cascades

Cascading climate risks:
Towards adaptive and
resilient European Societies

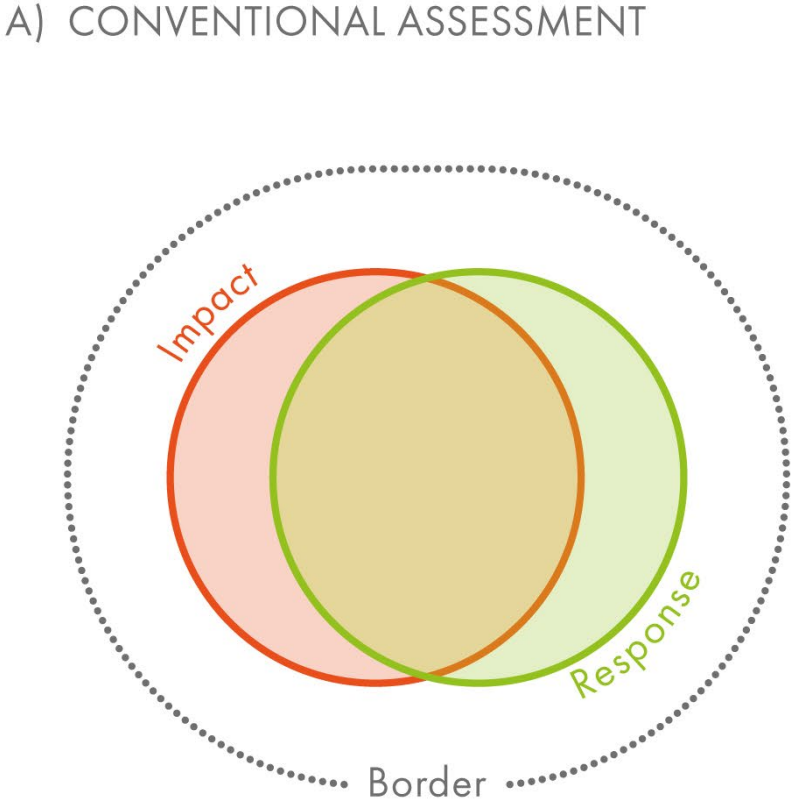
Characterising future international connectivity in the SSPs to assess cross-border climate risks

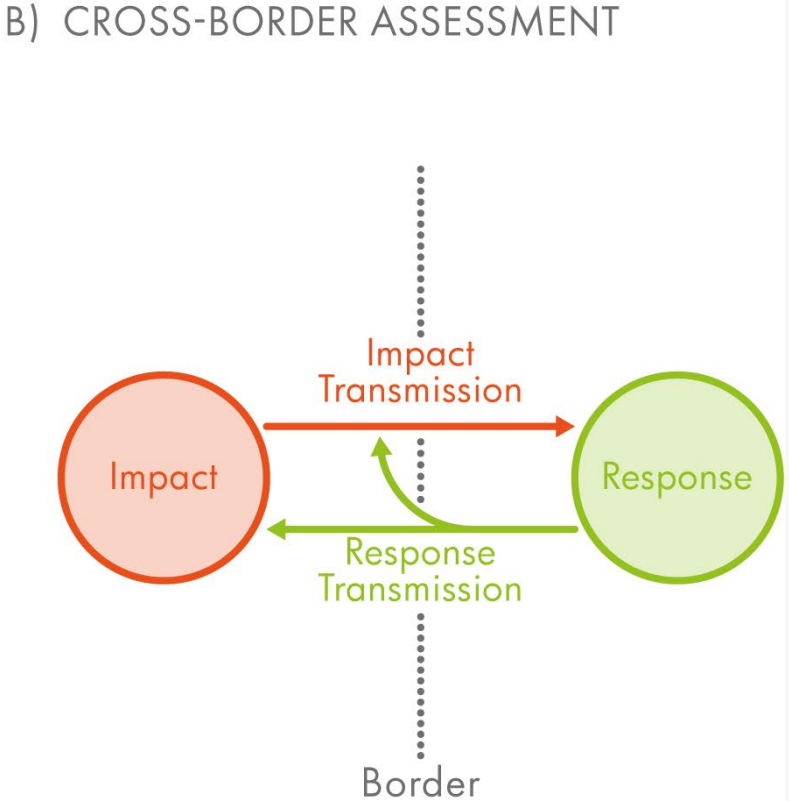
S. Fronzek*, T. Carter, Magnus Benzie, H. Carlsen, P. Magnuszewski, I. Monasterolo, C. Reyer, C. West
*) Finnish Environment Institute (SYKE)

CASCADES/RECEIPT conference, Potsdam/Germany, 16-18 October 2023

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

Relationship between an impact and a response





Example:

