

Network extension of situation-centered analysis

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A multimode network approach to study power in the Indonesian palm oil value chain *(manuscript in preparation)*

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Outline

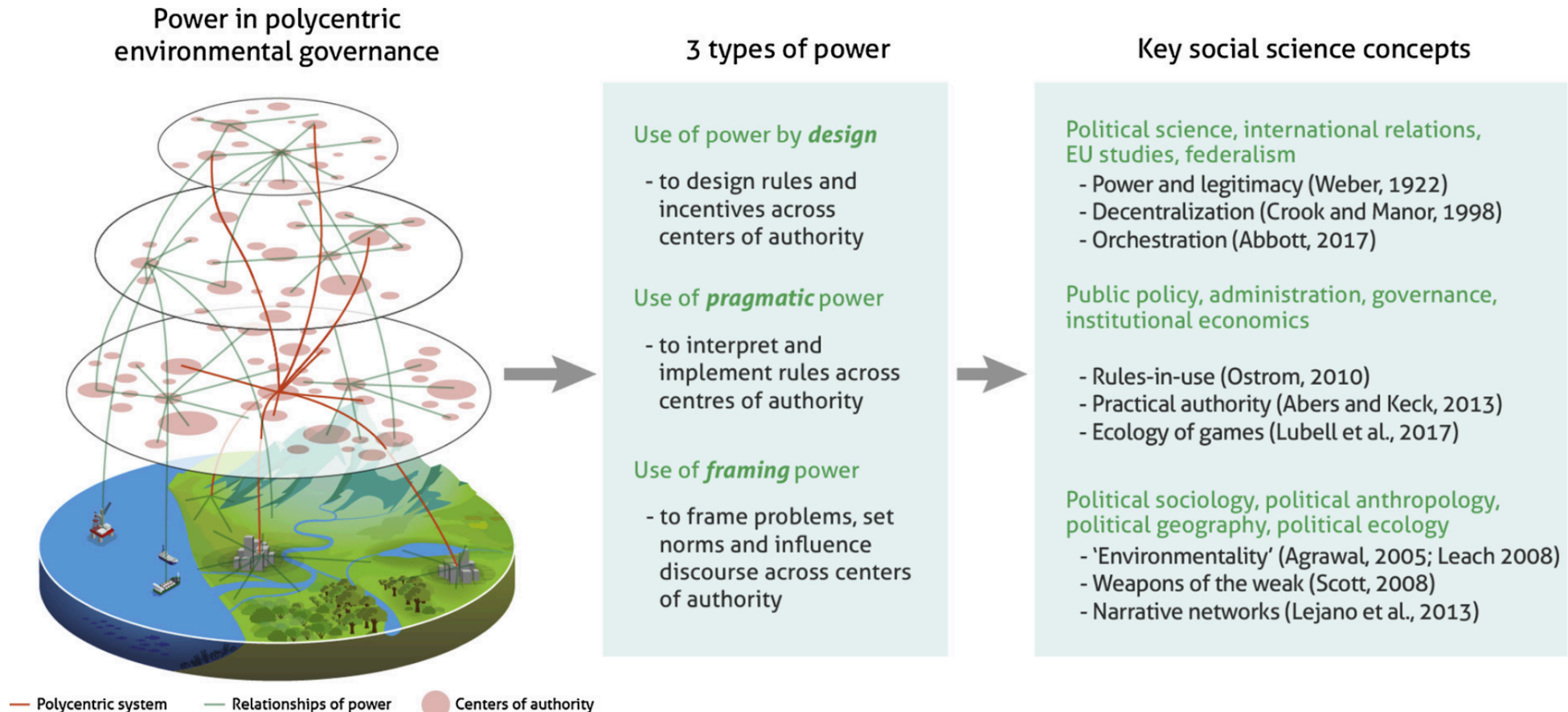
- Introduction
- Analytical framework
 - The multimode network approach to NAS
 - MN motifs and power
- Results
- Discussions and conclusion

Introduction

- Power, a ‘black box’ in the environmental governance, is key to explain interactions, decision-makings and actions (Brisbois et al., 2019; Clement, 2013, 2010; Epstein et al., 2014; Kashwan, 2016; Morrison, 2017; Mudliar, 2021)
- Polycentric power typology (Morrison et al. 2017; 2019): to examine power-laden social relationships among multiple semi-autonomous decision-making centers
 - *“...the uneven capacity of different actors to influence the goals, processes, and outcomes of a governance system”*

Introduction

- Polycentric power typology (Morrison et al., 2019)



Introduction

- Meanwhile...
- A growing attention to the network extension of situation-centered analysis (Kimmich, 2013; McGinnis, 2011; Pahl-Wostl et al., 2010; Schlüter et al., 2019; Sendzimir et al., 2010) known as Networks of Action Situations (NAS) (for review see Kimmich et al. (2022)).
- Multiple interdependent decision-making situations, which could be events, activities, venues, or any social spaces where actors interact and make strategic actions
- These interdependences are formalized as **biophysical**, **information**, **institutional**, and **actor** linkages (Kimmich, 2013; Kimmich and Villamayor-Tomas, 2019; Tan et al., 2023).

Introduction

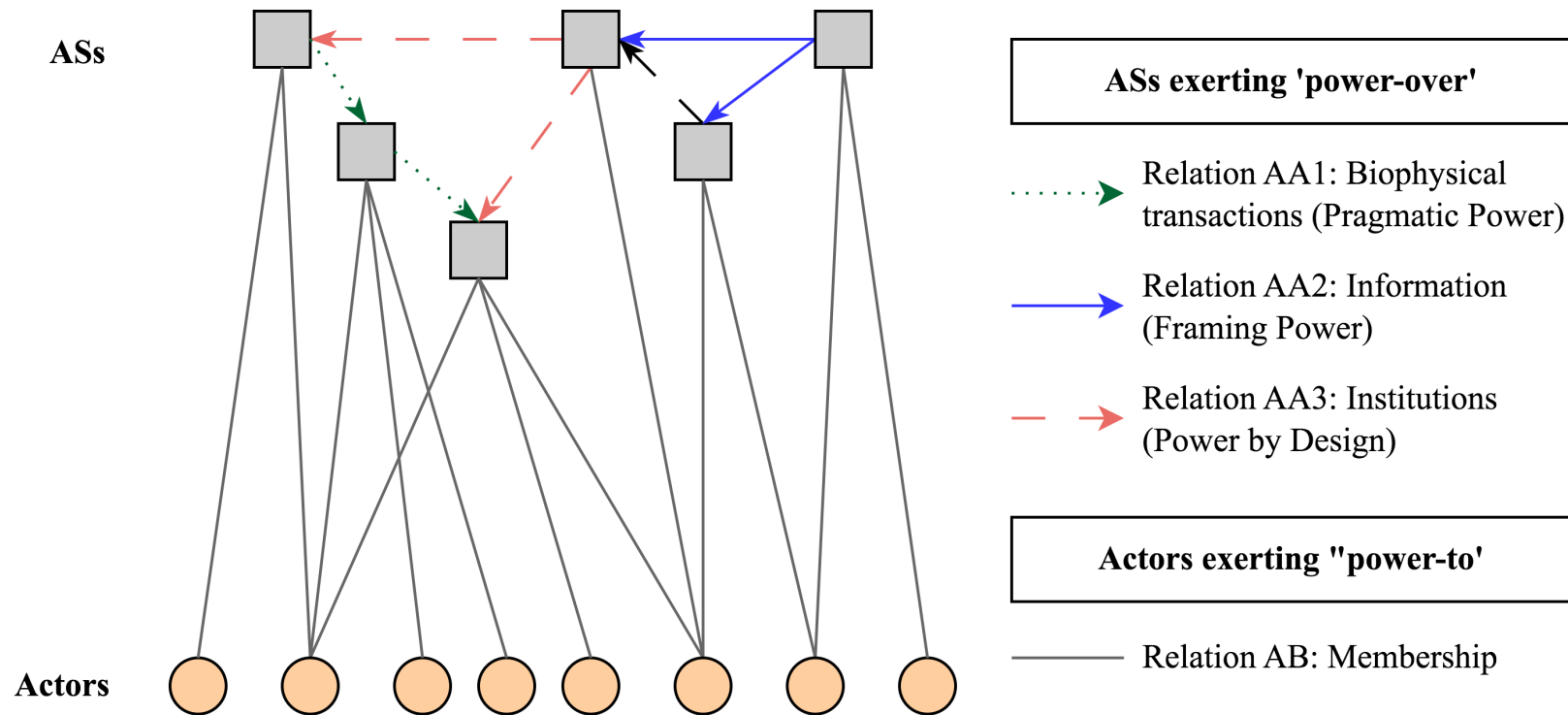
- Recent applications of the polycentric power typology with NAS research have sought to primarily identify forms of power mobilized by actors across decision-making situations (Méndez et al., 2023; Oberhauser et al., 2022; Srigiri and Dombrowsky, 2022).
- However, a critical gap remains how to theorize and assess hierarchies, influences and power relations embedded in the NAS complexities, including a set of ASs, their interdependences, and actors' participation in ASs (Cumming, 2016; Kimmich et al., 2022).

