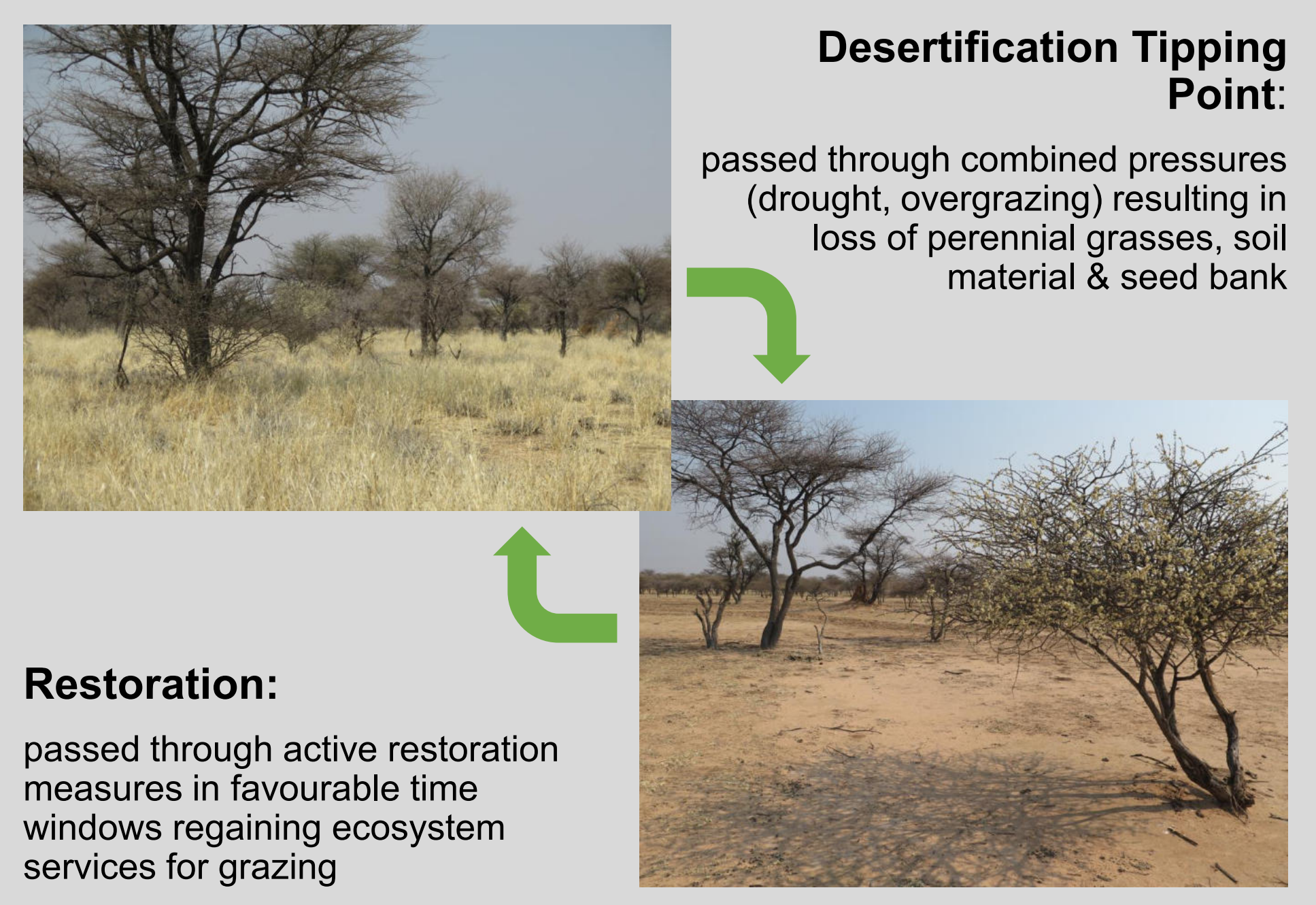


Introduction

- Drylands are well-known for regime shifts, where small shifts in human pressures and/or environmental conditions bring about abrupt changes towards alternative states.
- One major type of regime shifts in drylands occurs at a **‘Desertification Tipping Point’ (DTP)**.
- Crossing a DTP is assumed to be triggered by a combination of several drivers, with climate change (mainly droughts) and land-use change (mainly overgrazing) as the most important.
- It leads to a reduction or loss of the critical ecosystem service ‘forage provision’, with direct impacts on people's livelihoods and well-being.
- Research gap:** literature on ecological tipping points (TP) is well established and on social TPs is increasing, while studies focussing on the **interlinked social-ecological perspectives of TPs** are scarce.
- Objective:** to study social-ecological TPs in a rangeland system subjected to **climate change** in order to identify state changes with **limited reversibility** towards degradation in several **cascades** triggered by **positive feedback loops** running through the **ecological and the social subsystem**.



Study Region

- Namibia: Greater Waterberg Landscape Region, 250 km north of Windhoek
- Semi-arid climate: 350-400 mm/a, dry season May-Oct, rainy season Nov-Apr
- Dual land tenure system: freehold land and communal land incl. communal conservancies
- Farming types: cattle farming, guest/hunting farms, mixed farming
- Rainfall is an unreliable source of water for livestock, leading to dependency on groundwater resources

