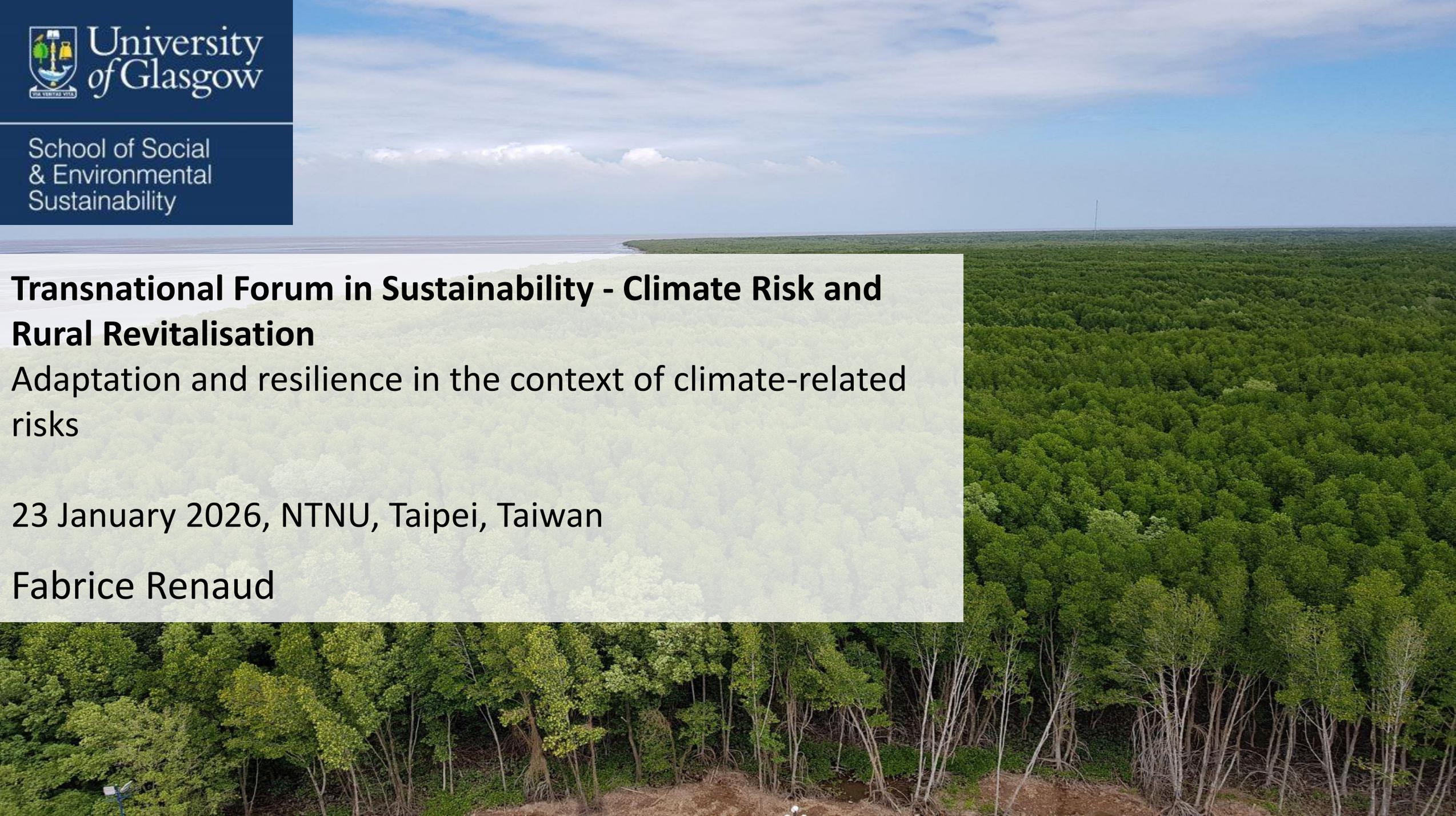


Transnational Forum in Sustainability - Climate Risk and Rural Revitalisation

Adaptation and resilience in the context of climate-related risks

23 January 2026, NTNU, Taipei, Taiwan

Fabrice Renaud



Outline

- Increasing risks globally
- Addressing risks through adaptation
- Addressing risks through green recovery/development
- Actions that can support green recovery and/or adoption of nature-based solutions
- Conclusion



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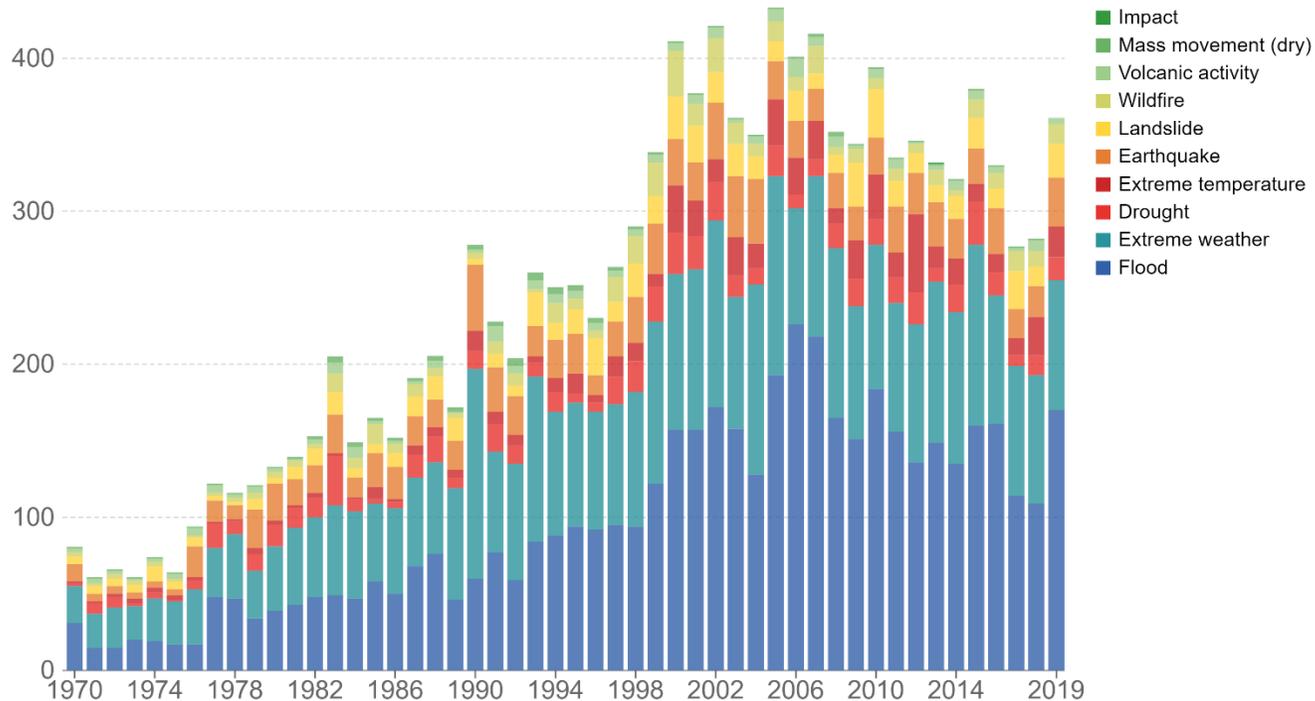
Increasing risks

Global trends in disasters from natural hazards

Global reported natural disasters by type, 1970 to 2019

The annual reported number of natural disasters, categorised by type. This includes both weather and non-weather related disasters.