Introduction

- We aim to harness the power theory from institutional analysis and a multimode network approach to address this research gap in the NAS literature.
- Case study: the Indonesian palm oil value chain governance
 - A global value chain system: oil palm plantations, local transactions, global transactions
 - Activities that impose institutional influences upon the value chain: Indonesian policy-making, plasma contract, global policy, certification
 - Activities that impose informational influences upon the value chain: land use conflict, discourse, monitoring, investment

Analytical framework

➤ The multimode network approach to NAS

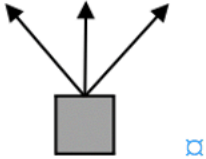
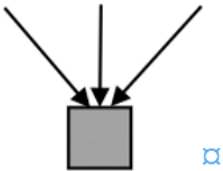
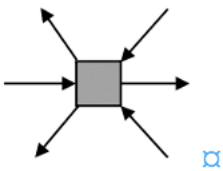


Analytical framework

- Power-over situations (adapted from Morrison et al. 2017; 2019)
 - Pragmatic power: the capacity of ASs to interpret, certify and operate rules established at the collective-choice and constitutional levels
 - Framing power: the capacity of ASs to shape problem-framing, norms, standards, and values, that may affect situations across governance levels
 - Power by design: the capacity of ASs to develop formal and informal rules that constrain or enable interactions and decision-making processes at other governance levels

Analytical framework

➤ The multimode network motifs and situation-centered power-over typologies

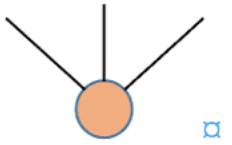
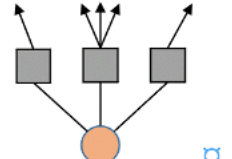
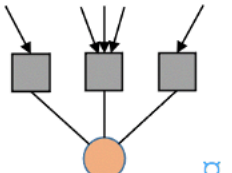
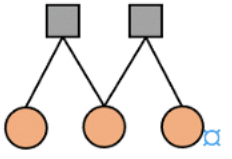
☐	Motifs☐	Power implications☐	Measurements☐
The extent of ASs exerting 'power-over' typology☐	(1) Out popularity¶ 	AS manifests higher power-over, because of many out-going biophysical relations (AA1), informational flows (AA2), and/or institutional linkages (AA3) to other ASs.☐	Three separate frequency counts, one for each relation, for the number of outgoing ties for a given AS, ☐
	(2) In popularity¶ 	AS is constrained by higher power-over, because of many in-coming biophysical relations (AA1), information flows (AA2), and/or institutional linkages (AA3) to <u>other</u> ASs.☐	Three separate frequency counts, one for each relation, for the number of incoming ties for a given AS.¶ ☐
	(3) AS Broker¶ 	AS manifests higher power-over, because of multiple incoming and outgoing biophysical relations (AA1), information flows (AA2), or institutional linkages (AA3) that enable the AS to connect otherwise disconnected ASs.¶ ☐	Three separate frequency counts, one for each relation, for the number of shortest paths between any pair of ASs that <u>pass through</u> a given AS.☐

Analytical framework

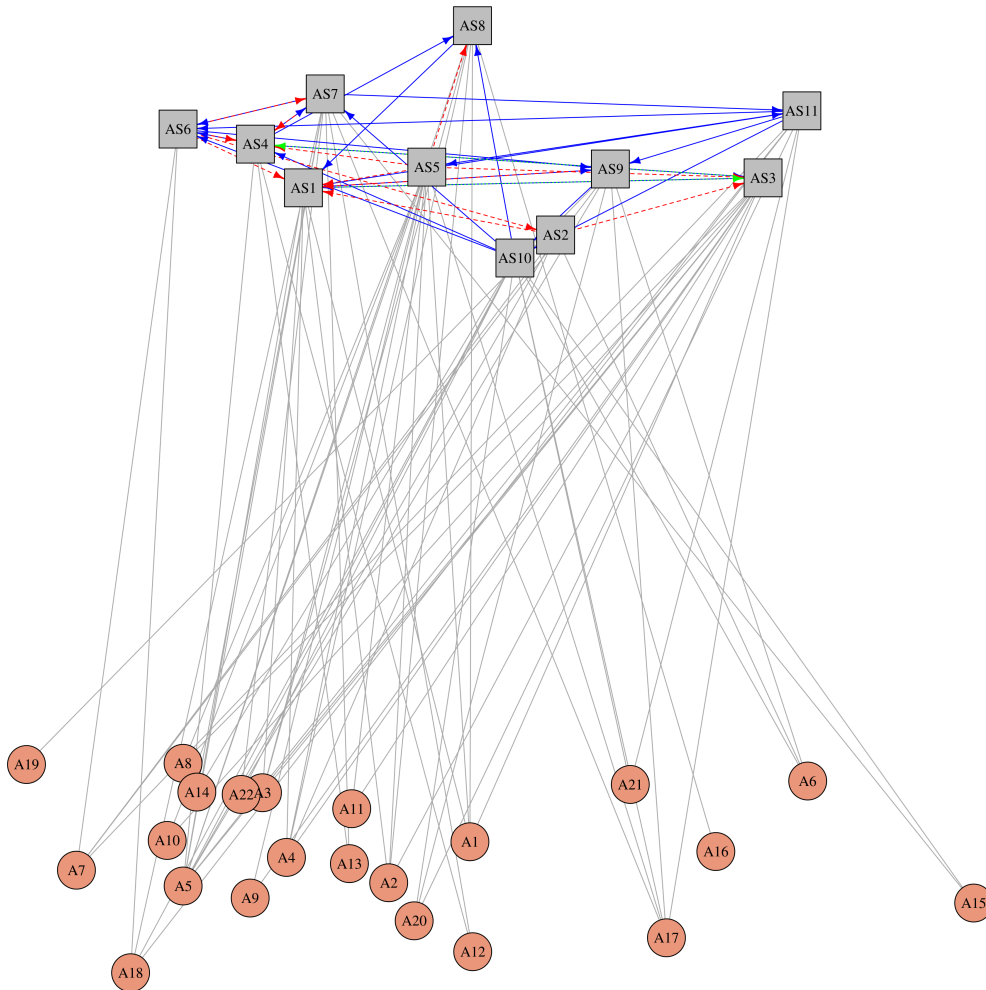
- Power-to actors
 - the capacity of an actor to exert influence in the network, not through directly controlling over others, to achieve one's goals and interests

Analytical framework

➤ The multimode network motifs and power-to actors

The extent of actors exerting 'power-to'	(4) Popularity 	Actor exerts higher 'power-to', because of their memberships in many ASs	Frequency count of the number of ASs, to which a given actor has membership.
	(5) Distance 2 out popularity 	Actor exerts higher 'power-to', because of their memberships to ASs that have many out-going biophysical relations (AA1), information flows (AA2), or institutional linkages (AA3) with other ASs	Three separate frequency counts, one for each relation in AB matrix, for the number of out-going ties from all situations, that a given actor has membership to.
	(6) Distance 2 in popularity 	Actor is constrained by higher 'power-to', because of their memberships to ASs that have many in-coming biophysical relations (AA1), information flows (AA2), or institutional linkages (AA3) with other ASs	Three separate frequency counts, one for each relation in AA matrix, for the number of in-coming ties from all situations, that a given actor has membership to.
	(7) Actor broker 	Actor exerts higher 'power-to' (see circle in the middle), because of multiple bipartite linkages that enable a given actor to connect actors with situations that they are not directly members to.	Frequency count of the number of shortest paths between any pair of actor and AS that <u>pass through</u> a given actor.