Impact: River flooding in Europe

European response: Flood protection; land management; building regulations (exposed areas)

Example:

Source: Carter et al. 2021

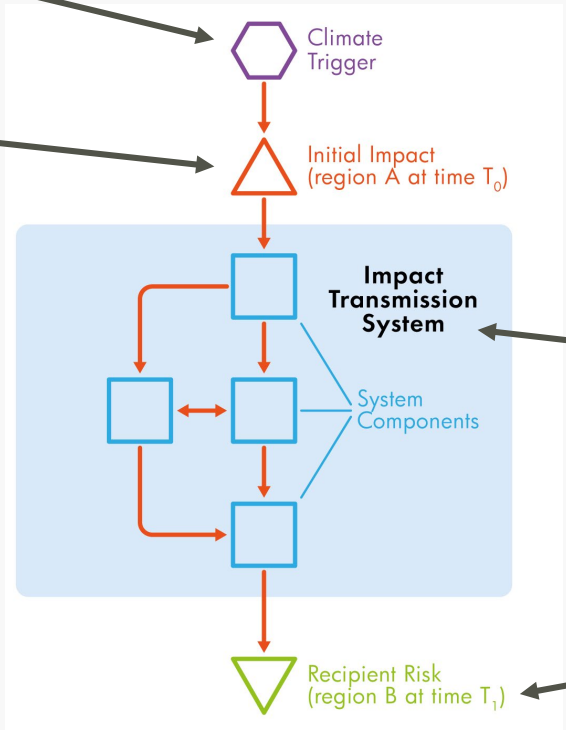
Impact outside Europe: Tropical cyclone in SE Asia with extensive damage to palm oil plantations; supply chain disruption; profits fall

European response: Substitution of supply; reduced credit to firms

Impact transmission leading to a risk of concern

Weather shock or slow-onset event linked to climate change (attribution)

Climate-related (other predisposing impacts not related to climate may precede this)



Impacts propagated from the initial impact between system components of varying complexity across borders and over time

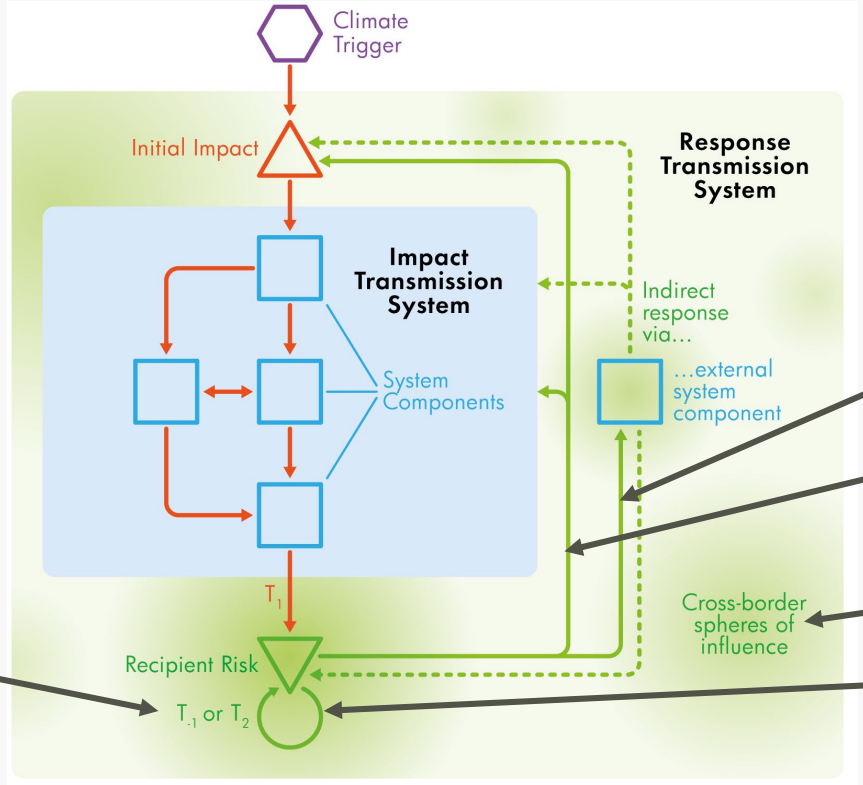
Aggregate or net impact transmitted to a region of interest

Source: Carter et al. 2021

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

Response transmission system for ameliorating risks from propagating impacts



Indirect interventions via a third party

Interventions targeting impacts (initial or propagated)