Our World
in Data



Source: EMDAT (2020): OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium
OurWorldInData.org/natural-disasters • CC BY

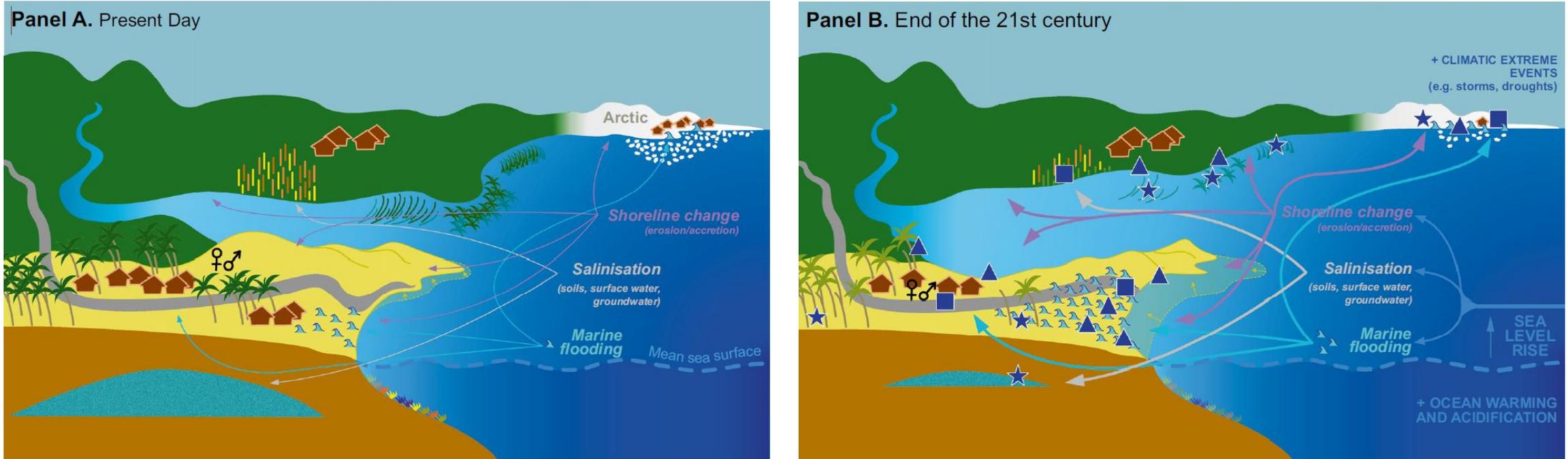
Source: Ritchie A. & Roser M. (2014) - "Natural Disasters". Published online at OurWorldInData.org. Retrieved from: '<https://ourworldindata.org/natural-disasters>' [Online Resource] Accessed May 2022. [CC BY]

Comparing trends in disasters between 1980-99 and 2000-19:

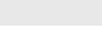
- Extreme temperatures x 3.3
- Flood x 2.3
- Landslides x 1.5
- Storms x 1.4
- Droughts x 1.3

Source: CRED & UNDRR (2020): Human costs of disasters. An overview of the last 20 years (2000-2019). Available from: <https://www.undrr.org/publication/human-cost-disasters-overview-last-20-years-2000-2019>

Schematic visualisation of SLR impacts by the end of the twenty-first century (hypothetical coastal area)



Physical and environmental settings

-  From open ocean to coastal waters
-  Dunes and sand beaches
-  Groundwater lens
-  Sea ice
-  Mangroves
-  Marshes
-  Seagrasses
-  Coral reefs

Human assets

-  People, sociocultural values
-  Buildings
-  Infrastructure
-  Crops (agriculture)
-  Trees (e.g. coconut)

Risks to territories

-  Loss of land
-  Loss of ecosystem services
-  Risk to people, settlements and activities (e.g., roads)

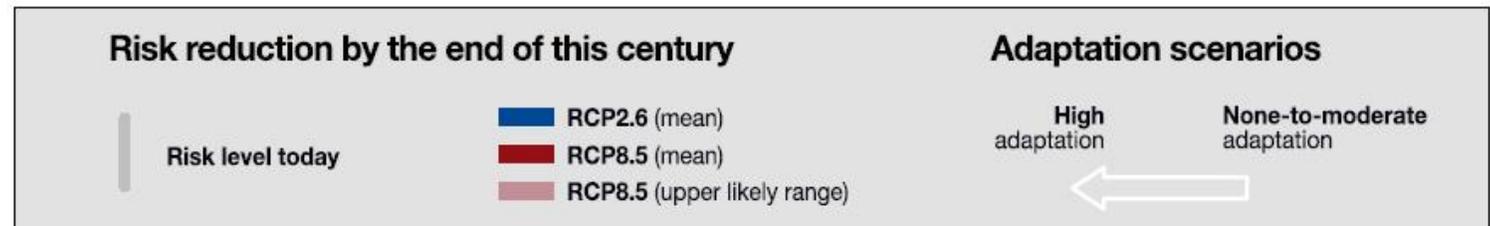
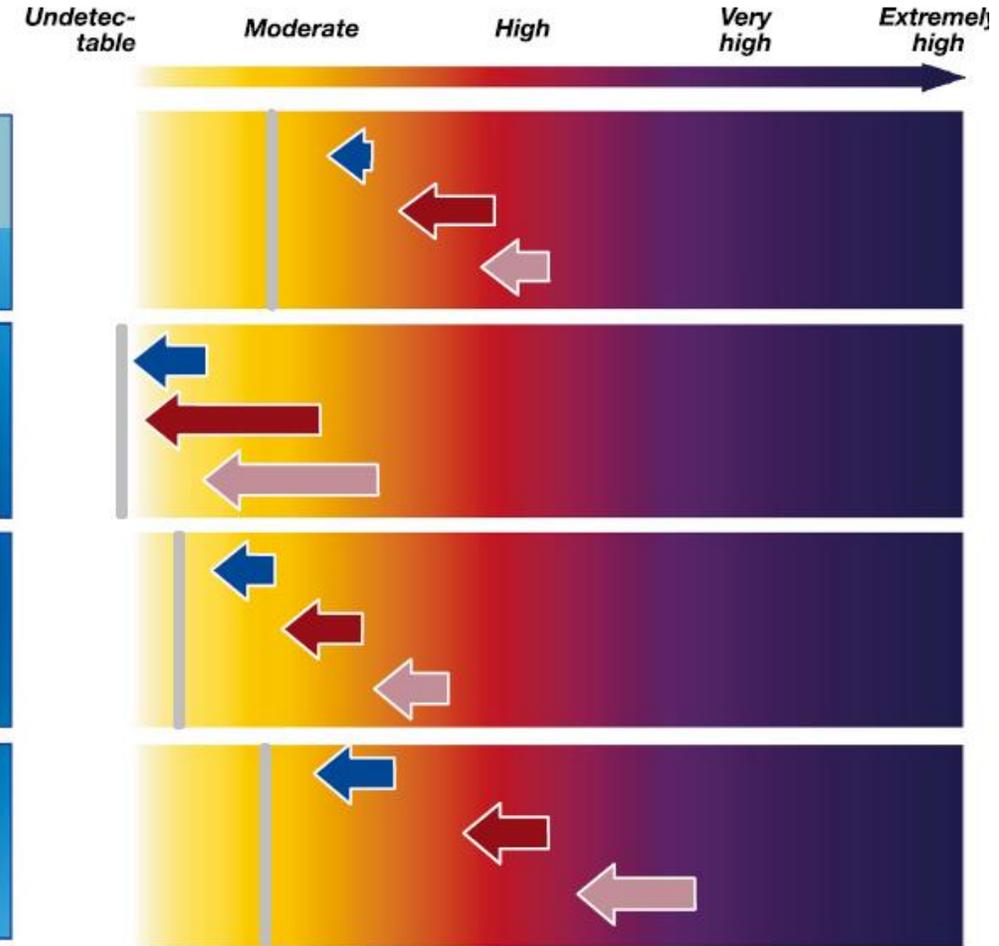
Synthesis on additional SLR risk