Results

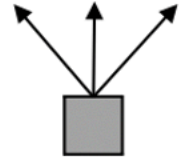
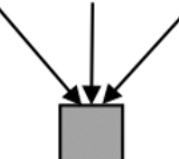
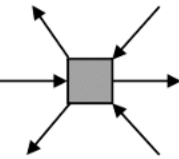


Network description

- Relation AA2 (information): most prevalent, dense and structurally central; with the density of 0.18 with 20 edges)
- Relation AA3 (institution): intermediate; with the density of 0.11 with 12 edges
- Relation AA1 (BT): sparse; density of 0.02 with 2 edges
- Relation AB (Actor – AS): 68 ties between 11ASs and 22 Actors; average degree of ASs is 6, of actors is approx. 3

Results

➤ The extent of power-over typologies mobilized by ASs

ASs manifesting power-over typology		AS1	AS2	AS3	AS4	AS5	AS6	AS7	AS8	AS9	AS10	AS11
(1) Out popularity 	Pragmatic	1		1								
	Framing	2		1	4		1	2	2	1	4	4
	Design		2			4	4	1		1		
(2) In popularity 	Pragmatic			1	1							
	Framing	2		1	1	1	4	2	2	3	2	2
	Design	4	1	2	3			1	1			
(3) AS broker 	Pragmatic			1								
	Framing	16		0.5	7		3	8.5	5.5	15	34	23.5
	Design		1									

AS1: plantation

AS3: local market

AS4: global market

AS2: plasma contract

AS5: certification

AS6: Indonesian

policymaking

AS7: global policymaking

AS8: Investment

AS9: land use conflict

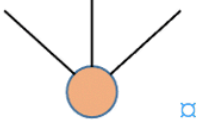
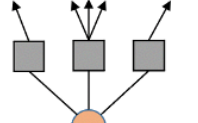
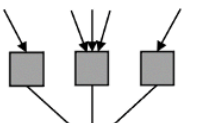
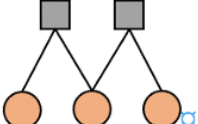
AS10: Discourse

AS11: monitoring

Results

➤ The extent of power-to mobilized by actors

A1-A5 growers; A5: producing companies; A7: local government; A17: NGOs; A18: GoI

Actors exerting 'power-to'		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22
(4) Popularity 		4	4	4	5	10	3	4	2	2	2	2	2	2	2	2	1	5	4	1	3	2	2
(5) Distance 2 out popularity 	Pragmatic	2	2	2	2	2			1	1	1	1											
	Framing	4	4	4	4	19	5	6	1	1	1	1	6	6	6	6	1	11	11	1	9	8	6
	Design	4	4	4	6	8	3	7	4	4	4	4	1	1	1	1		6	5	1	1		1
(6) Distance 2 in popularity 	Pragmatic	1	1	1	1	2			1	1	1	1	1	1									
	Framing	6	6	6	6	16	5	9	2	2	2	2	3	3	4	4	2	10	10	3	7	4	4
	Design	7	7	7	8	12	1	1	2	2	2	2	4	4	1	1	1	1	1				1
(7) Actor broker 		4.5	4.5	4.5	17	224	6.3	18	0.2	0.2	0.2	0.2	1.6	1.6	1.3	1.3		48.5	21.3		4.1	0.9	1.3

Conclusions

- We adopted a multimode network approach to uncover different forms of power relations manifested through decision-making processes and actors
- The developed framework demonstrates how key concepts from NAS can gain further clarity via operationalizations of power typologies from an SNA approach.
- Limitations:
 - Generic aggregation of ASs that may miss out complex dynamics and interactions of actors in that situation
 - Frequency count that does not distinguish the nature of the links, e.g., if all AA1 linkages exert same level (or even direction) of pragmatic power; if all actors in one situation mobilize same extent of power-to?

The dynamics of linked action situations in the Austrian Danube reveals governance changes (manuscript in review)

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What are we interested about?

- Study area: a 48km Danube river stretch connecting Vienna and Bratislava. Currently within the Donau-Auen National Park
- Social and environmental issues:
 - Multifaceted biophysical and economic issues: floodplain disconnections; biodiversity loss; riverbed incision; unstablized water level; flooding
 - Conflict resolution processes among stakeholders

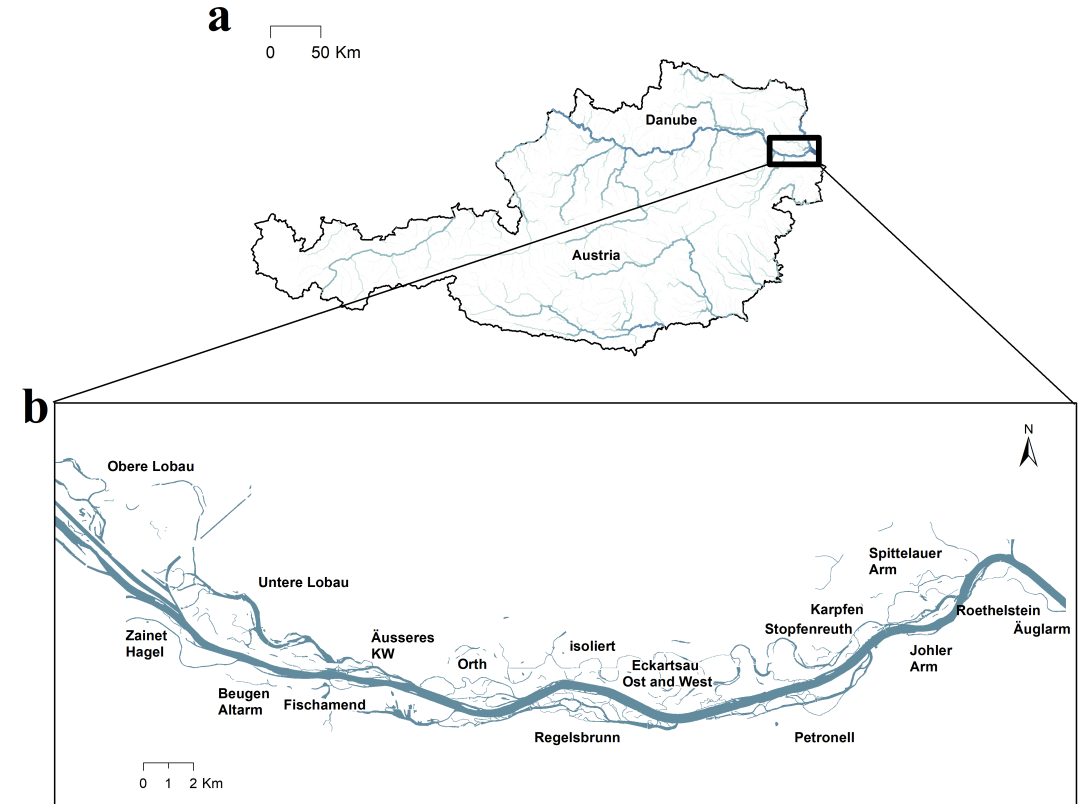


Figure 1: (a) Geographic location of the Danube east of Vienna; (b) Floodplain regions in the Danube Alluvial National Park