Green shading: ability to respond depends on actor's sphere of influence

Responses may be reactive or anticipatory

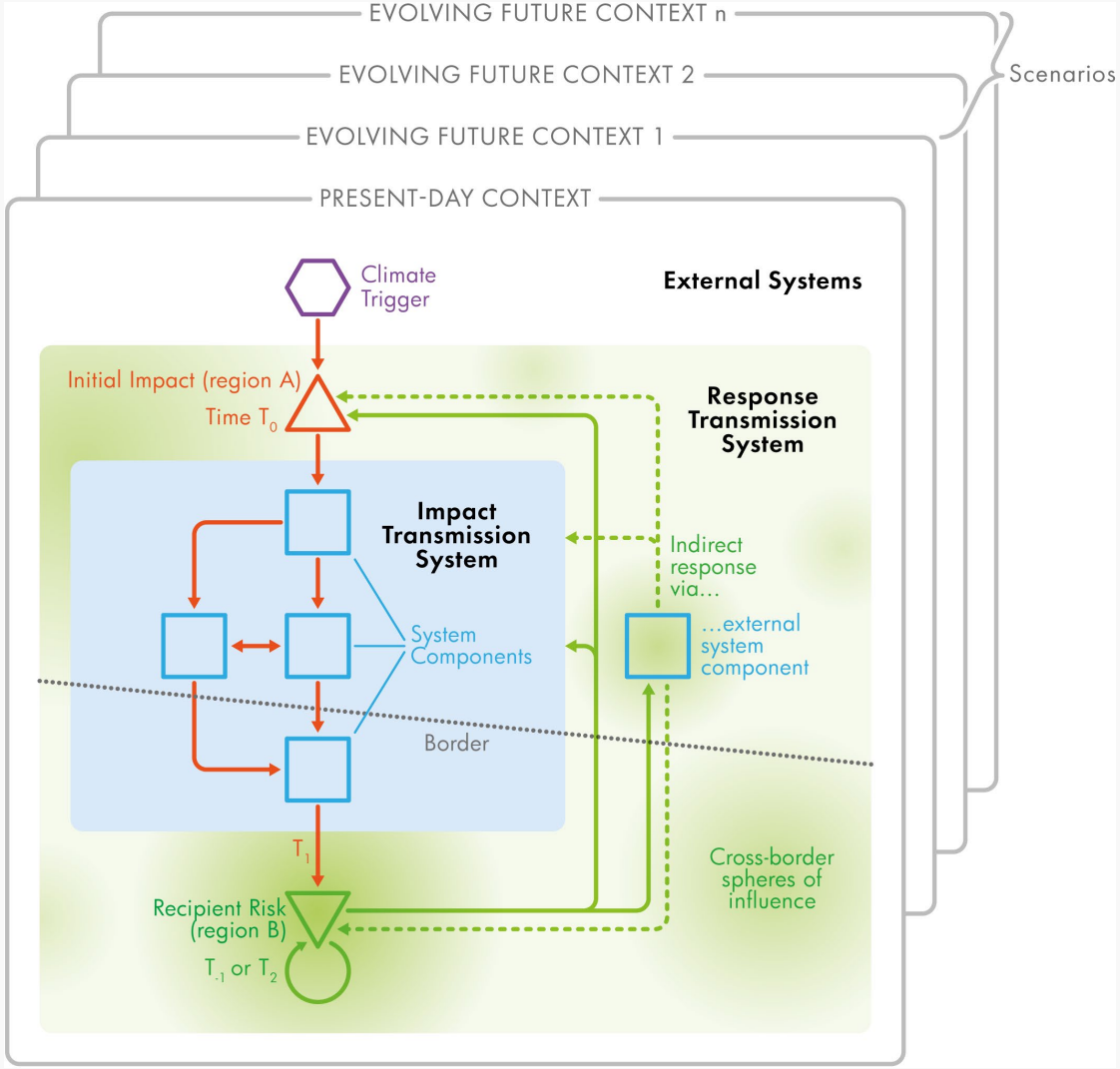
Interventions targeting recipient risk (exposure or vulnerability)

Source: Carter et al. 2021

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

Generalised conceptual framework for analysing the transmission of cross-border climate change impacts, risks and responses in the context of present-day and alternative future conditions