Source: Magnan et al. (2022): Sea level rise risks and societal adaptation benefits in low-lying coastal areas. *Scientific Reports* 12:10677. <https://doi.org/10.1038/s41598-022-14303-w>. [CC-BY 4.0]

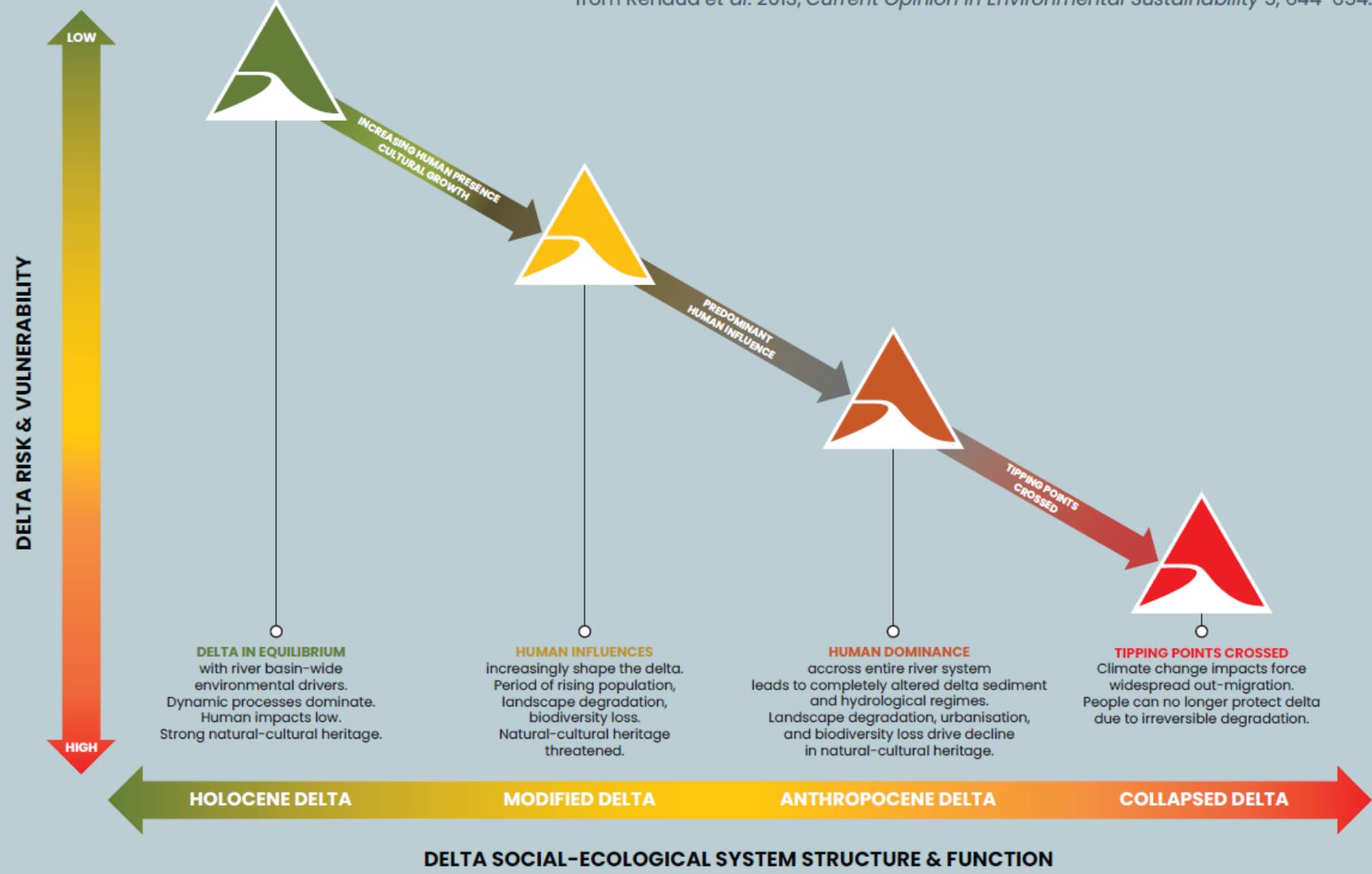
LOW-LYING COASTAL SETTLEMENT ARCHETYPES



RISK FROM SEA-LEVEL RISE (in 2100)