Social-environmental phenomenon of interest

- Floodplain disconnections and riverbed incisions
- Changes to governance system over time

Research question:

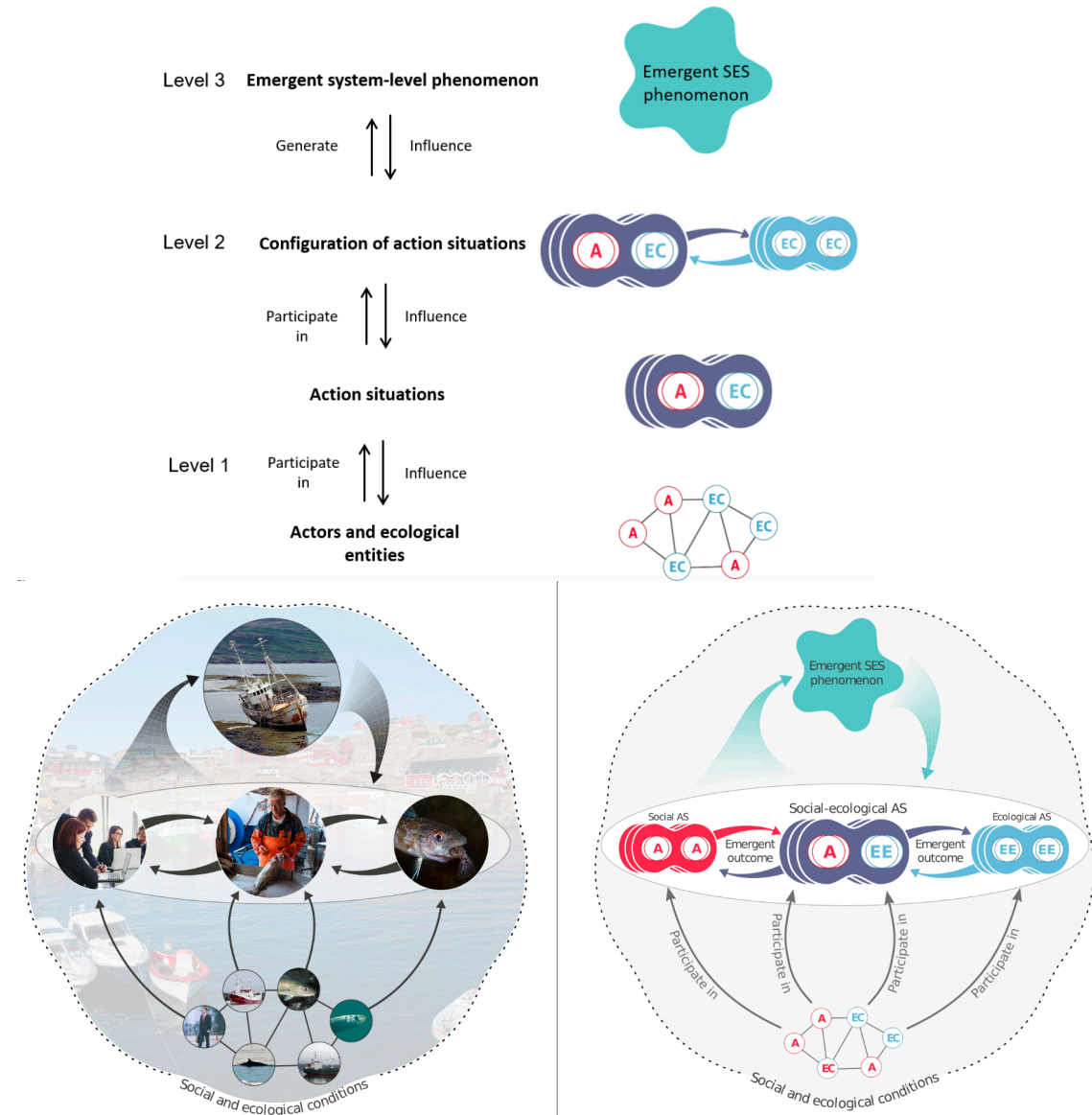
What are the social, institutional and ecological processes in driving governance changes in the river-floodplain area?

The Social-Ecological Action Situations (SE-AS) framework

Social AS: defined by the participating **human actors**, their capacities, rules, and structures that govern **their interactions**

Social-Ecological AS: defined by the participating **human actors and ecological entities**, their capacities, and the social and biophysical rules and structures that govern **their interactions**

Ecological AS: defined by the participating **ecological entities**, their attributes, and the biophysical rules that govern **their interaction**

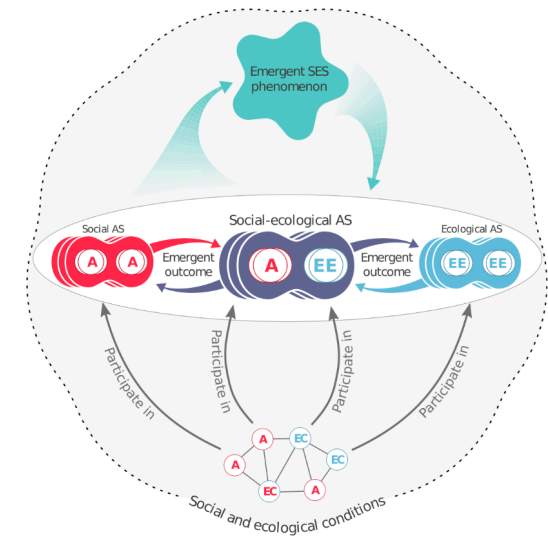


Source: Schlütler et al. (2019)

Conceptualizing our ecological AS

- River-floodplain landscape interactions

- **Entities**: aggregated river patches (located every 100 mts) in the river-floodplain landscape
- **Interactions**: hydrological connections (days of a year that water flow from one entity to another)
- **Outcomes**:
 - Habitat Connectivity (conservation)
 - Lowest navigable water level (economic)