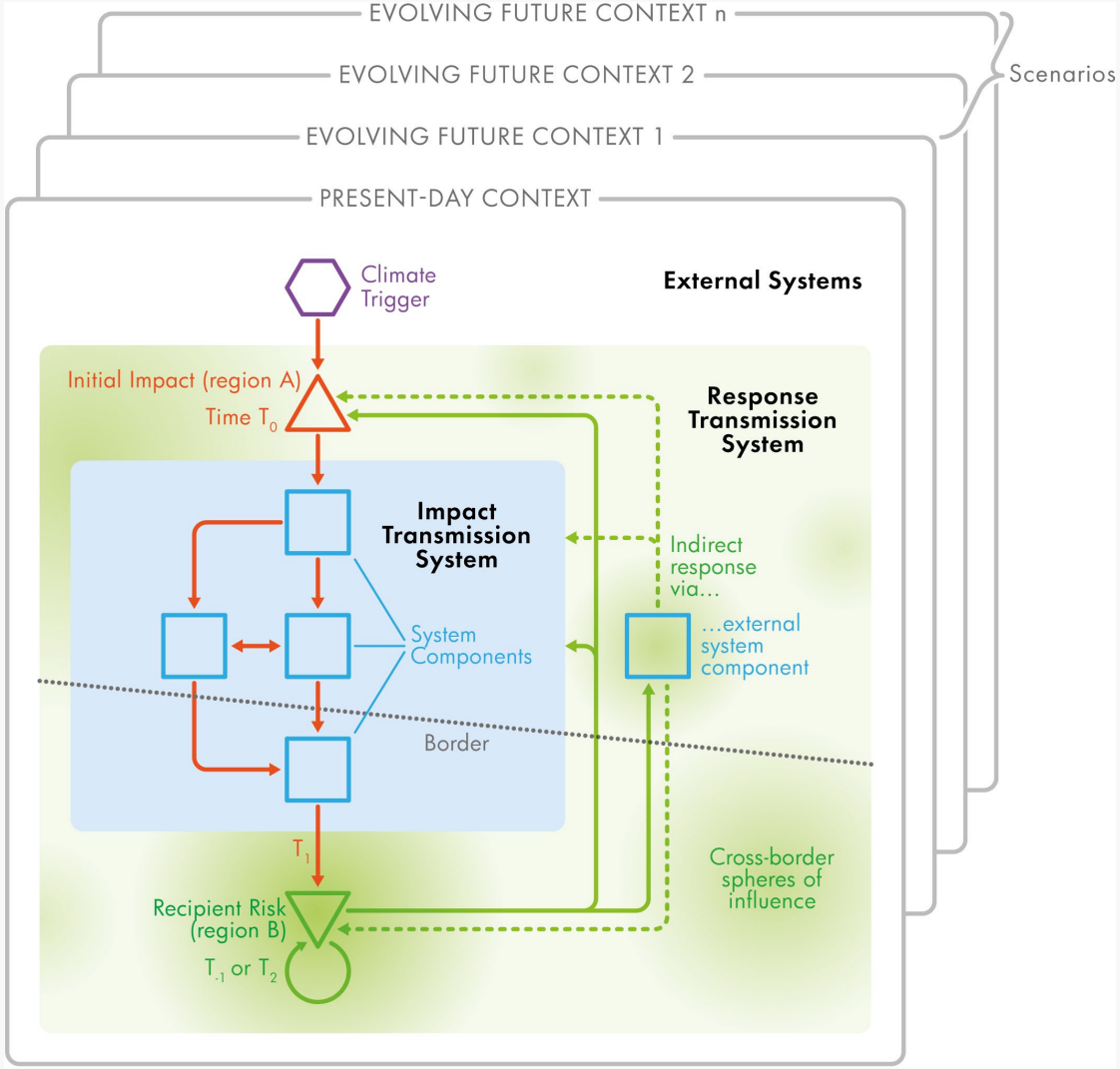


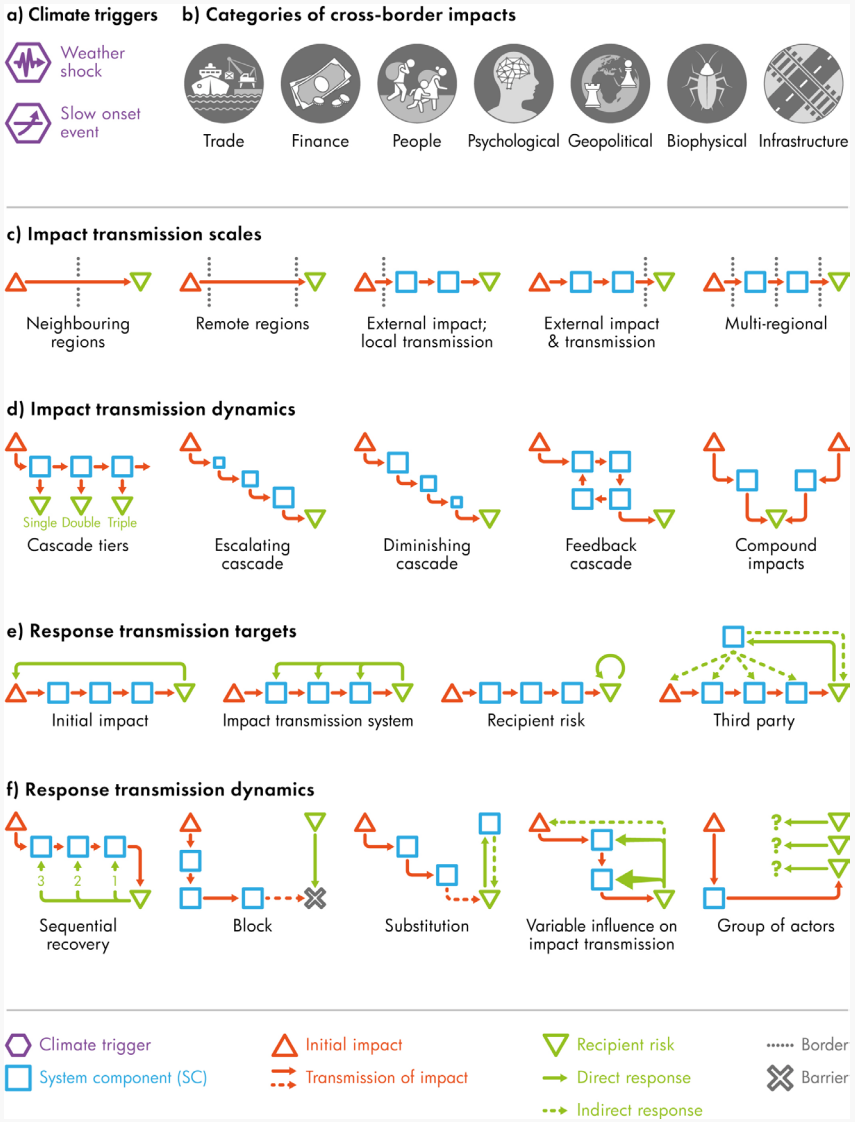
Source: Carter et al. 2021