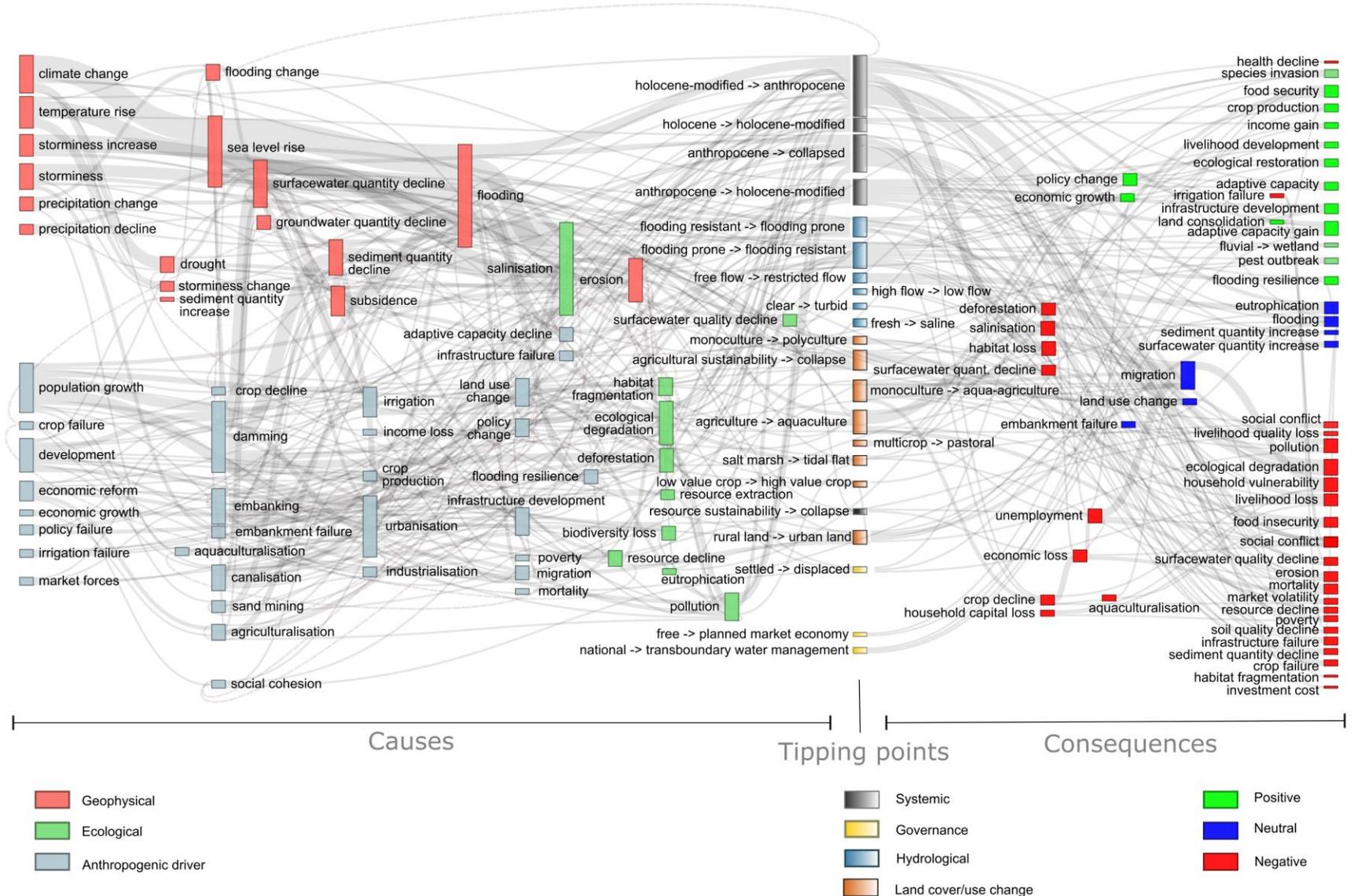


Trajectory of delta social-ecological systems (SES) under rising human pressure over time, emphasising the relationship between increasing risk and vulnerability and loss of resilience related to degradation of delta ecosystem structure and function (more recently threatened further by climate change). There is an imperative to avoid tipping into more degraded or 'collapsed' states and the Hub's 5-year research aimed at addressing this threat. Original SES descriptors modified from Renaud *et al.* 2013, *Current Opinion in Environmental Sustainability* 5, 644-654.



Causes and consequences of tipping points in river deltas

Example of a chain:
Cause: climate change
 - sea-level rise - salinity intrusion
Tipping pt: agriculture
 → brackish aquaculture
Consequences: (+) economic growth; (-) environmental degradation

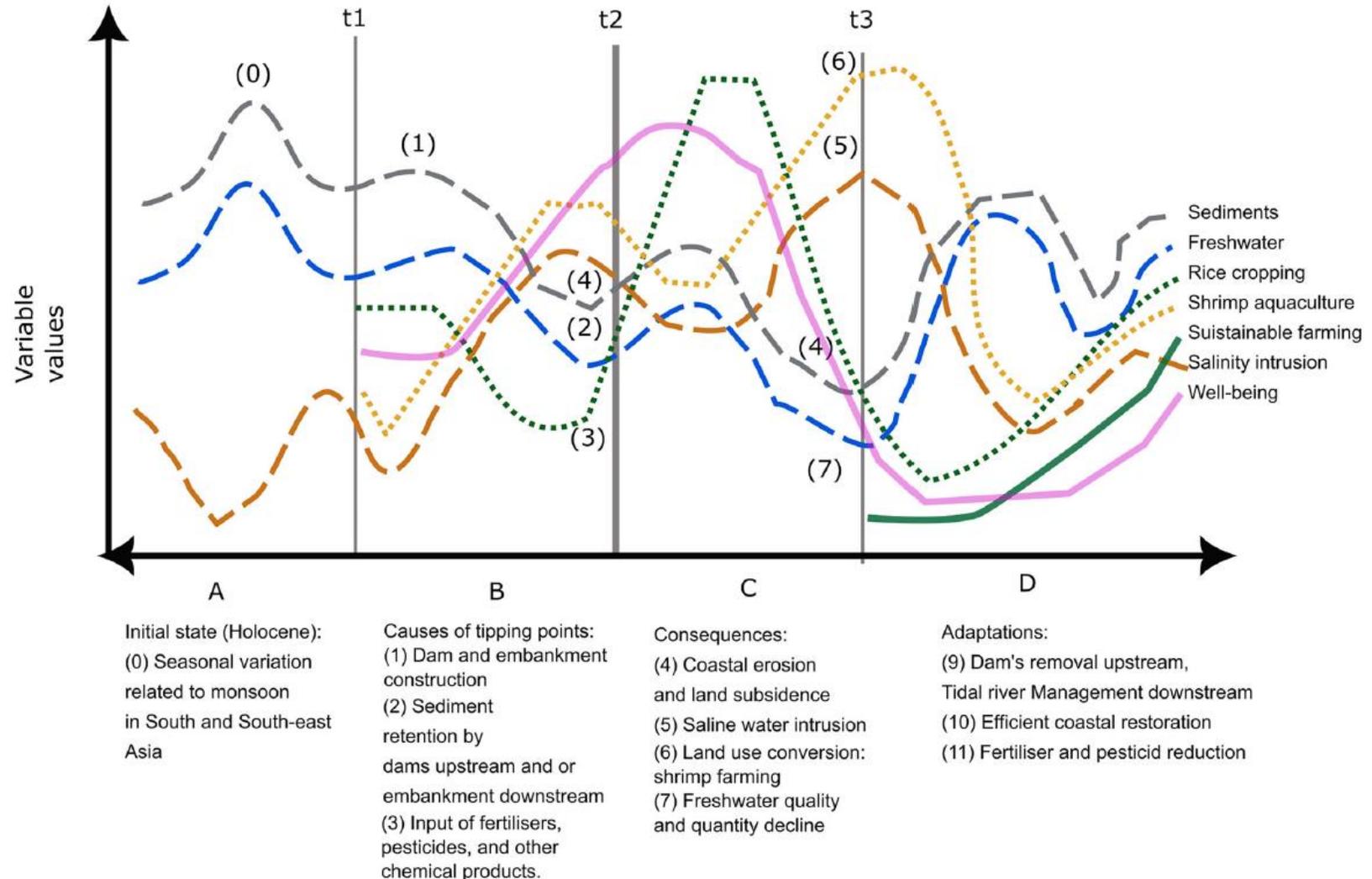


Source: Cremin et al (2024):
 Causes and consequences of
 tipping points in river delta
 social-ecological systems.
Ambio 53:1015–1036.

