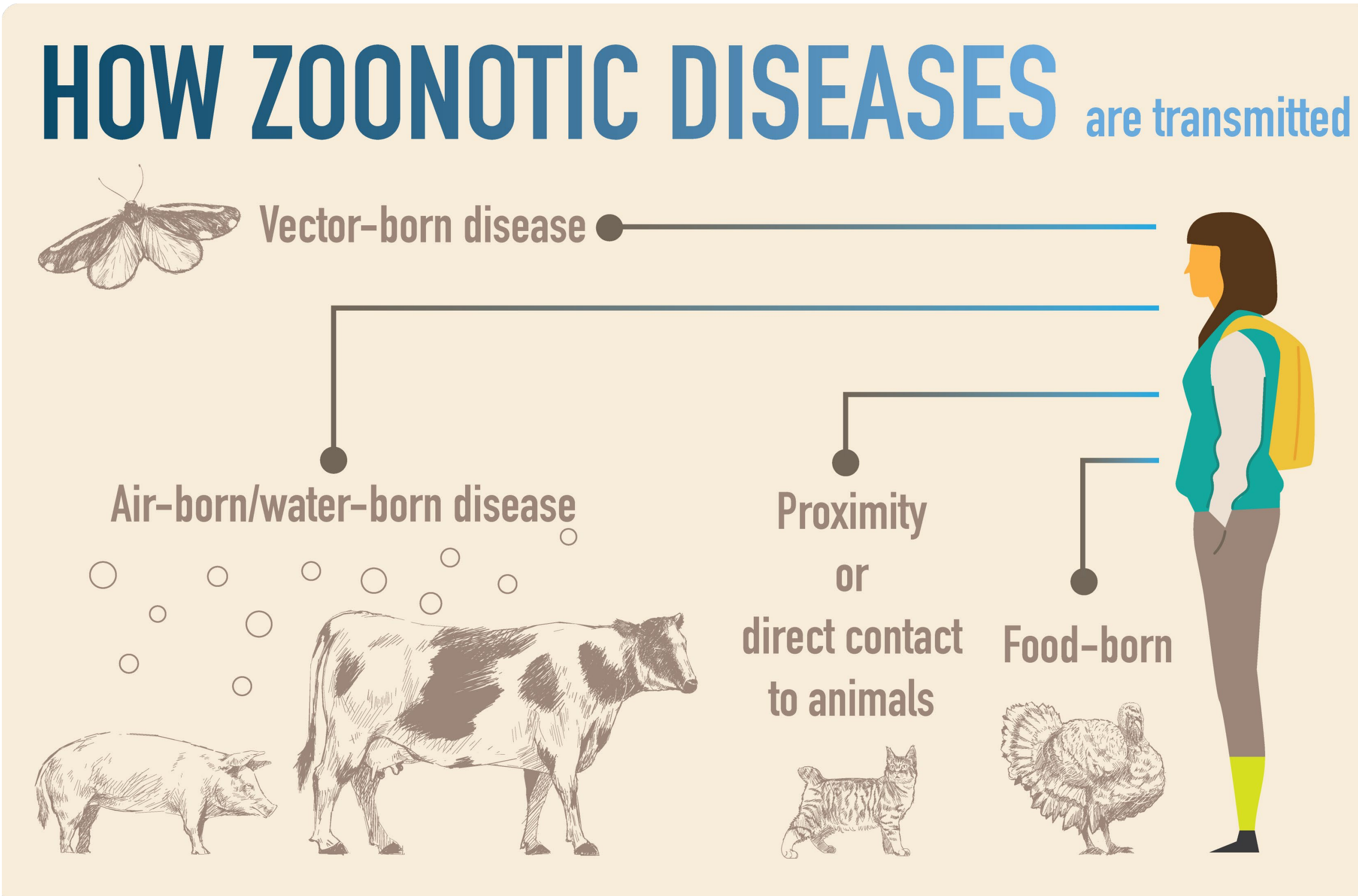
Animal-human interactions and virus spill over

- Studies on virus spill over (*zoonotic viruses*) due to animal-human interaction, pre-date COVID-19