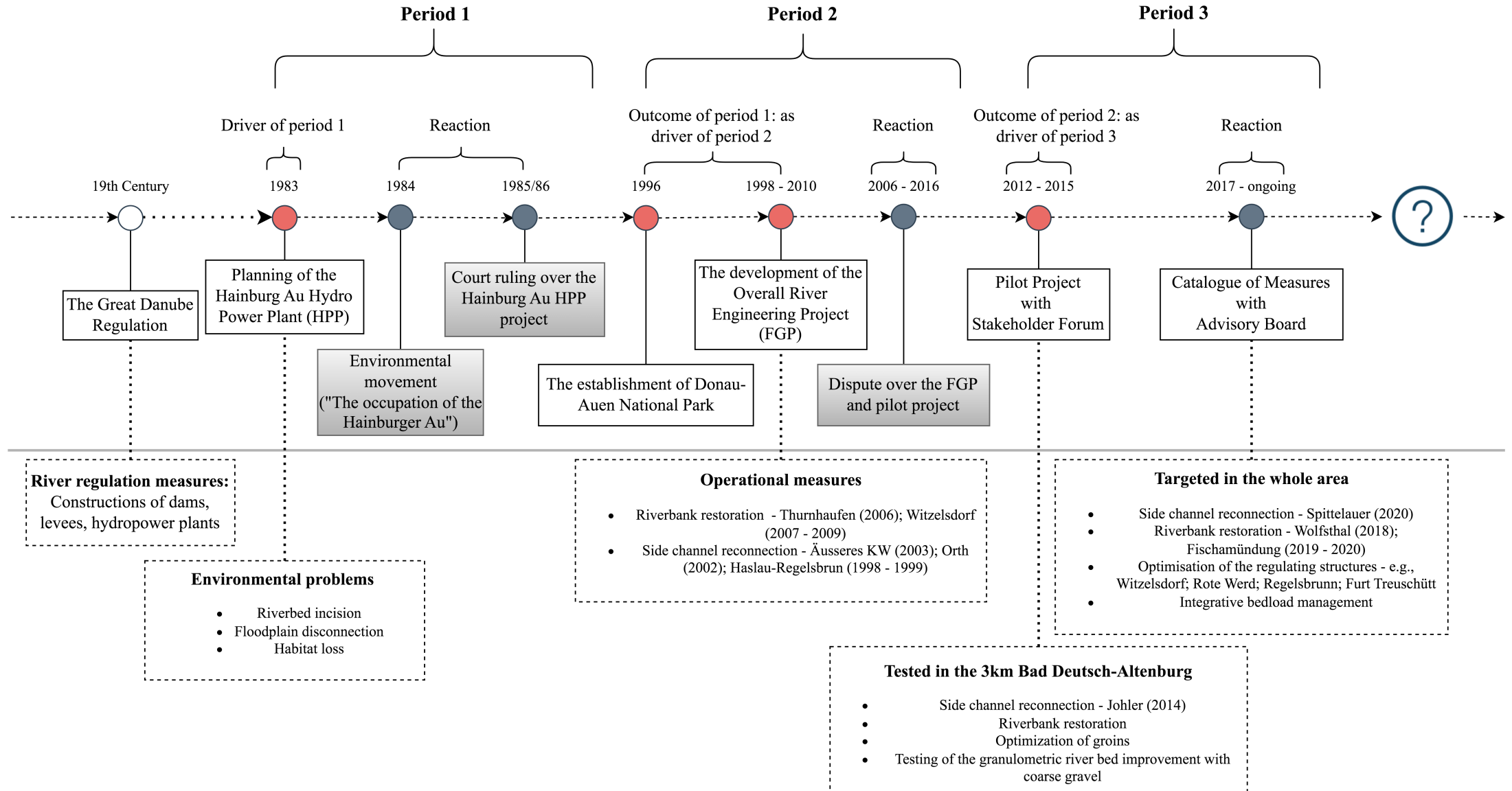


Source: Schlütler et al. (2019)

Data collection

- Initial information provided by researchers from the team, with decades of research experience in the field; and good connections with key stakeholder – the waterway company
- Desk research
 - Secondary dataset: relevant literature; website from the waterway company, ministry of transportation; media article
- Semi-structured interviews (approx. 40 – 90 mins) and online survey (approx. 15 mins) with key stakeholders (12)
 - Focus more on their activities and interactions with others

Outlining key events and activities



Data collection

- Ecological data
 - Frequency of lateral hydrological connections for year 1996, 2003, 2020 (published by Funk et al. 2023), which is used to calculate Habitat Connectivity (HC), an indicator of governance outcome on conservation
 - Daily water level from 1955 to 2020, which is publicly available from the monitoring station Hainburg, which is used to calculate lowest navigable water level, an indicator of governance outcome on economy

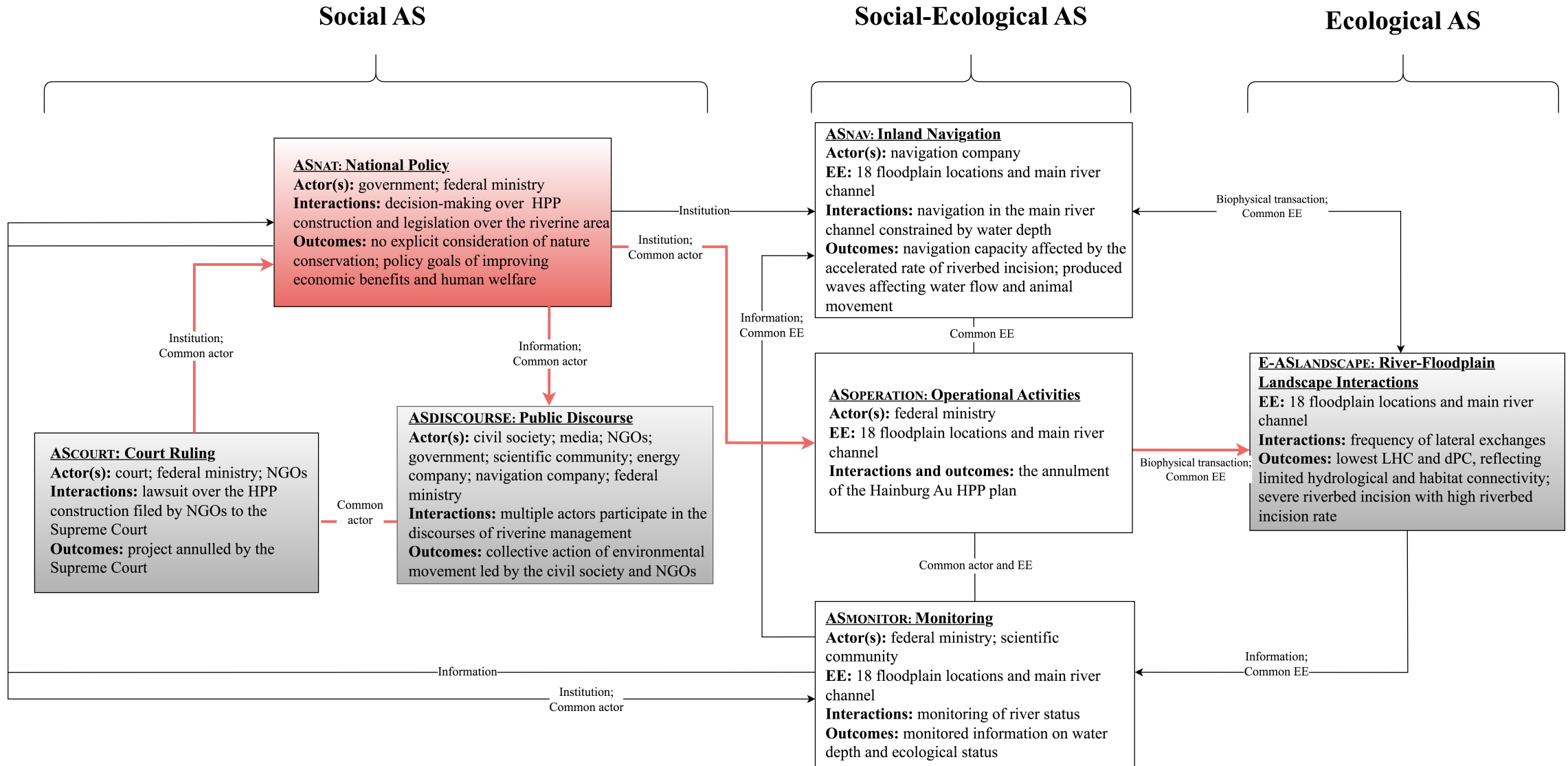
Table 1

A list of identified social-ecological, social, and ecological ASs over time, where the red boxes highlight the three situations that occurred at later periods