<https://doi.org/10.1007/s13280-023-01978-2>. [CC-BY]

Feedback loops and regime shifts in River delta's Social-ecological systems

Source: Cremin et al (2024):
Causes and consequences of
tipping points in river delta
social-ecological systems.
Ambio 53:1015–1036.
<https://doi.org/10.1007/s13280-023-01978-2>. [CC-BY]





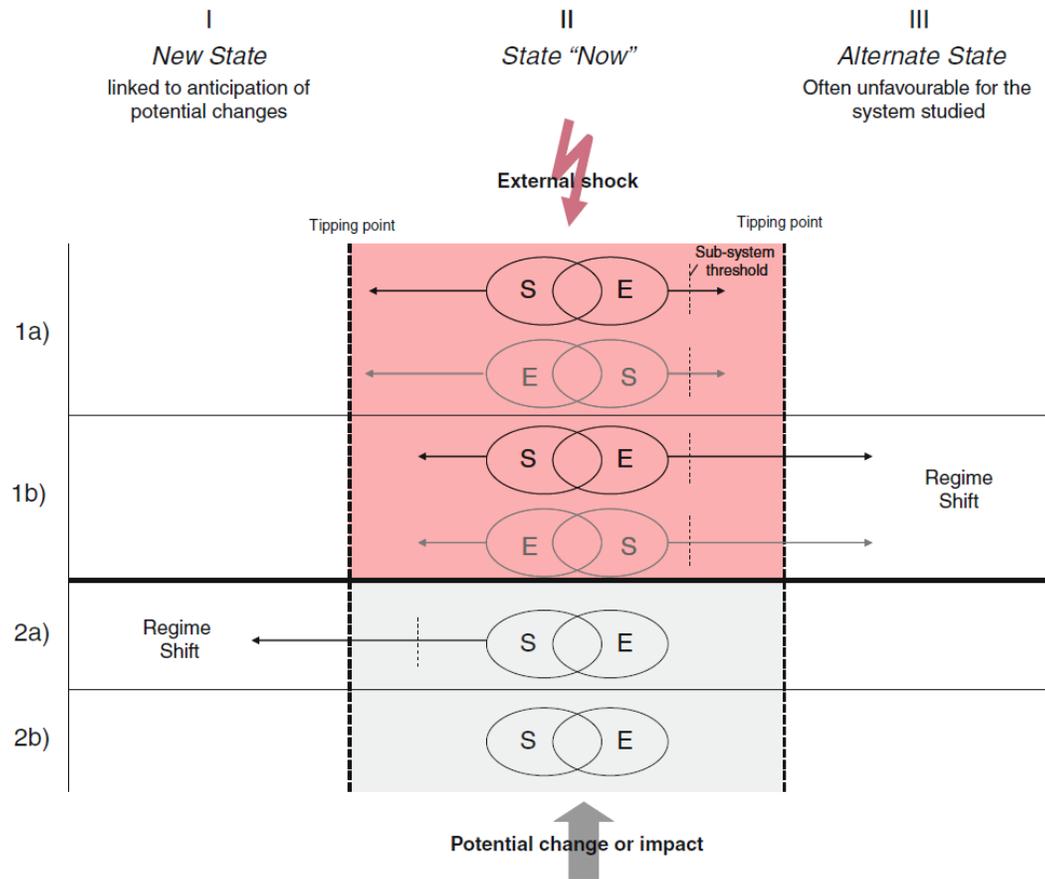
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Addressing risks through adaptation

Actions to address tipping points

| Avoid negative tipping points | Enhance positive tipping points |
|---|--|
| Monitoring: better monitoring, and modelling of SES dynamics | Integrated approaches for river and coastal zone management |
| Releasing freshwater and sediment from upstream | Restore coastal ecosystems and implement green infrastructures |
| Regulating and controlling groundwater extraction | Develop climate-smart infrastructures |
| Regulating land use to avoid land loss and enhancing the protection and conservation of ecosystems through policies | Develop climate-smart agriculture |
| Learning and knowledge exchange between stakeholders | Improve the land-use planning |
| Adaptation through participatory co-management approaches | Invest in livelihood development |
| Scale: understanding the interactions between small-scale and large-scale tipping points | Negotiate multilaterally with the transboundary nations |

Adaptation to avoid tipping points



- Single and cascading hazards will affect components of social-ecological systems (SES)
- The less vulnerable these components are the less likely they are to pass a tipping point
- Healthy ecosystems can:
 - withstand better hazard impact
 - help the social system not to collapse (e.g. provisioning services)



Adaptation actions

Adaptation options:

- Avoid: do not carry out activities in a potential exposed area
- Protect: build infrastructure to protect lives/assets
- Accommodate: accept the hazard but adapt to it
- Managed retreat/realignment: abandon (part of) an area

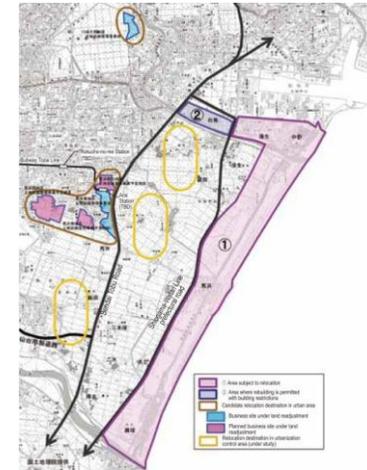


Photo Credit: Naoya Furuta/IUCN.
Do not reproduce



Source:

<https://commons.wikimedia.org/wiki/File:Inle-Yawnghwe.jpg> [CC BY SA 3.0]



Source: Sendai City
Earthquake Disaster
Reconstruction Plan (2011)



Incremental Adaptation (salinity intrusion)

“Adaptation that maintains the essence and integrity of a system or process at a given scale (Park et al., 2012)”



Using different rice cultivars (e.g. increase salinity tolerance)

Source: Fabrice Renaud (UNU-EHS)



Transformational Adaptation (salinity intrusion)

“Adaptation that changes the fundamental attributes of a Social ecological system in anticipation of climate change and its impacts”



Shift from rice (left) to mangrove/shrimp cultivation (right)

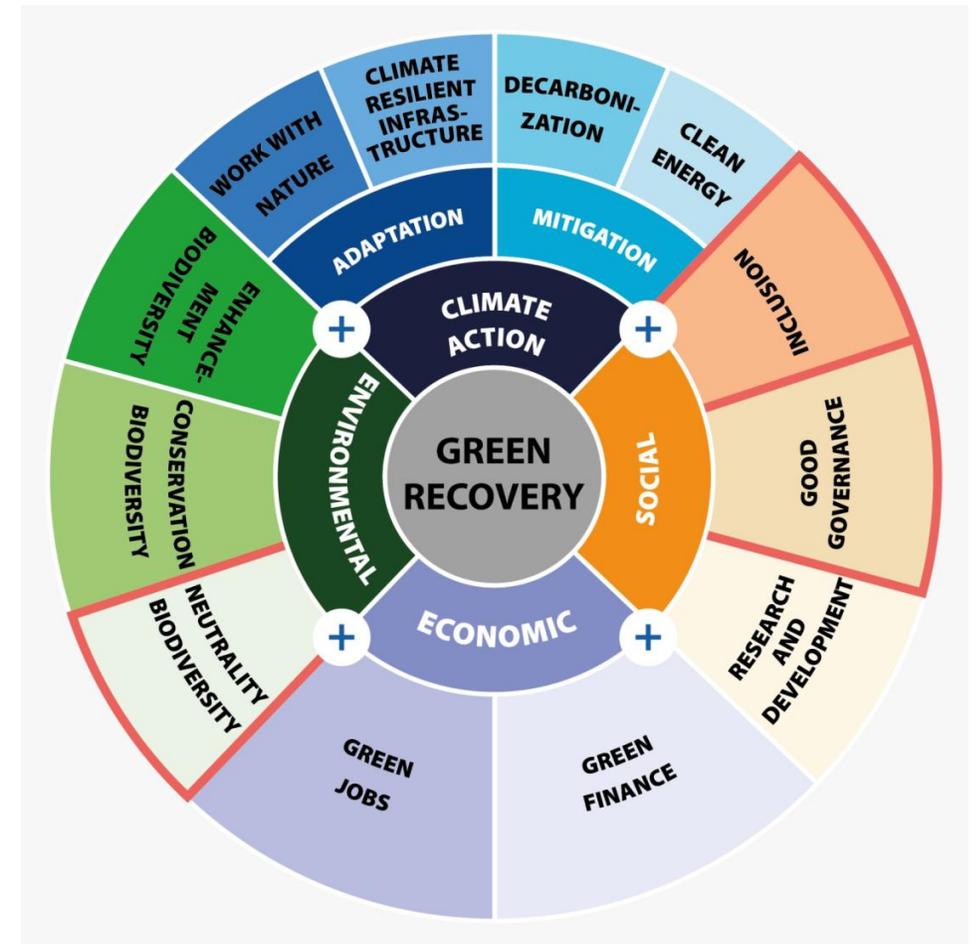
Source: Fabrice Renaud (UoG)