Reservoir species	Zoonotic disease examples
Companion animals	
Cats	Toxoplasmosis, Q fever, variant Creutzfeldt-Jakob disease, Capnocytophaga canimorsus, Plague, Bartonellosis
Dogs	Q fever, Rabies, Leptospirosis, Capnocytophaga canimorsus
Horses	Tuberculosis
Livestock	
Cattles	Q fever, Creutzfeldt-Jacob disease, Crimean-Congo haemorrhagic fever, Tuberculosis, Leptospirosis, Rift Valley fever, Tuberculosis, Brucellosis
Pigs	Toxoplasmosis, Japanese encephalitis, Campylobacteriosis, Tuberculosis, Streptococcosis, Tularaemia, Brucello-sis, Leptospirosis, zoonotic influenza
Sheep/goats	Toxoplasmosis, Q fever, Rift Valley fever, Tularaemia, Brucellosis
Deer	Q fever, Tuberculosis, Human granulocytotropic anaplasmosis, Leptospirosis
Poultry	
Poultry/fowl	Campylobacteriosis, Chlamydiosis, Salmonellosis, influenza
Wild mammals	
Badger	Tuberculosis
Raccoons/skunks	Rabies
Bats	Rabies, Ebola, SARS, Nipah virus
Wild boar	Toxoplasmosis, Tuberculosis, Streptococcosis
Wild deer	Q fever, Tuberculosis, Human granulocytotropic anaplasmosis
Foxes	Q fever, Tularaemia, Echinococcosus, Rabies
Rabbits/hares	Q fever, Tularaemia
Rodents	Toxoplasmosis, Q fever, Leptospirosis, Dobrava-Belgrade virus, Tularaemia, Plague, Monkeypox
Ground squirrels	Plague
Wild birds	
Birds including waterfowl	Influenza, Japanese encephalitis, Q fever, West Nile fever, Eastern equine encephalitis, Chlamydiosis
Aquatic	
Fish	Leptospirosis
Arthropod	
Insects and arachnids	Campylobacteriosis

From https://blogs.egu.eu/divisions/cl/2020/03/16/corona/

Animal-human interactions and virus spill over



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Animal-human interactions and virus spill over

Recent research has found that two main human-related drivers have facilitated the transmission of animal viruses to humans (Johnson et al. 2020):

- Decreased distance between humans and wildlife – driven mainly by **deforestation and wild habitat conversion**
- Increased **rates of extinction** of big mammals (predators), and increasing populations of small rodents, main carrier of zoonotic diseases

Stress hormones can suppress the immune system in animals, therefore helping the virus spread (Martin et al. 2011) (e.g. in wet markets)

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More pandemic outbreaks are likely to happen if biodiversity and distance between humans and nature decrease