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

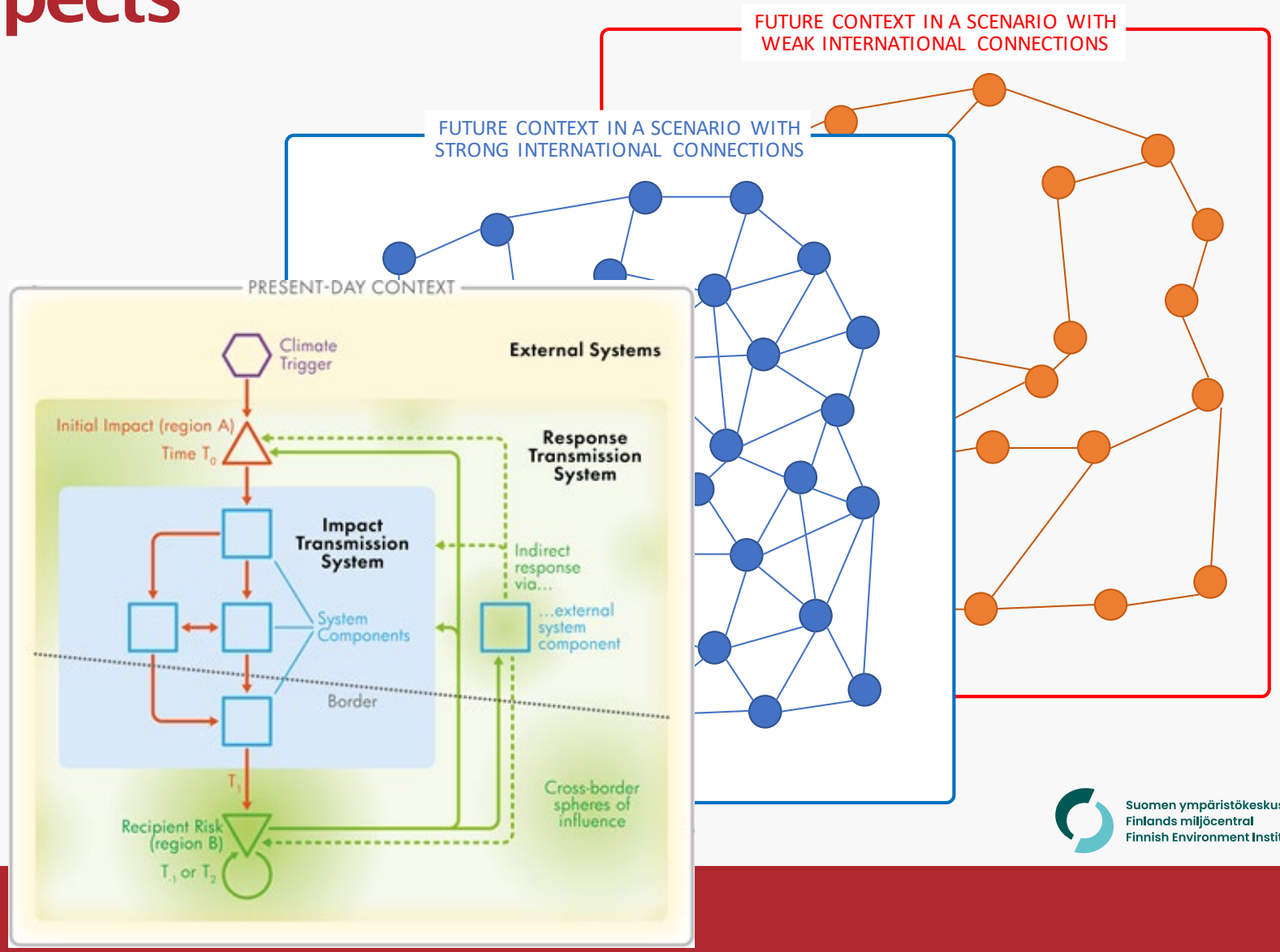
Generalised conceptual framework with alternative typologies