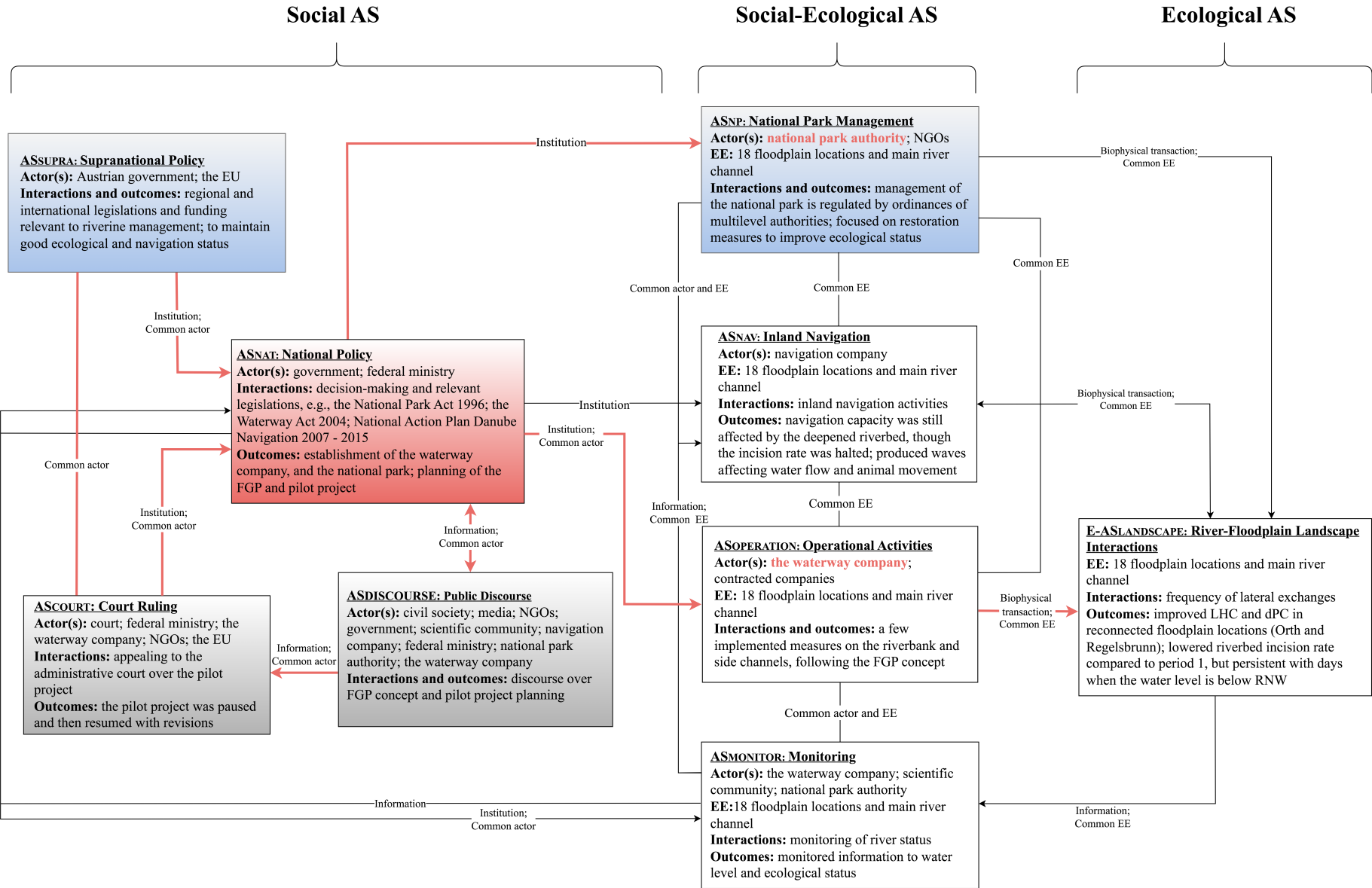
AS	Descriptions	Human/non-human entities	Interactions and outcomes	Attributes
Social-Ecological Action Situation (SE-AS)				
AS _{OPERATION}	River converting measures, e.g., dams; hydropower plant; side-channel reconnections	Federal ministry; the waterway company; others (e.g., contracted private companies for operation)	Affect the biophysical system in tangible ways; structured by human-constructed and ecological rules, as well as information on the river conditions	All three periods; Operational level
AS _{NAV}	Inland navigation activities	Navigation company	Affect the biophysical system in tangible ways; constrained by river conditions, especially the navigable water level	All three periods; Operational level
AS _{MONITOR}	Monitoring activities of river conditions	Federal ministry; scientific community; the waterway company; national park authority	Monitored information used to inform operational activities and policy makings	All three periods; Operational level
AS _{NP}	Management activities by the national park authority	National park authority; NGO, who owns part of the land in the national park area	Operational activities implemented by the national park authority to restore and improve ecological conditions of the area	Period 2 and 3; operational level
Social Action Situations (S-AS)				
AS _{NAT}	Policy-making at the national level	National government; federal ministry	Relevant legislations in managing the river-floodplain area: e.g., the National Park Act; Federal Waterway Act	All three periods; Collective-choice level
AS _{COURT}	Court ruling	Court; NGOs; national park authority; the waterway company	Lawsuits over planning and implementation of operational activities in the river-floodplain area	All three periods; Collective-choice level
AS _{DISCOURSE}	Public discourse in terms of managing the river-floodplain area	A variety of actors who are involved in the discourse of the river-floodplain management	Discourse produced and disseminated by different interest groups, taking forms of information briefing, environmental movement, media coverage, etc.	All three periods; Collective-choice level
AS _{FORUM}	Policy forum	A selected list of actors from the public sector, private sector, and civil society	Actors with various policy interests participate in the policy forum, coordinated by the waterway company, discussing operational measures, receiving information, etc.	Period 3; Collective-choice level
AS _{SUPRA}	Legislations and funding by the supranational authorities	The EU and international organizations	Relevant legislations set by the supranational authorities in managing the river-floodplain area: e.g., Water Framework Directive; Habitat Directive; TEN-T guidelines	Period 2 and 3; Collective-choice level
Ecological Action Situation (E-AS)				
E-AS _{LANDSCAPE}	Biophysical interactions and processes between river patches	18 floodplain areas and the main river channel	The interactions are captured as the frequency of lateral exchanges between main river channel and floodplain water bodies. The outcomes shape and are shaped by its biophysical rules and operational activities	All three periods

An overview of identified ASs

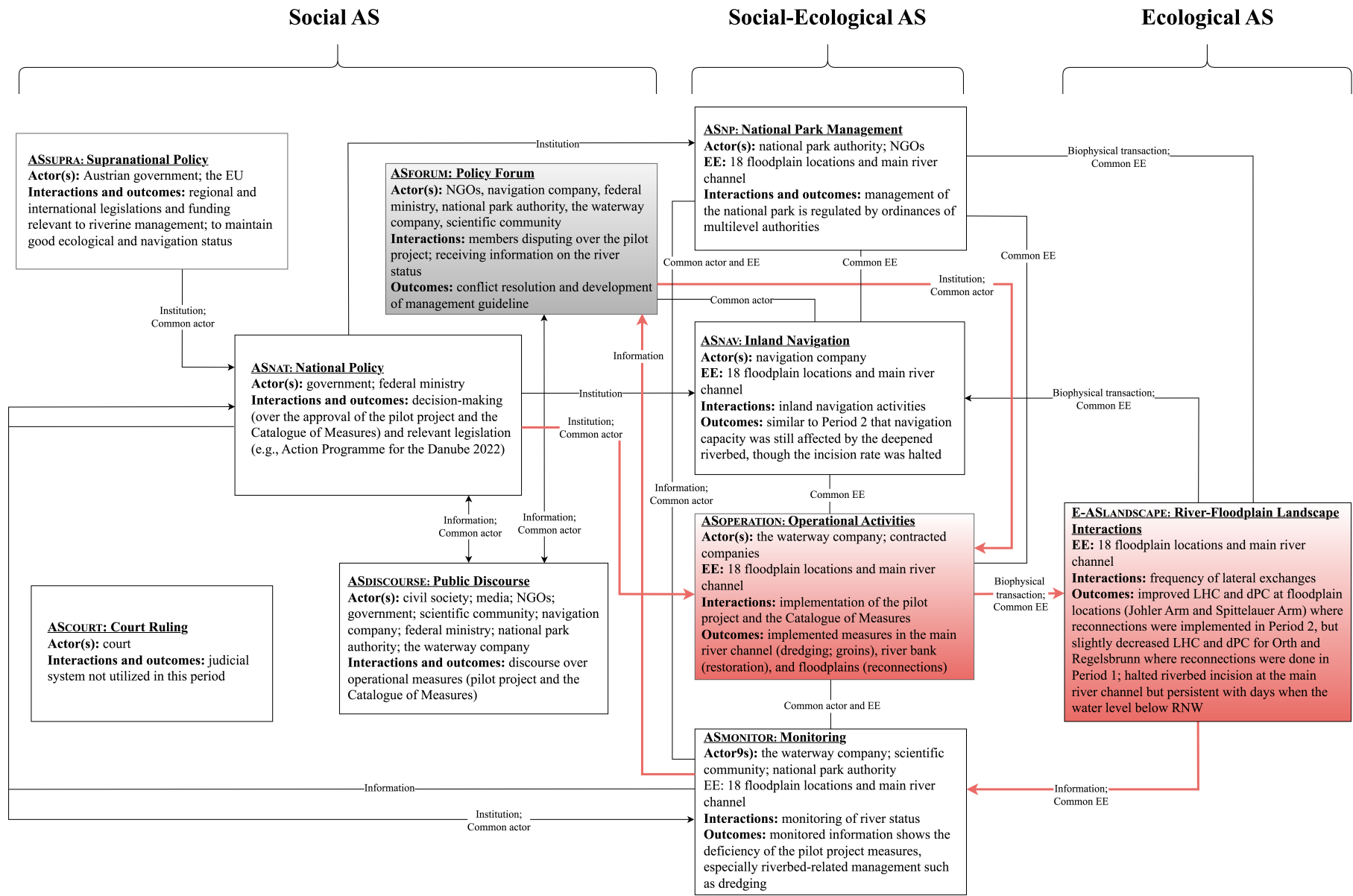
Period 1: Collective actions by civil society against top-down river governance prioritizing economic benefit