Ecological risks can cascade through networks and jump between dimensions

Networks

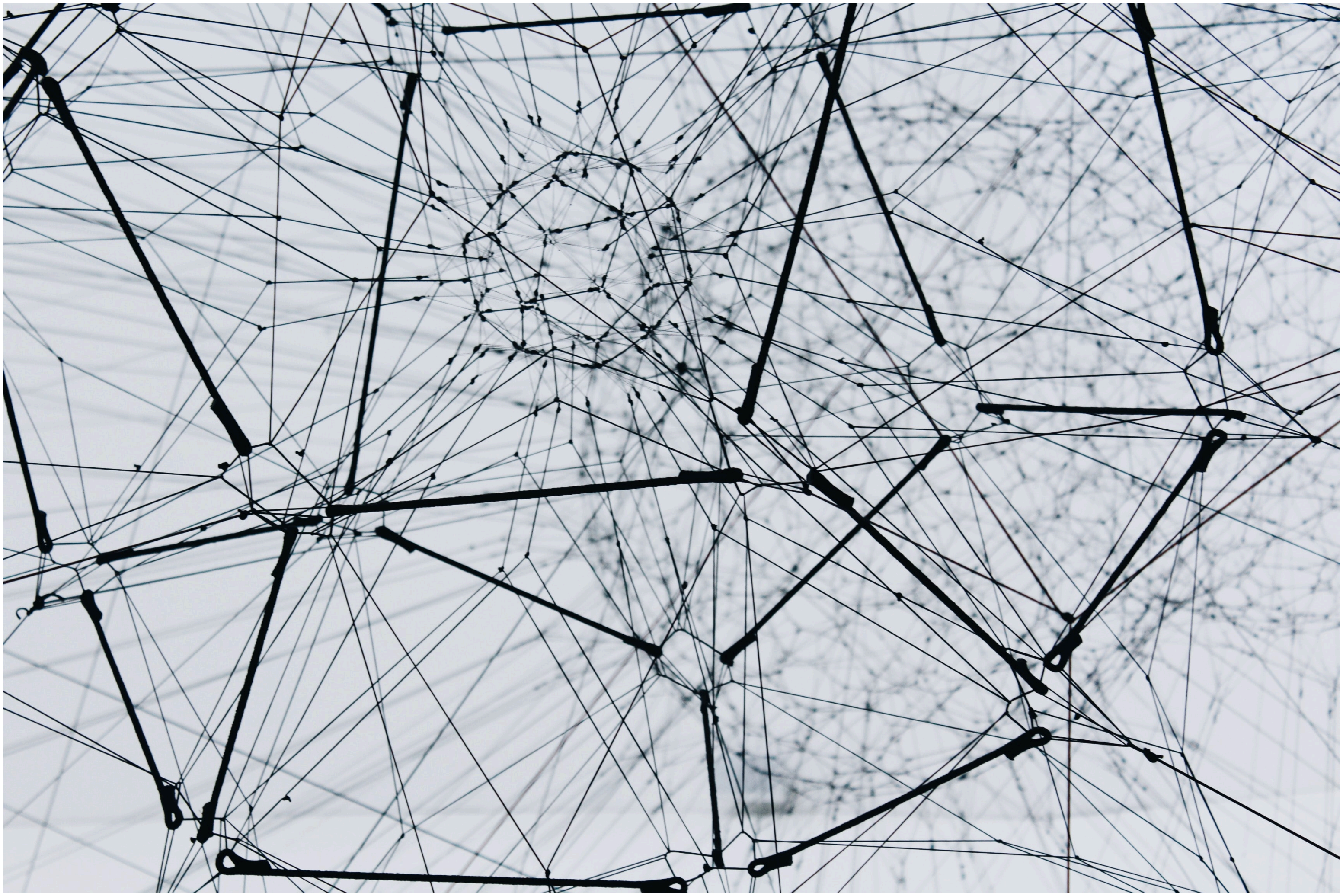


Photo by Alina Grubnyak on Unsplash

Increased interconnectivity in our complex social-ecological system…

Networks such as the internet, international trade, the finance system **connect** our complex social-ecological system.

↓

The density, capacity and speed of **connections** is **increasing** (Homer-Dixon, et al. 2015)