Addressing the risks through green recovery/development

A conceptual framework for green recovery

- Definition: “Post-pandemic green recovery describes strategies and measures that combat the social, economic and environmental impacts of the global COVID-19 pandemic. It facilitates long-term transformative change towards sustainability, biodiversity protection, resilience and climate neutrality” (adapted from GIZ n.d., 2020; UNEP 2021; OECD 2020)
- Follows the dimensions of the definition: sustainability (3 dimensions); biodiversity protection; climate neutrality; resilience





Link between the framework and resilience

Diversity

Explicitly addressed through e.g. biodiversity and inclusion

Inclusivity & Equity

Explicitly addressed as a standalone, key element

Adaptive Learning

Implicitly addressed through e.g., governance and research

Connectivity

Implicitly addressed through consideration of interconnectedness of all dimensions

Redundancy

Implicitly addressed through the combination of diversity and connectivity



Sources:

Dimensions of resilience: Rockström, J.; Norstamp, A.; Matthews, N.; Biggs, R.; Folke, C.; Harikishun, A. et al. (2023): Shaping a resilient future in response to COVID-19. In Nature Sustainability (6), pp. 897–907.

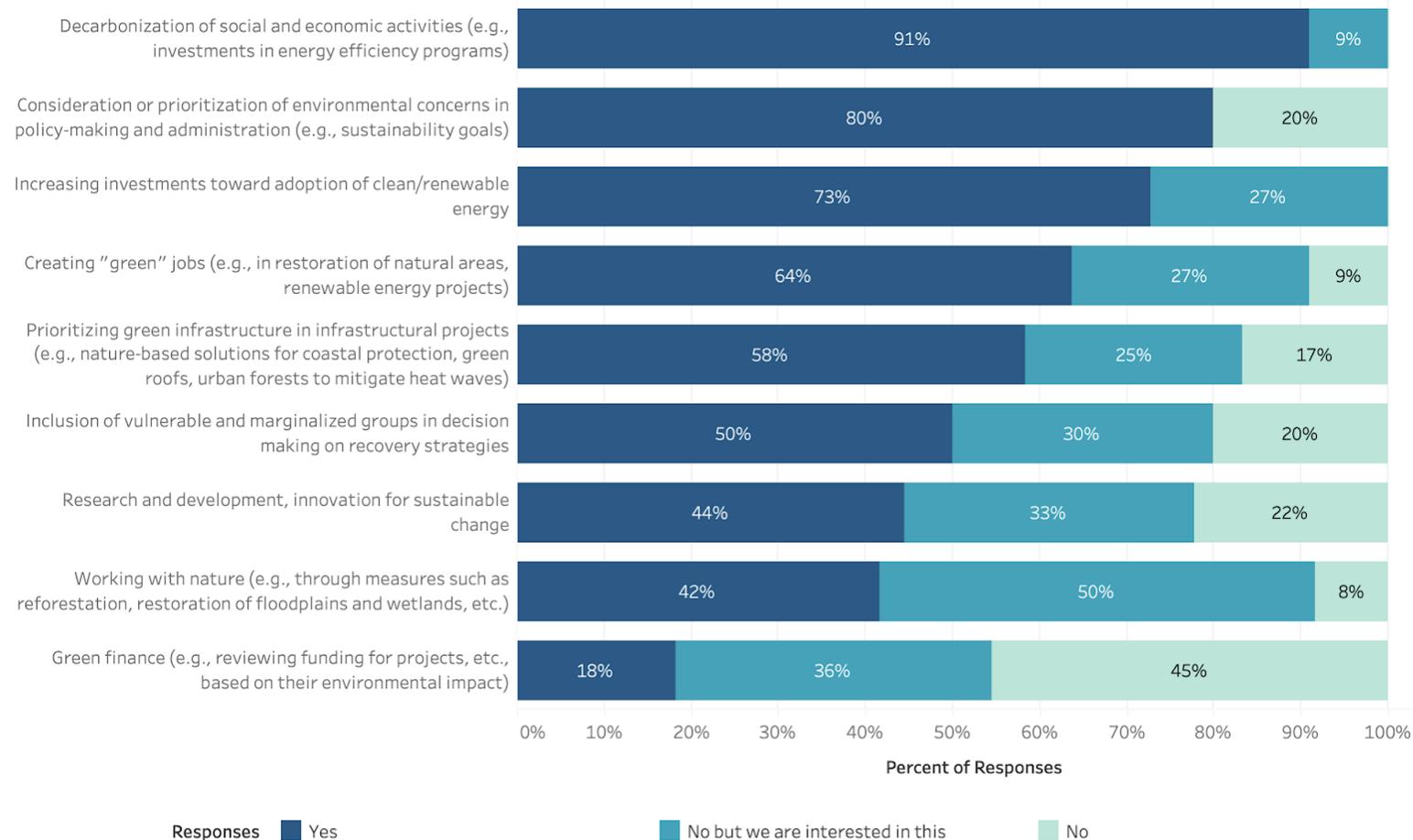
Framework and links to resilience: Hartmann et al (2025) A conceptual framework for a post-COVID-19 green recovery of the Blue Economy. *Marine Policy*, 171: 106446.

<https://doi.org/10.1016/j.marpol.2024.106446>. [CC-BY]

Uptake of Green Recovery - Scotland

Scotland: Has your organisation started implementing any of the following recovery and growth strategies?