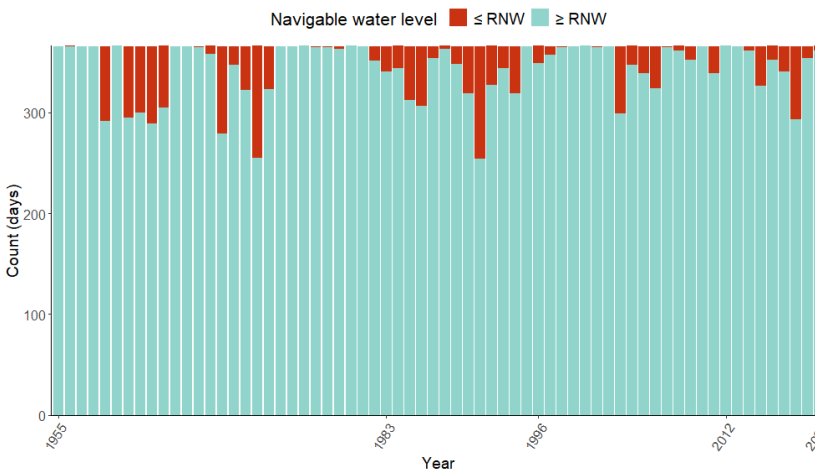
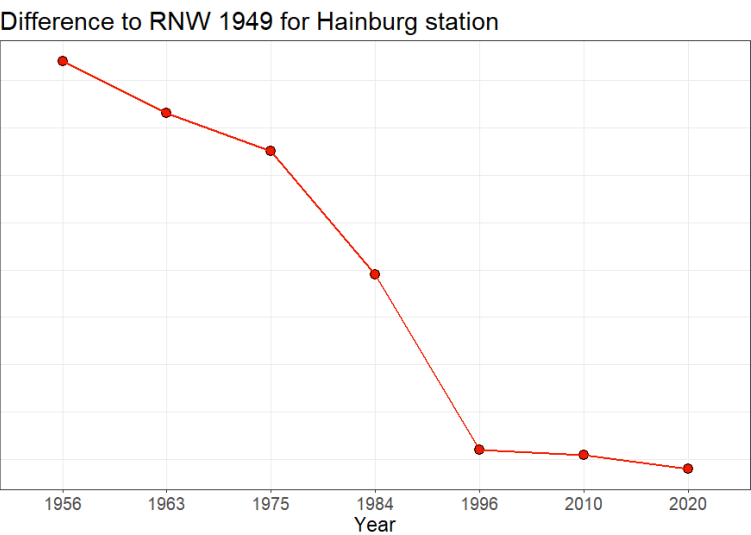
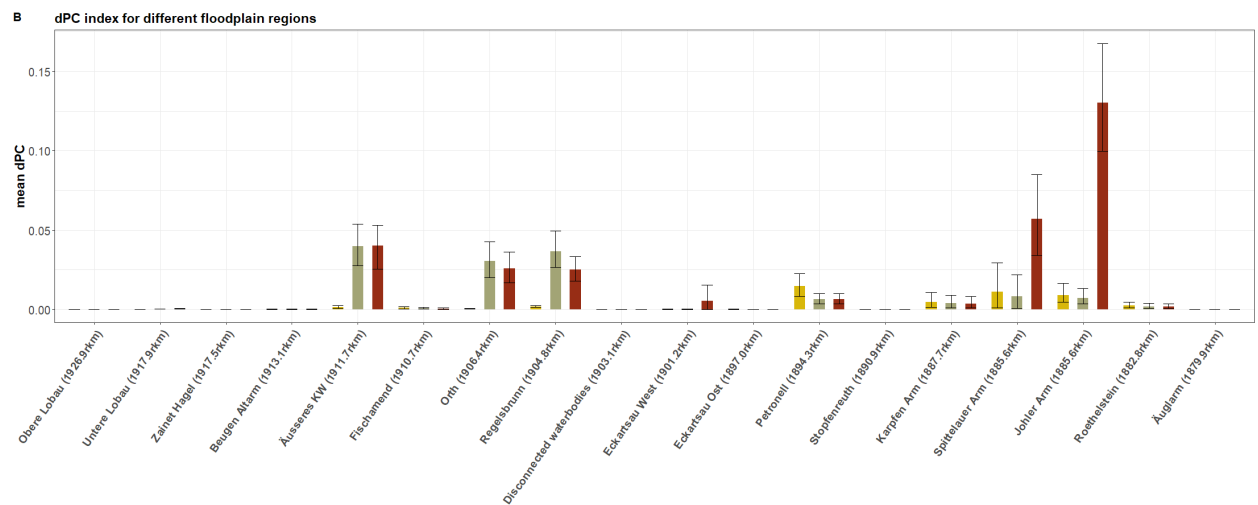
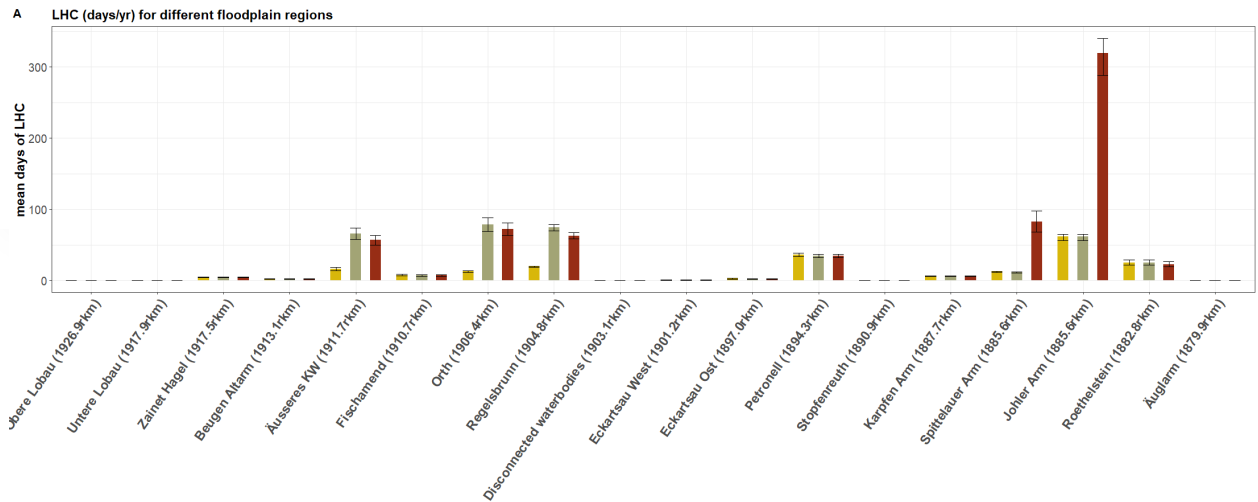
Period 2: New planning phase with aligned policy goals, remaining the lack of wider societal participation in the decision-making process