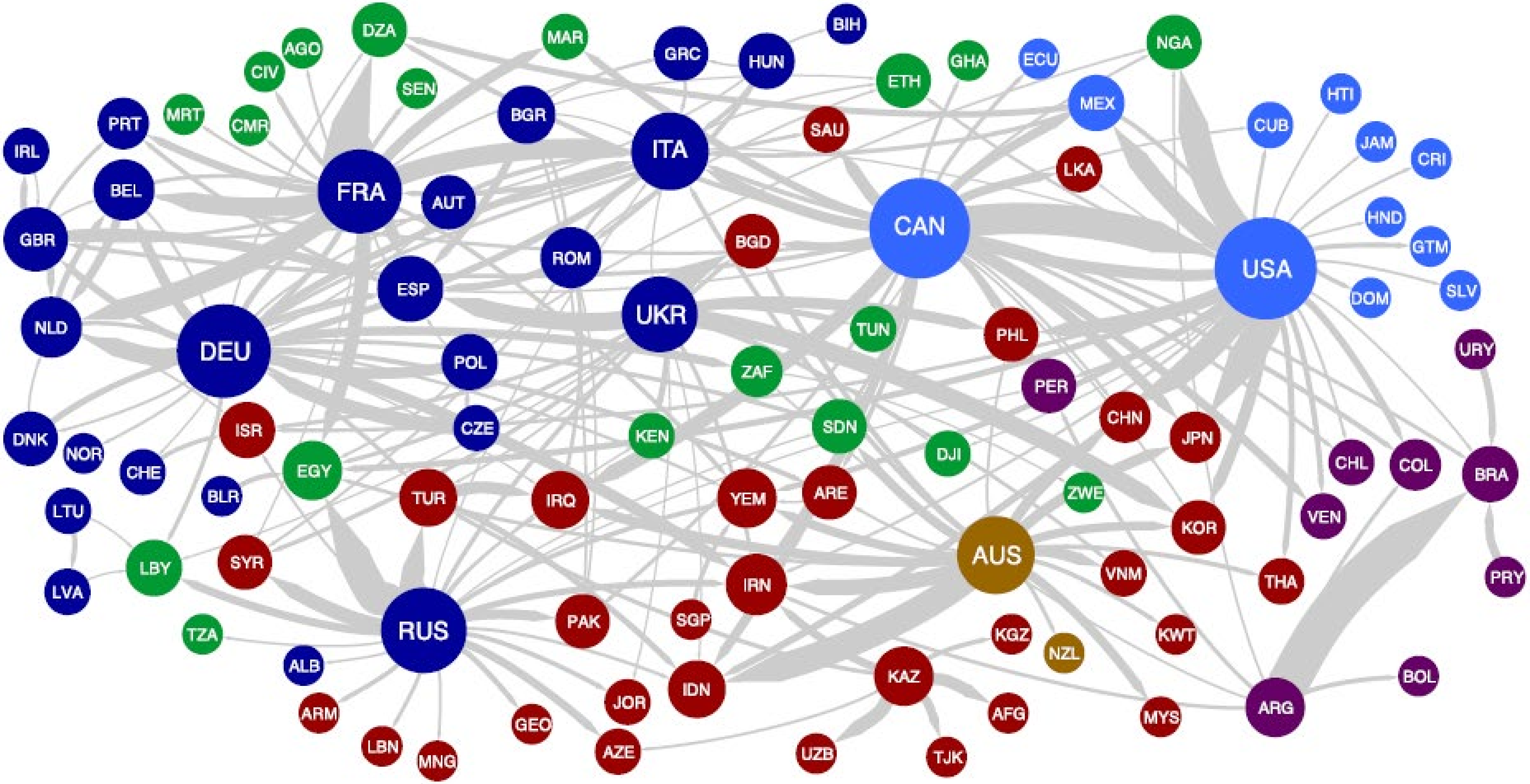
↓

Make the system more interconnected and more opaque

↓

More complex, more opaque systems are more difficult to understand and behaviours more difficult to predict

An example of cascading ecological shocks



Wheat Trade Network, 2009

Source: Puma et al. (2015)

Lebanon - an illustration of a cascading social-ecological crisis

Lebanon - an illustration of a social-ecological crisis

Before Covid-19 Lebanon was already in a ‘fragile’ situation

- Complex political system legacy from civil war
- One of main recipient of Syrian refugees (around 1.5m refugees – the most per capita in the world) (UNHCR 2019)
- Water scarce region
- Large food importer (80% of food demand)
- Mismanagement of service provision (lack of continuous electricity, no drinking water, etc)

Economic + political crisis (anti-corruption/ protests since October 2019)

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Covid-19 effects on Lebanon

- Lebanese pound down 80%
- Drop in food imports
- Food inflation at 200%
- Further unrest