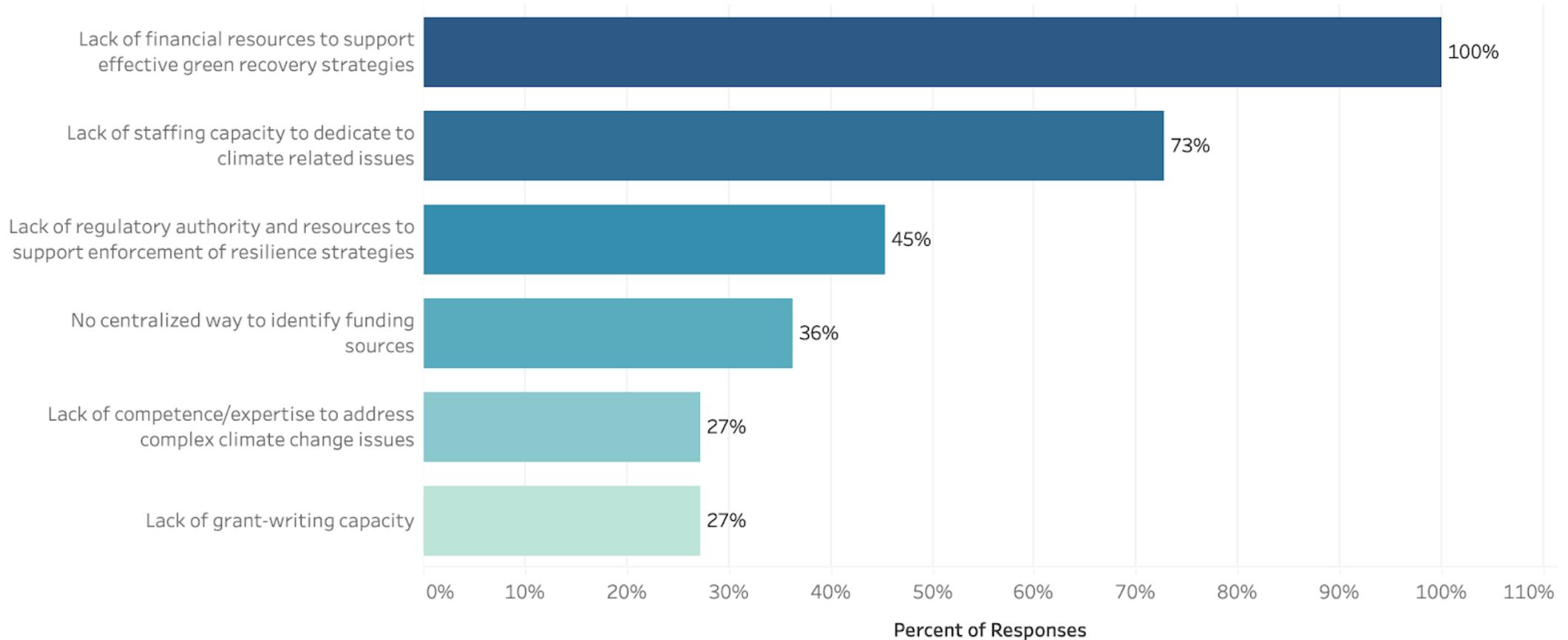
(n=12)*



* Number of municipalities that did not answer this question: 18



Barriers to uptake of Green Recovery - Scotland



* Number of municipalities that did not answer this question: 19



Actions that can support
green recovery and/or
adoption of nature-based
solutions

Analysis of Policies for Green Recovery



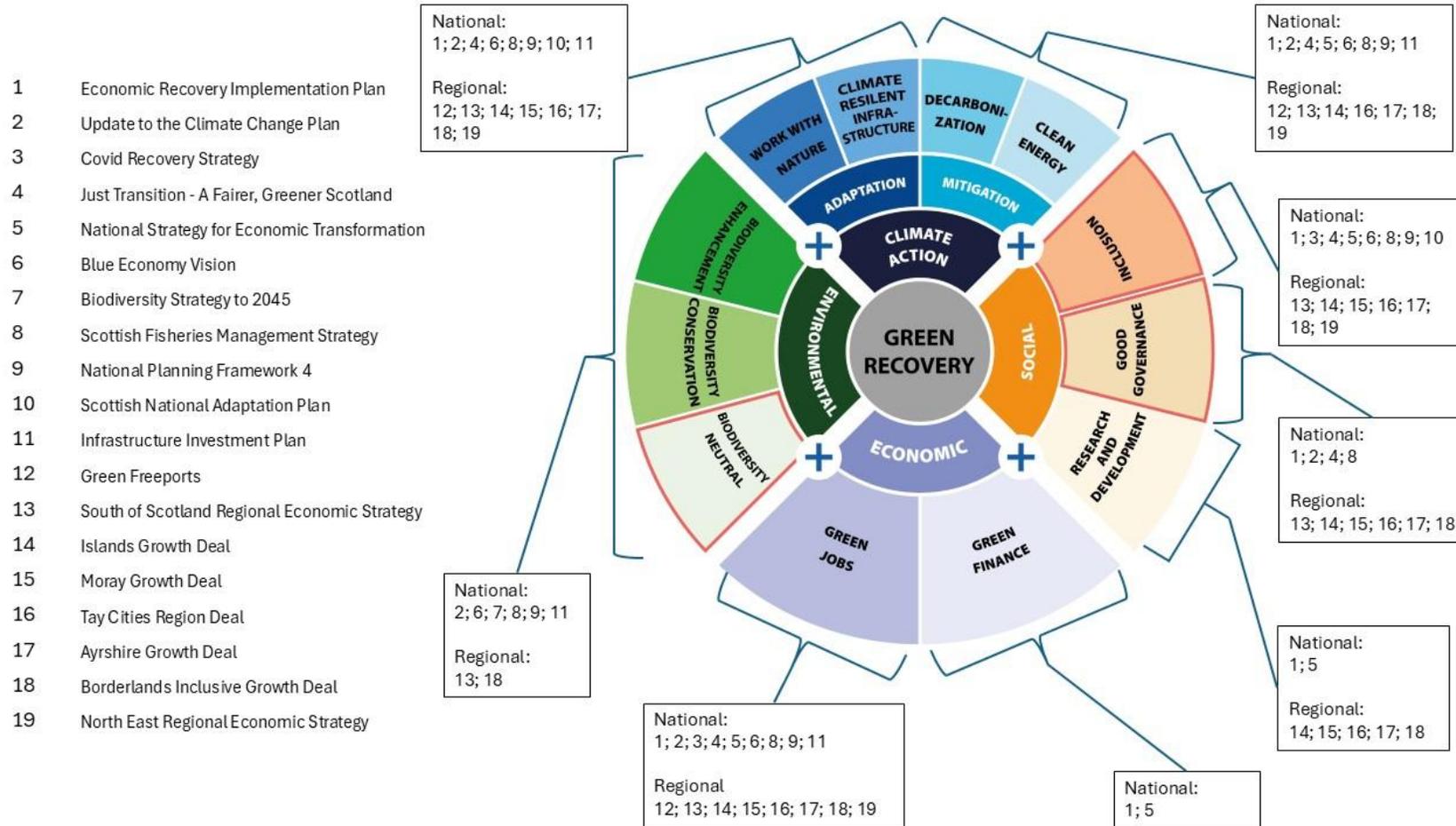
- ‘Green Recovery’ not commonly an explicit goal of policy – a variety of terms used – and policies operate across multiple time frames.
- Policies addressing each of the elements of green recovery exist in each of the case study regions.
- ‘Essential’ elements – biodiversity, good governance and inclusion – are also present.
- Pillars of green recovery are not always addressed holistically – e.g. biodiversity policies tend not to be integrated with economic and social goals.
- But even when enacted individually, policies can equate to a comprehensive package that support green recovery or development

Source: Hartmann et al (2025) A conceptual framework for a post-COVID-19 green recovery of the Blue Economy. *Marine Policy*, 171: 106446. <https://doi.org/10.1016/j.marpol.2024.106446>. [CC-BY]

Source: Clelland et al (accepted manuscript) Do post-pandemic policies support a holistic green recovery and sustainable development? Evidence from three coastal regions. *Sustainability: Science, Practice and Policy* (in press)

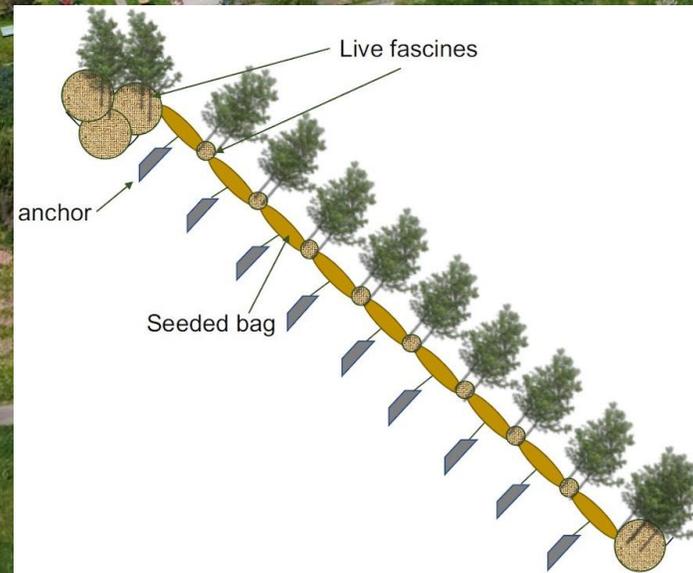


How do Policies in Scotland Map across the Framework?