cascades

Extension of the conceptual framework to highlight scenario aspects



Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

Shared Socioeconomic Pathways (SSPs)

- Scenario framework widely applied in climate research

Source: O'Neill et al. 2017

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

How connected is the world in the SSP narratives?

Quotes fr .004

	Political (globa	migration)
SSP1	• increasingly e international c • inequality is r • energy, institu • strong and fle • a global focus high levels of • Technology tr rights and oth	nediate levels. Although increasing markets allows people to move around more onal livelihoods and the renewed emphasis on reduce migration incentives.
SSP2	• There is relati institutions, t • Tensions with rarely, and ne and when the economic inst • access to glob relations • challenges in	ountries continues at intermediate levels on of labor markets, but there are of greater international migration when enged by food insecurity, conflict, and other
SSP3	• A resurgent n conflicts push • limited numbe • difficulty in ac • a world that is them • Global govern effective glob	ional migration
SSP4	• a gap widens contributes to fragmented co intensive, low • International i of the globally	richer groups, but difficult for low-income
SSP5	• rapid rise in g • On the interna increasingly c	y is increased by gradually opening up labor isparities decrease. y is increased by gradually opening up labor isparities decrease. Migration from poorer to uffers the effect of aging populations in ies.

Global Environmental Change 42 (2017) 169–180

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century

Brian C. O'Neill [a,*], Elmar Kriegler [b], Kristie L. Ebi [c], Eric Kemp-Benedict [d], Keywan Riahi [e,f], Dale S. Rothman [g], Bas J. van Ruijven [a], Detlef P. van Vuuren [h,i], Joern Birkmann [j], Kasper Kok [k], Marc Levy [l], William Solecki [m]

[a] National Center for Atmospheric Research (NCAR), PO Box 3000, Boulder, CO 80305, USA
[b] Potsdam Institute for Climate Impact Research, PO Box 601203, 14412 Potsdam, Germany
[c] University of Washington, Seattle, WA, USA
[d] Stockholm Environment Institute, 15th Floor, Witthyakit Building, 254 Chulalongkorn University, Chulalongkorn Soi 64, Phyathai Road, Pathumwan, Bangkok 10330, Thailand
[e] International Institute for Applied Systems Analysis, Laxenburg, Austria
[f] Graz Univeristy of Technology, Graz, Austria
[g] Frederick S. Pardee Center for International Futures, Josef Korbel School of International Studies, University of Denver, 2201 South Gaylord Street, Denver, CO 80208-0500, USA
[h] PBL Netherlands Environmental Assessment Agency, Bilthoven, The Netherlands
[i] Copernicus Institute for Sustainable Development, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands
[j] Institute for Spatial and Regional Planning, University of Stuttgart, Pfaffenwaldring 7, 70569 Stuttgart, Germany
[k] Soil Geography and Landscape Group, Wageningen University, Wageningen, The Netherlands
[l] Center for International Earth Science Information Network (CIESIN), Columbia University, 61 Route 9W, PO Box 1000, Palisades, NY 10964, USA
[m] CUNY Institute for Sustainable Cities and Department of Geography, Hunter College—City of New York, 695 Park Avenue, New York, NY 10021, USA

How connected is the world in the SSPs?

Interpreting global narratives

	Policy[1]	Trade[1]		Migration[1]					
SSP1	High	High		Medium					
SSP2	Medium	Medium		Medium					
SSP3	Low	Low		Low					
SSP4	Medium	Low+high		Low+high					
SSP5	High	High		High					

Sources: [1] – global narratives (O'Neill et al. 2017)

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

How connected is the world in the SSPs?