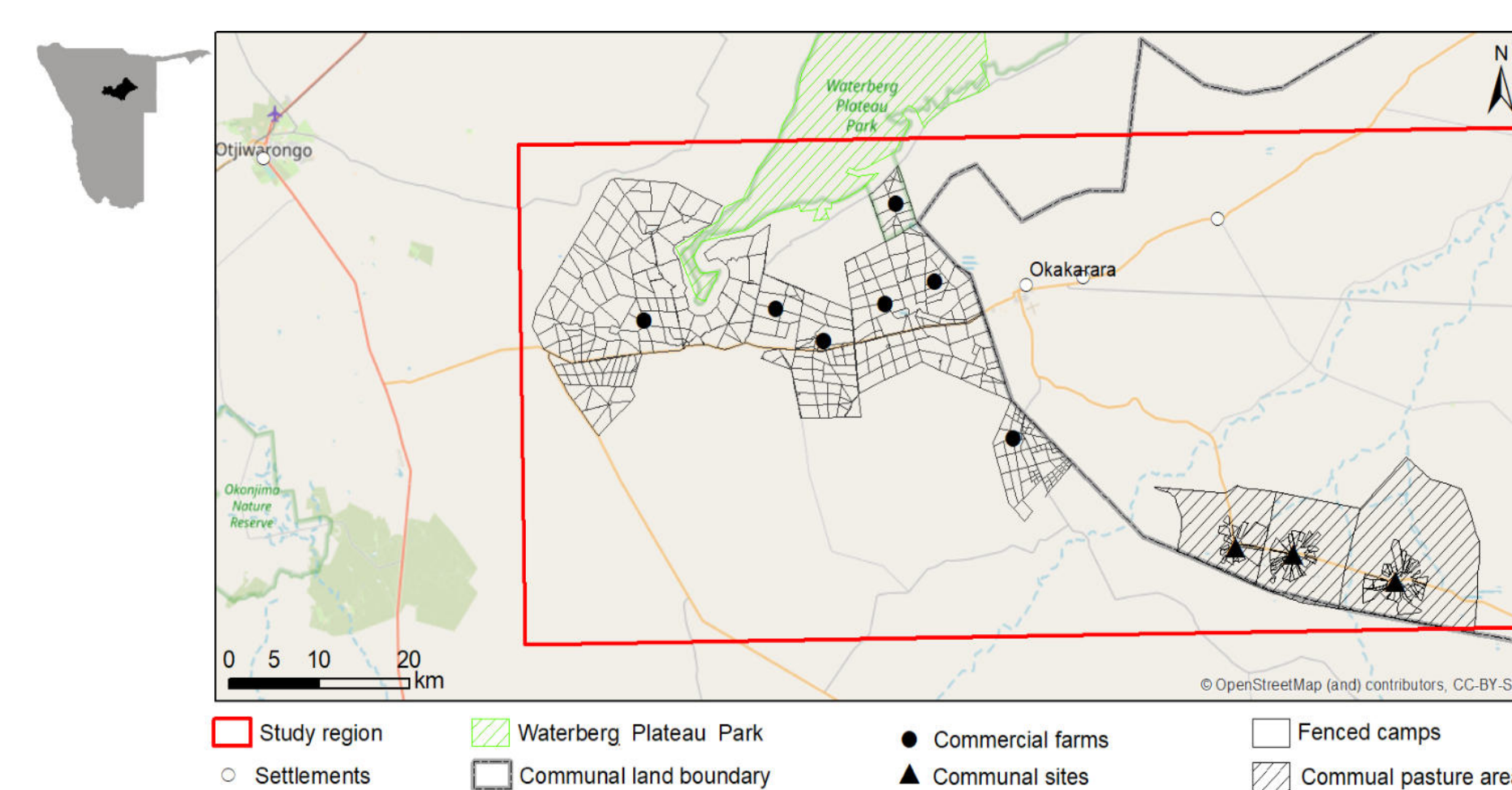


Fig. 1: Greater Waterberg Landscape Region / Source: Brinkmann et al. (2023)



Methods

- Literature research
- Semi-structured interviews
- Participatory mapping
- Analysis of remote sensing data
- Anthropological studies
- Policy analysis
- Establish references to relevant concepts: Social-Ecological Systems (SES)