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Food riots

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Covid-19 effects on Lebanon

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Food riots

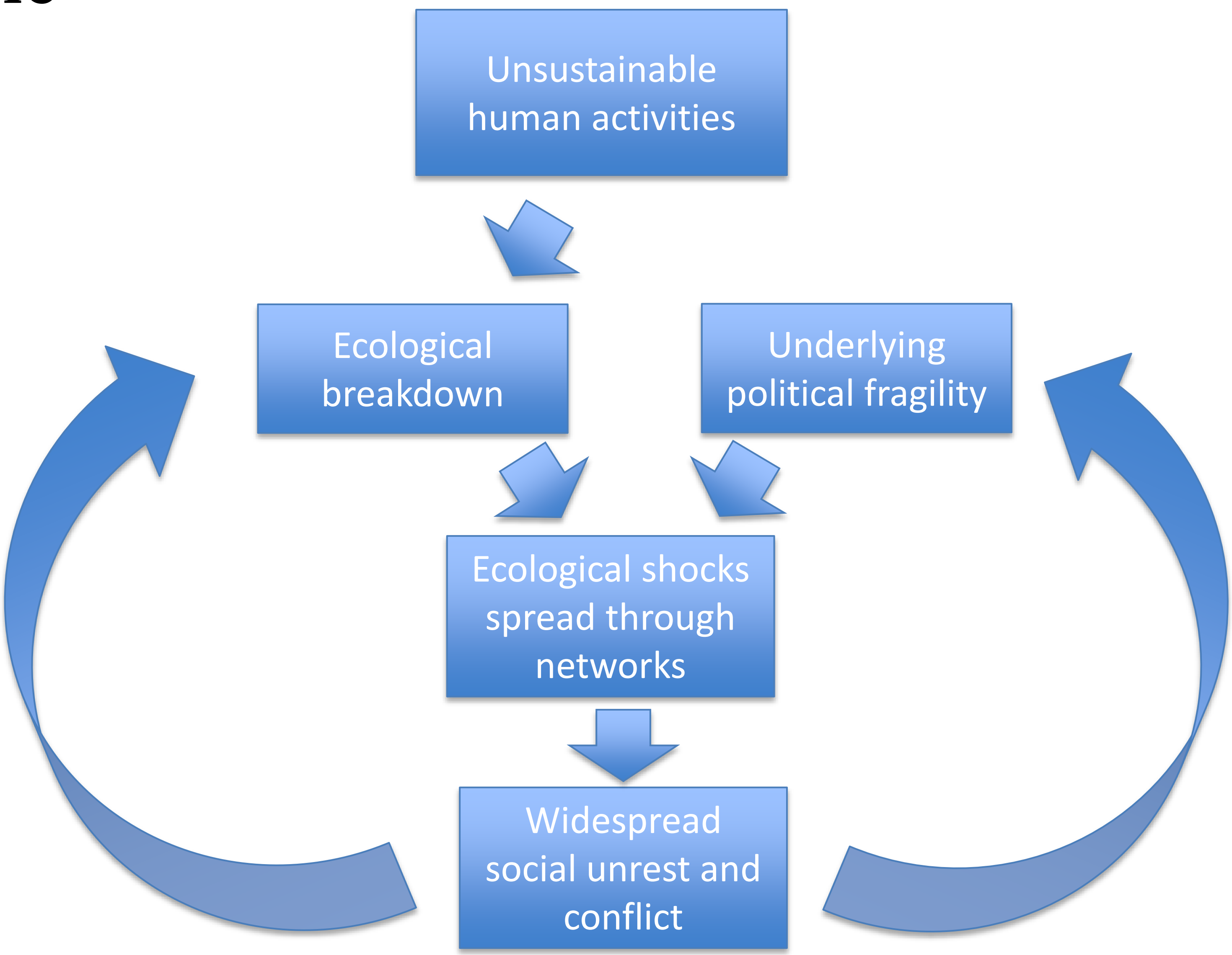
(Plus the obvious elephant in the room that was the blast, with consequent increase in anti-government protests)

Lebanon - an illustration of a social-ecological crisis

Empirical example of how fragile situations can be further exacerbated by environmental shocks that travel through networks and result in increased conflict

Conclusions and reflections

Conclusions – A vicious social-ecological cycle



Conclusions – Better models and better decisions

We need **better models to**

- Better understand dynamics
- Better understand how shocks travel
- Better understand second-order effects of decisions
- Identify situations at risk

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- Better understand dynamics
- Better understand how shocks travel
- Better understand second-order effects of decisions
- Identify situations at risk

Ultimately, make better decisions

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