Period 3: A process of conflict resolution, where scientific knowledge and monitoring information matter



Changes in the E-AS over time



Discussion and conclusions

- Network dynamics over time
 - Tracing the social-biophysical-institutional drivers, responses, and outcomes
 - Key dynamics: emergence of new actors and ASs; changes of dynamics within the same network structure; situations may exist but not utilized
 - Why certain network dynamics emerged?
 - Future studies to draw on connectivity science and network tools to analyze the evolution of SE-AS structure and functions

Discussion and conclusions

- Integrating ecological dynamics into institutional analysis
 - The biophysical system often treated as governance context in the IAD/PG approach
 - The SE-AS framework explicitly accounts for the biophysical process and its intertwininess with social-institutional dynamics in driving governance changes
 - The key to operationalize the SE-AS framework to enable interdisciplinary research lies in the delineation process of the E-AS
 - Discovering key forms of social-biophysical interdependence
 - HC and RNW analysis reveals how quickly the riverine system responds to human actions
 - Institutional changes in the S-AS are driven by interactions between SE-ASs and E-AS

Discussion and conclusions

- Extensions on the ecological complexity
 - There is a persistent riverbed incision issue despite of bedload management measures
 - Likely attributable to the historical river engineering measures, and impacts of climate change, as pointed by a recent hydrology research (Klasz and Baumgartner, 2024)
 - Building on the SE-AS approach to examine the role of climate change or other biophysical processes in contributing to the issue

Reference

- Brisbois, M.C., Morris, M., de Loë, R., 2019. Augmenting the IAD framework to reveal power in collaborative governance – An illustrative application to resource industry dominated processes. *World Dev.* 120, 159–168. <https://doi.org/10.1016/j.worlddev.2018.02.017>
- Clement, F., 2013. For critical social-ecological system studies: integrating power and discourses to move beyond the right institutional fit. *Environ. Conserv.* 40, 1–4. <https://doi.org/10.1017/S0376892912000276>
- Clement, F., 2010. Analysing decentralised natural resource governance: proposition for a “politicised” institutional analysis and development framework. *Policy Sci.* 43, 129–156. <https://doi.org/10.1007/s11077-009-9100-8>
- Cumming, G.S., 2016. Heterarchies: Reconciling Networks and Hierarchies. *Trends Ecol. Evol.* 31, 622–632. <https://doi.org/10.1016/j.tree.2016.04.009>
- Epstein, G., Bennett, A., Gruby, R., Acton, L., Nenadovic, M., 2014. Studying Power with the Social-Ecological System Framework, in: Manfredo, M.J., Vaske, J.J., Rechkemmer, A., Duke, E.A. (Eds.), *Understanding Society and Natural Resources: Forging New Strands of Integration Across the Social Sciences*. Springer Netherlands, Dordrecht, pp. 111–135. https://doi.org/10.1007/978-94-017-8959-2_6
- Kashwan, P., 2016. Integrating power in institutional analysis: A micro-foundation perspective. *J. Theor. Polit.* 28, 5–26. <https://doi.org/10.1177/0951629815586877>
- Kimmich, C., 2013. Linking action situations: Coordination, conflicts, and evolution in electricity provision for irrigation in Andhra Pradesh, India. *Ecol. Econ.* 90, 150–158. <https://doi.org/10.1016/j.ecolecon.2013.03.017>
- Kimmich, C., Baldwin, E., Kellner, E., Oberlack, C., Villamayor-Tomas, S., 2022. Networks of action situations: a systematic review of empirical research. *Sustain. Sci.* <https://doi.org/10.1007/s11625-022-01121-2>
- Kimmich, C., Villamayor-Tomas, S., 2019. Assessing Action Situation Networks: A Configurational Perspective on Water and Energy Governance in Irrigation Systems. *Water Econ. Policy* 05, 1850005. <https://doi.org/10.1142/S2382624X18500054>
- McGinnis, M.D., 2011. Networks of Adjacent Action Situations in Polycentric Governance. *Policy Stud. J.* 39, 51–78. <https://doi.org/10.1111/j.1541-0072.2010.00396.x>
- Méndez, P.F., Clement, F., Palau-Salvador, G., Diaz-Delgado, R., Villamayor-Tomas, S., 2023. Understanding the governance of sustainability pathways: hydraulic megaprojects, social–ecological traps, and power in networks of action situations. *Sustain. Sci.* 18, 303–321. <https://doi.org/10.1007/s11625-022-01258-0>
- Morrison, T.H., Adger, W.N., Brown, K., Lemos, M.C., Huitema, D., Hughes, T.P., 2017. Mitigation and adaptation in polycentric systems: sources of power in the pursuit of collective goals. *WIREs Clim. Change* 8, e479. <https://doi.org/10.1002/wcc.479>
- Morrison, T.H., Adger, W.N., Brown, K., Lemos, M.C., Huitema, D., Phelps, J., Evans, L., Cohen, P., Song, A.M., Turner, R., Quinn, T., Hughes, T.P., 2019. The black box of power in polycentric environmental governance. *Glob. Environ. Change* 57, 101934. <https://doi.org/10.1016/j.gloenvcha.2019.101934>
- Mudliar, P., 2021. Polycentric to monocentric governance: Power dynamics in Lake Victoria’s fisheries. *Environ. Policy Gov.* 31, 302–315. <https://doi.org/10.1002/eet.1917>
- Oberhauser, D., Hägele, R., Dombrowsky, I., 2022. Unravelling hidden factors explaining competition for and overuse of groundwater in Azraq, Jordan: digging deeper into a network of action situations. *Sustain. Sci.* <https://doi.org/10.1007/s11625-022-01135-w>
- Pahl-Wostl, C., Holtz, G., Kastens, B., Knieper, C., 2010. Analyzing complex water governance regimes: the Management and Transition Framework. *Environ. Sci. Policy, Special issue: Water governance in times of change* 13, 571–581. <https://doi.org/10.1016/j.envsci.2010.08.006>
- Schlüter, M., Haider, L., Lade, S., Lindkvist, E., Martin, R., Orach, K., Wijermans, N., Folke, C., 2019. Capturing emergent phenomena in social-ecological systems: an analytical framework. *Ecol. Soc.* 24. <https://doi.org/10.5751/ES-11012-240311>
- Sendzimir, J., Flachner, Z., Pahl-Wostl, C., Knieper, C., 2010. Stalled regime transition in the upper Tisza River Basin: the dynamics of linked action situations. *Environ. Sci. Policy, Special issue: Water governance in times of change* 13, 604–619. <https://doi.org/10.1016/j.envsci.2010.09.005>
- Srigiri, S.R., Dombrowsky, I., 2022. Analysing the Water-Energy-Food Nexus From a Polycentric Governance Perspective: Conceptual and Methodological Framework. *Front. Environ. Sci.* 10.
- Tan, R., Xiong, C., Kimmich, C., 2023. An agent-situation-based model for networked action situations: Cap-and-trade land policies in China. *Land Use Policy* 131, 106743. <https://doi.org/10.1016/j.landusepol.2023.106743>