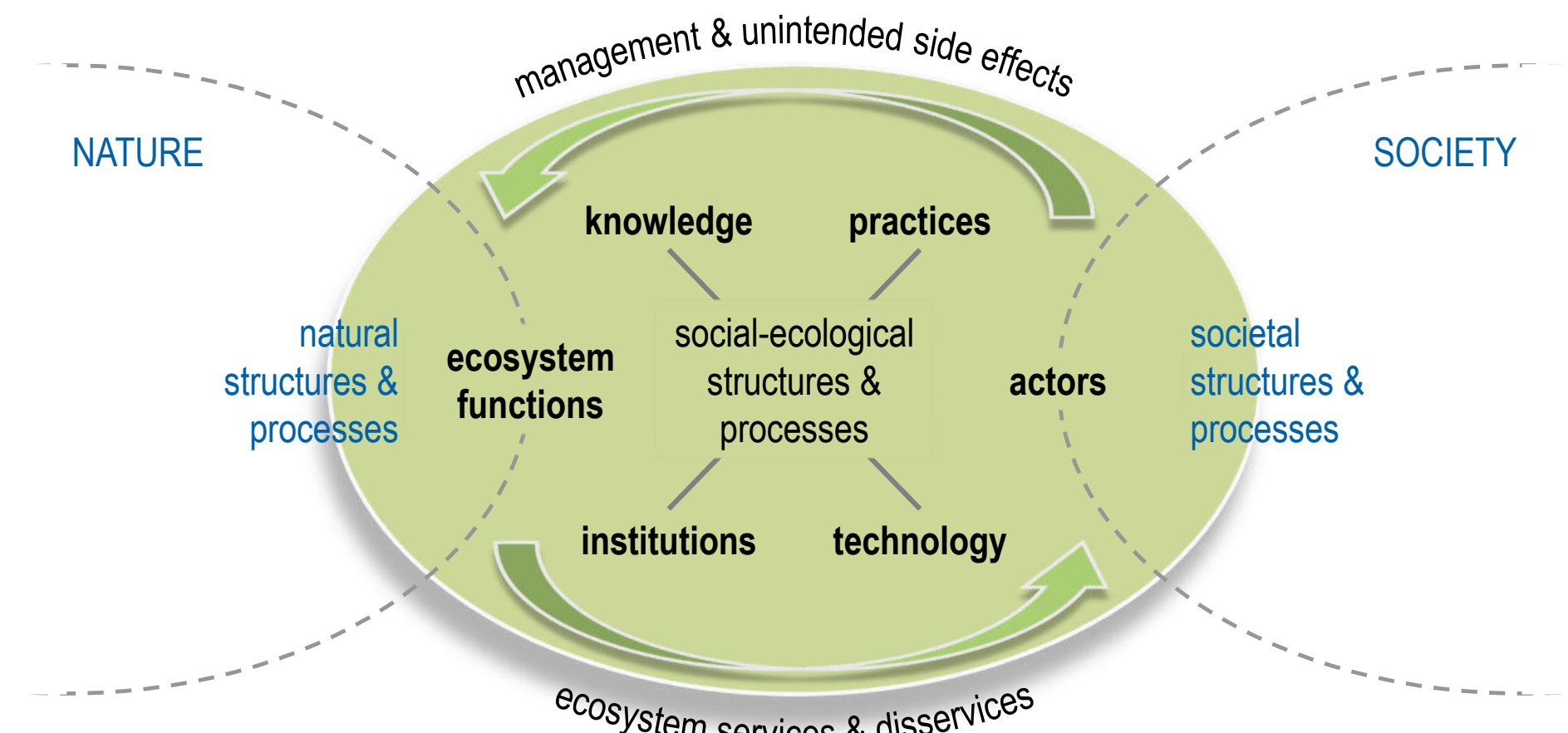


Fig. 2: Concept of Social-Ecological Systems (SES) (Liehr et al. 2017)



Results

- Rangeland changes since 1965 (Fig. 3): woodland & savannah: decrease
shrubland & barren land: increase
... with potential trend reversal since 2011
freehold: more shrub- & woodland
communal: more barren land & grass-dominated savannah
- Identification of (self-reinforcing) feedback loops in the social-ecological system (Fig. 4)
- Exemplary loop: drought – loss of grass biomass – reduction of carrying capacity – overstocking – overgrazing – further loss of grass biomass – use of supplementary fodder – further overgrazing until the vegetation cover is depleted
- Risk of system instability and driving the whole social-ecological system towards a DTP
- Coping strategies like wildlife management, tourism, camp rotation and bush thinning/use leading to stabilizing loops