Quantifications of SSP drivers

	Policy[1]	Trade[1]	Trade[2]	Migration[1]	Migration[3]				
SSP1	High	High	Medium	Medium	Medium				
SSP2	Medium	Medium	Medium	Medium	Medium				
SSP3	Low	Low	Low	Low	Low				
SSP4	Medium	Low+high	Low/med	Low+high	Medium				
SSP5	High	High	High	High	High				

Sources: [1] – global narratives (O'Neill et al. 2017)
[2] – assumptions of trade openness used in an SSP-quantification of GDP (Dellink et al. 2017)
[3] – assumptions for international migration in SSP population projections (KC & Lutz 2017)

How connected is the world in the SSPs?

Finance hardly mentioned in the global narratives

	Policy[1]	Trade[1]	Trade[2]	Migration[1]	Migration[3]	Finance[4]			
SSP1	High	High	Medium	Medium	Medium	High			
SSP2	Medium	Medium	Medium	Medium	Medium	Medium			
SSP3	Low	Low	Low	Low	Low	Low			
SSP4	Medium	Low+high	Low/med	Low+high	Medium	Low+high			
SSP5	High	High	High	High	High	High			

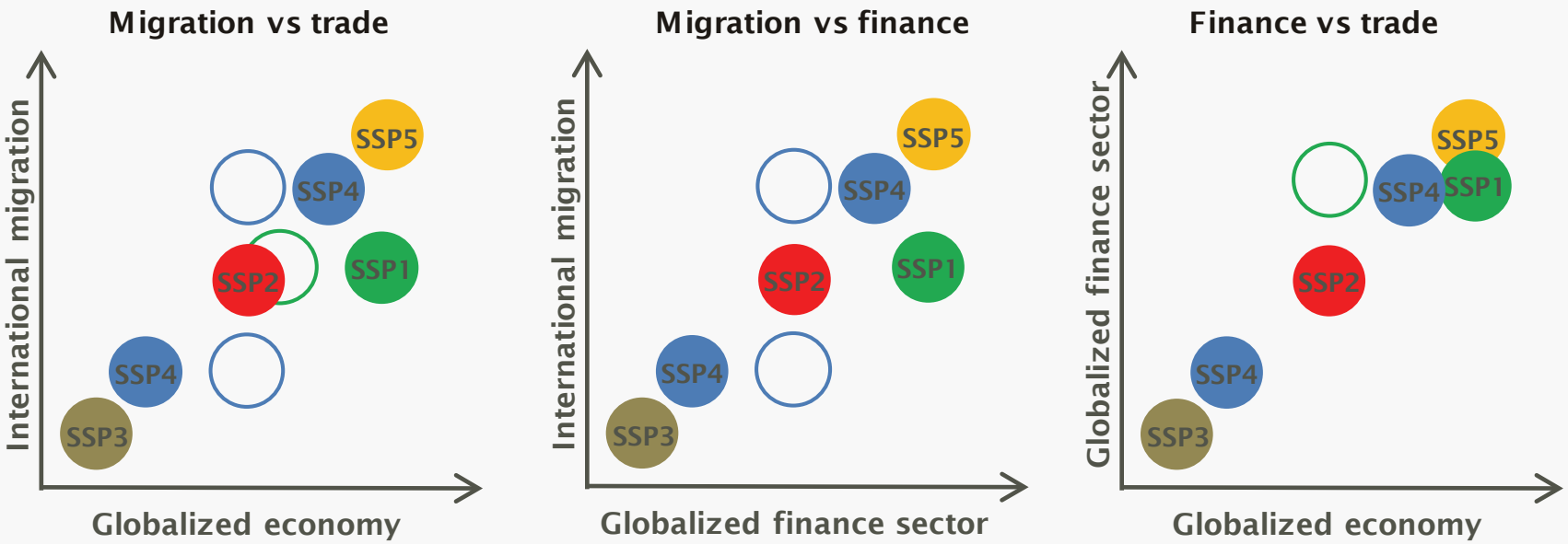
Sources: [1] – global narratives (O'Neill et al. 2017)
[2] – assumptions of trade openness used in an SSP-quantification of GDP (Dellink et al. 2017)
[3] – assumptions for international migration in SSP population projections (KC & Lutz 2017)
[4] – based on Battiston & Monasterolo (2018) and Monasterola (pers. comm.)

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

How connected is the world in the SSP narratives?

Source: O'Neill et al. 2017



Source: Carter et al. 2020, CASCADES D2.1

A possible extension of the SSPs would be to consider scenarios that pair high connectivity in one aspect with low connectivity in another.

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

How connected is the world in the SSPs?