Catterline Bay, Aberdeenshire, Scotland

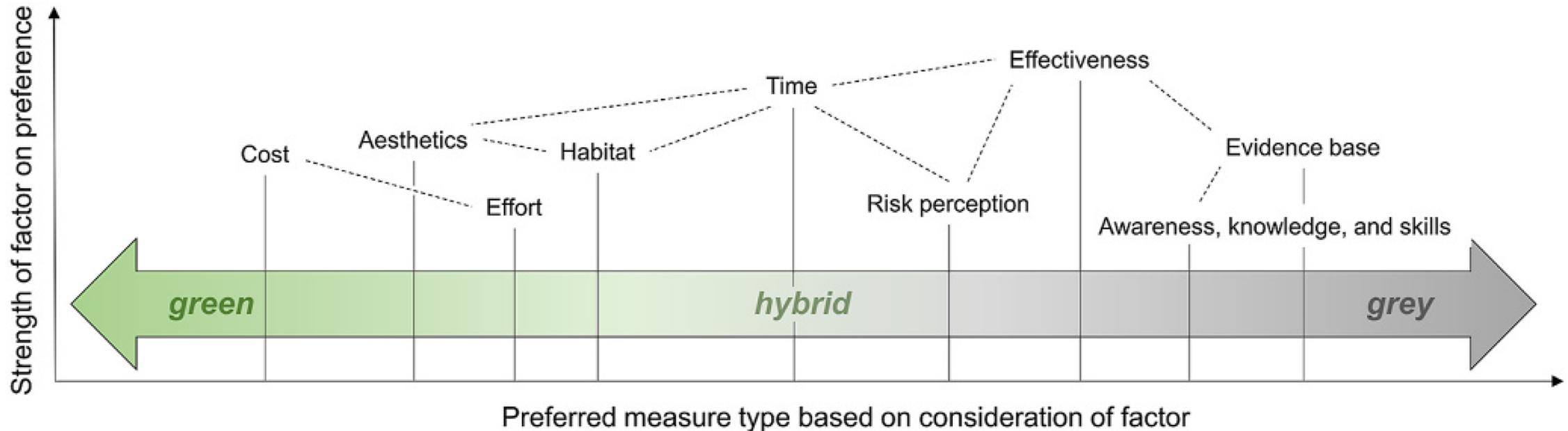
Research led by Glasgow Caledonian University



Understanding public perception: Factors that influence preferences towards green, hybrid, or grey measures



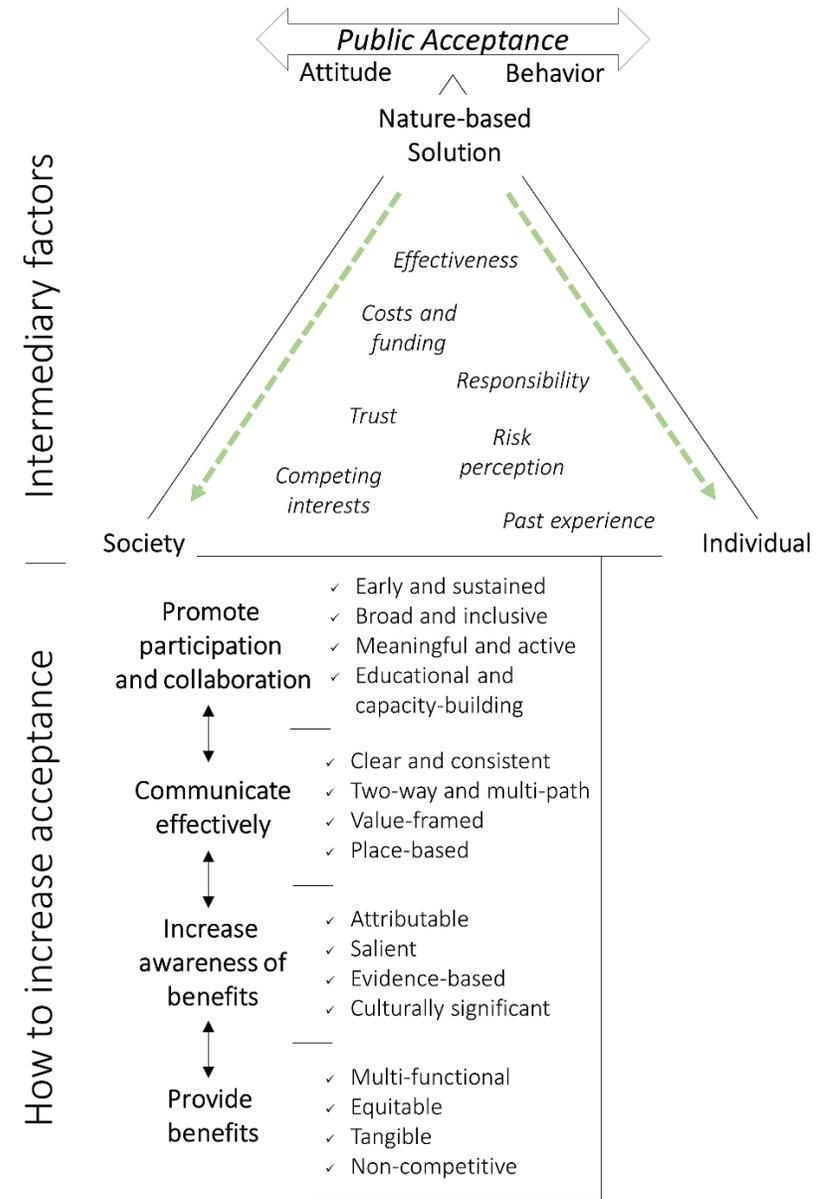
OPERANDUM
Open-air laboratories for Nature-based Solutions to Manage hydro-meteorological risks



----- Close interrelation between factors



Understanding Public Acceptance of Nature-based Solutions framework (PA-NbS)



Source: Anderson and Renaud (2020). A review of public acceptance of Nature-based Solutions: the ‘why’, ‘when’, and ‘how’ of success for disaster risk reduction measures. *Ambio* 50:1552–1573.

Conclusion

- Risks from climate-related hazards are increasing globally
- These, combined with other anthropogenic processes can lead to systems tipping points
- Adaptation, including system transformation can change rural system trajectories positively and make them more resilient
- Nature-based solutions and green recovery/development concepts and frameworks can support transformative adaptation in rural settings
- These actions need to be co-developed with all concerned stakeholders to ensure their success



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Thank You!

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