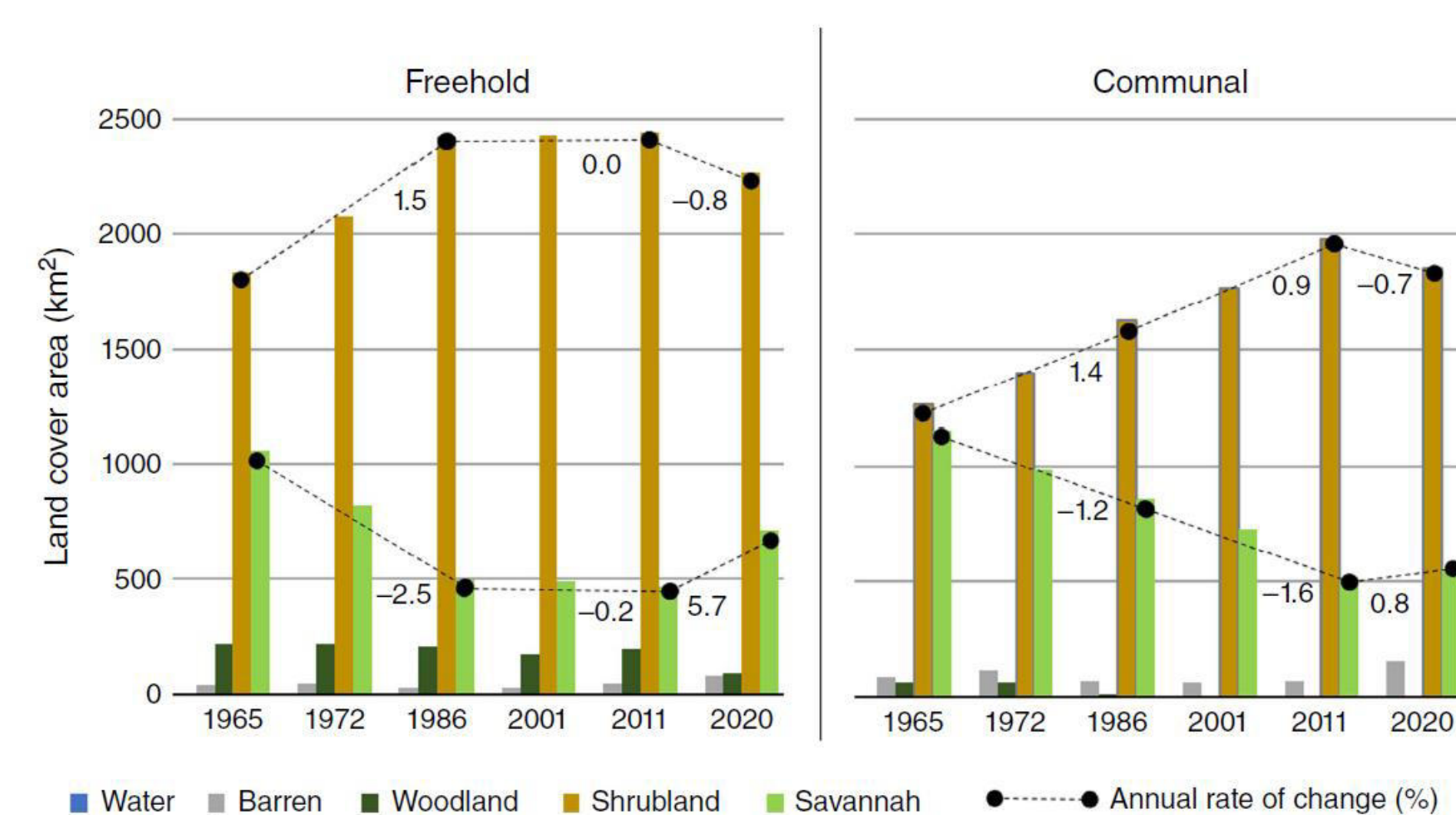


Fig. 3: Land-cover area (km²) from 1965 to 2020 and annual rate of change (%) for shrubland and savanna for the periods from 1965 to 1986, 1986 to 2011 and 2011 to 2020 on freehold and communal land in the Greater Waterberg Landscape region (Brinkmann et al. 2023).

Conclusion

- Diversification of farm income through off-farm activities may stabilise the social subsystem, but can lead to overstocking contributing to destabilise the social-ecological system.
- While the loss of vegetation cover and seedbank depletion are hardly reversible, bush encroachment can be reversed temporarily through bush thinning and may lead to a more resilient social-ecological system.
- DTPs are characterised not only by ecological, but also by social tipping point dynamics and their precursor phenomena.
- Both, ecological and social tipping point dynamics combine to form interlinked social-ecological tipping point dynamics.
- Social-ecological tipping points are characterised by the fact that they cascade through the system as a whole and transform it.