Scanning the SSP literature database (v1, 2014-2019, >1300 papers; O'Neill et al. 2020 & v2, 2020-20, 1134 papers, Green et al. 2022) and literature search

	Policy[1]	Trade[1]	Trade[2]	Migration[1]	Migration[3]	Finance[4]	EU intern. cooperation[5]	Armed conflict[6]	Invasive species[7]
SSP1	High	High	Medium	Medium	Medium	High	High	Low-med	Low
SSP2	Medium	Medium	Medium	Medium	Medium	Medium	-	Medium	High
SSP3	Low	Low	Low	Low	Low	Low	Low	High	Medium
SSP4	Medium	Low+high	Low/med	Low+high	Medium	Low+high	High	Med-high	High
SSP5	High	High	High	High	High	High	High	Low	High

Sources:
[1] – global narratives (O'Neill et al. 2017)
[2] – assumptions of trade openness used in an SSP-quantification of GDP (Dellink et al. 2017)
[3] – assumptions for international migration in SSP population projections (KC & Lutz 2017)
[4] – based on Battiston & Monasterolo (2018) and Monasterola (pers. comm.)
[5] – European SSPs (Kok et al. 2019)
[6] – Hegre et al. 2016
[7] – Roura-Pascual et al. 2021

Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

Examples of issues to be refined in the cross-border dimensions of the SSPs

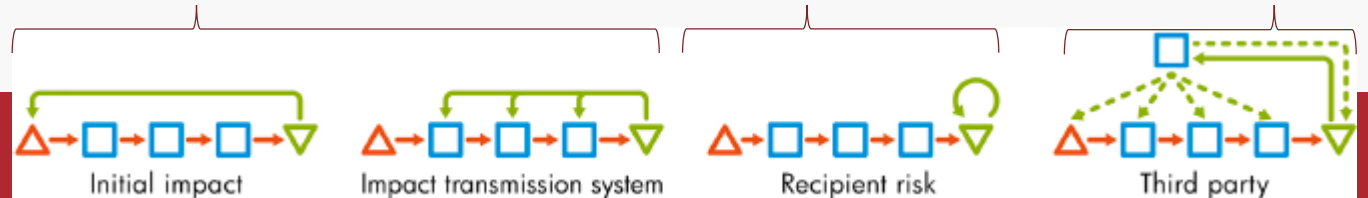
Impact transmission

- **Trade:** What free trade zones are in place? What are the market restrictions and custom duties for international trade? How diverse are supply chains?
- **Finance:** How easy are international financial transactions? What financial restrictions are in place? What international investments can be made in different regions?
- **People:** What are the regional zones for free movement of labour? What restrictions incentives are there to migrate?
- **Psychological:** How freely is information available? How much do perceptions about climate risks distort the truth?
- **Geopolitical:** Are there regional geopolitical blocks in place? How effective are international institutions, are different institutions overlapping or contradictory?
- **Biophysical:** What is the level of cooperation in transboundary water management and the level of competition of water resources? What is the level of measures to prevent the spread of invasive species?
- **Infrastructure:** Are there chokepoints that depend on individual infrastructure?

Regional extensions of the SSPs to include the regions connections to the rest of world

Response transmission

Level of international disaster funds, welfare in region of recipient risk, diversification of supply chains



Suomen ympäristökeskus
Finlands miljöcentral
Finnish Environment Institute

cascades

Conclusions

- International connectivity under the SSPs cover a wide range of levels.
- These are largely consistent across different dimensions (e.g. a high connectivity in trade is paired with high connectivity in both migration and finance).
- A possible extension of the SSPs would be to consider scenarios that pair high connectivity in one aspect with low connectivity in another.
- More detail in scenario descriptions of international connectivity including their quantification would improve assessments of future cross-border climate risks.
- Lower levels of connectivity might imply a relatively lower cross-border proportion compared to direct climate change risks; however, it also implies reduced international cooperation to address these risks.

Thanks for your attention!

References

Conceptual framework:
Carter, T.R, M. Benzie, E. Campiglio, H. Carlsen, S. Fronzek, M. Hildén, C.P.O. Reyer and C. West (2021). A conceptual framework for cross-border impacts of climate change. Global Environmental Change 69:102307, doi:10.1016/j.gloenvcha.2021.102307

Elements of cross-border dimensions of the SSPs:
Dellink et al. (2017, doi:10.1016/j.gloenvcha.2015.06.004) – KC & Lutz (2017, doi:10.1016/j.gloenvcha.2014.06.004) – Battiston & Monasterolo (2018, doi:10.2139/ssrn.3266041) – Kok et al. (2019, doi:10.1007/s10113-018-1400-0) – Hegre et al. (2016, doi:10.1088/1748-9326/11/5/054002) – Roura-Pascual et al. (2021, doi:10.1007/s11625-021-00963-6) – O'Neill et al. (2017, doi:10.1016/j.gloenvcha.2015.01.004) – O'Neill et al. (2020, doi:10.1038/s41558-020-00952-0)

Contact: Stefan.Fronzek@syke.fi