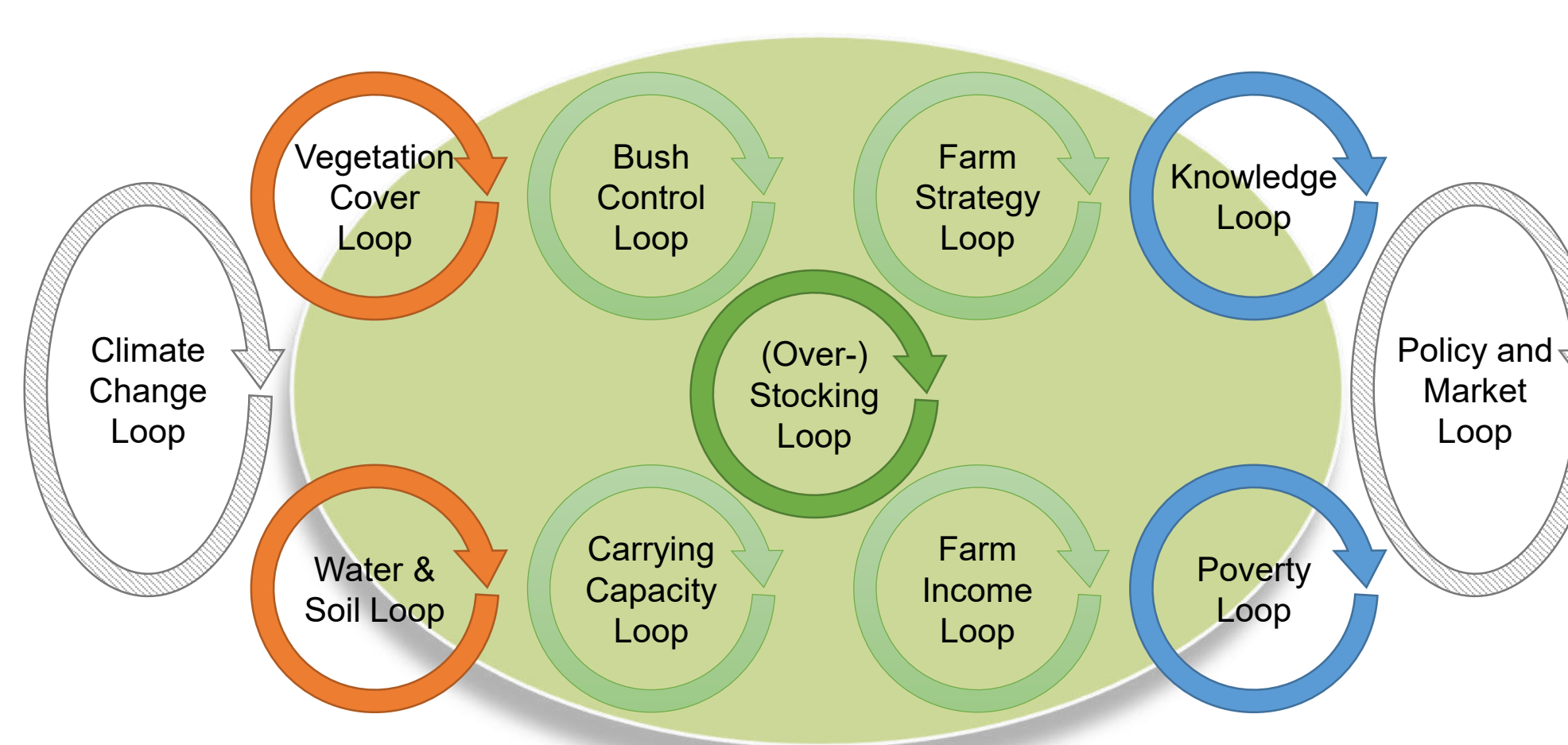


Fig. 4: Identified causal feedback loops that are interlinked and through which tipping point dynamics spread across the entire system, thus becoming social-ecological tipping points. The arrangement of the loops is based on the structure of the SES, above (own illustration).

Acknowledgements

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Project Information

The collaborative German-Namibian research project “NamTip – A Namibian Perspective on Desertification Tipping Points in the Face of Climate Change” aims to better understand the development of ecological tipping points in dryland rangelands by assessing desertification and woody plant encroachment processes. It also explores management options for preventing such tipping points and restoring degraded rangeland ecosystems.

Pre-phase: 06/2017 – 05/2018
First main phase: 04/2019 – 07/2023
Second main phase: 09/2023 – 08/2025

Bibliography

- Brinkmann, Katja/Diego A. Menestrey Schwiieger/Lena Grieger/Sara Heshmati/Markus Rauchecker (2023): How and why do rangeland changes and their underlying drivers differ across Namibia's two major land-tenure systems?. The Rangeland Journal 45 (3), 123-139
- Liehr, Stefan/Julia Röhrig/Marion Mehring/Thomas Kluge (2017): How the Social-Ecological Systems Concept Can Guide Transdisciplinary Research and Implementation: Addressing Water Challenges in Central Northern Namibia. Sustainability 9 (7), 1109
- Lütkeemeier, Robert/Meed Mbidzo/Stefan Liehr (2021): Water security and rangeland sustainability: Transdisciplinary research insights from Namibian-German collaborations. South African Journal of Science 117 (1/2), 7773
- Menestrey Schwiieger, Diego A. (2022): Exploring pastoralists' perceptions of desertification tipping points in Namibia's communal drylands: An ethnographic case study from Okakarara constituency. Pastoralism Research Policy and Practice 12(3):1-15