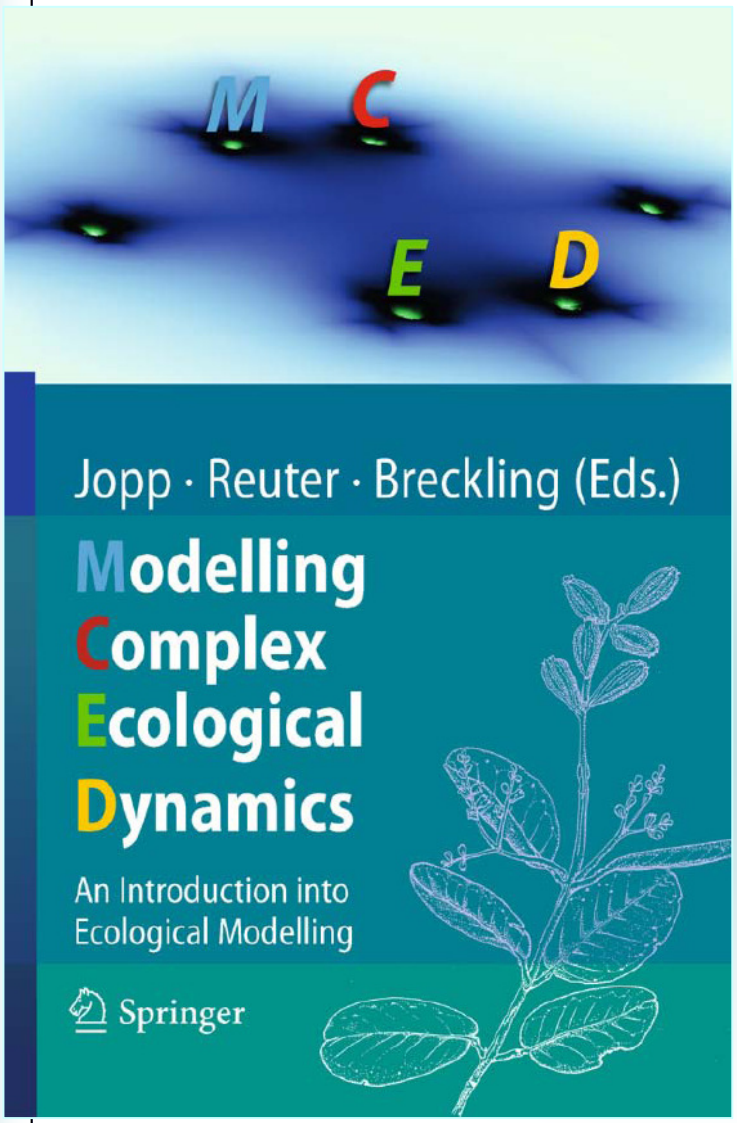
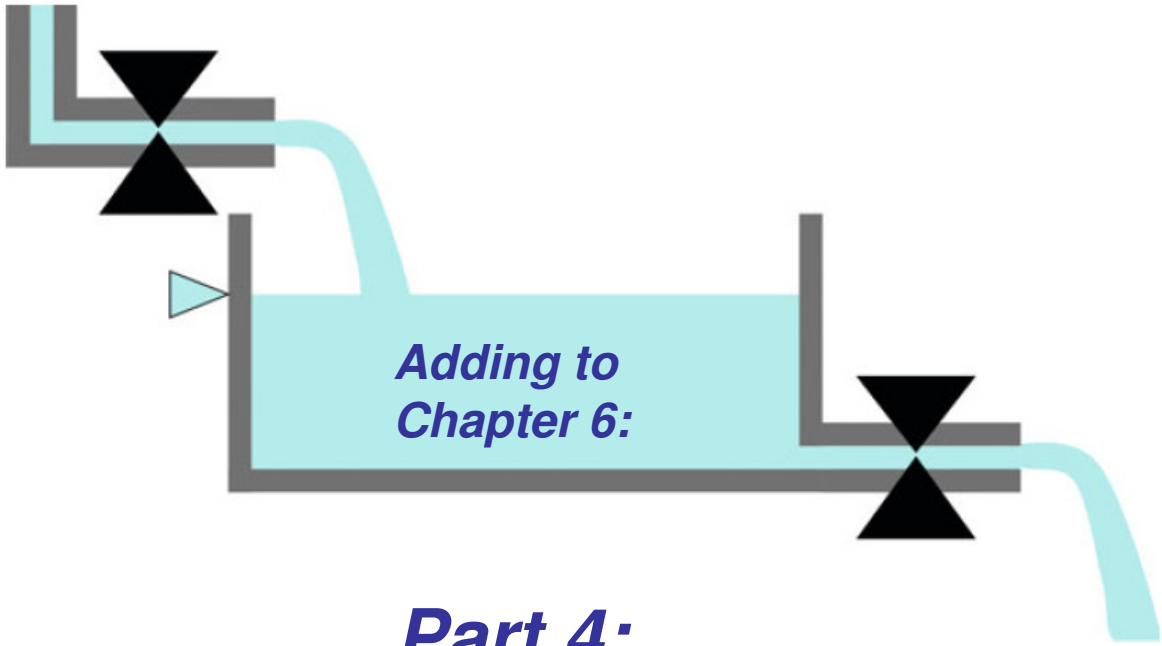


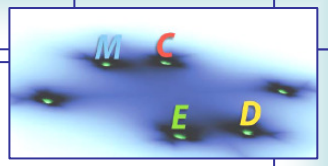
Presentation material accompanying

Chapter 6: Differential Equations

Modelling Complex Ecological Dynamics



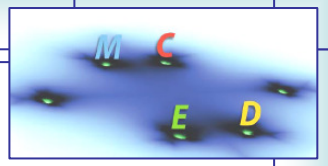
Part 4: Ecological Stability



Preface

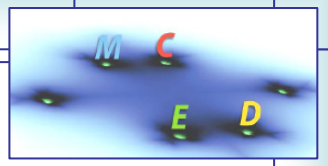
- *The presentation is free for use in non-commercial teaching context.*
- *The content was based on lecture material developed (among others) for the course "Systems Analysis" in the Master of Science Programme "International Studies in Aquatic Tropical Ecology" at the University of Bremen during the years 1999 – 2011*
- *Because of the page restriction this presentation partially extends the content covered in MCED Chapter 6 Differential Equations.*

Broder Breckling
Hauke Reuter
Uta Berger



Ecological Stability

(will be expanded …)



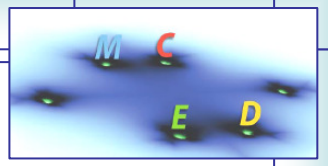
Ecological Stability concept

How to distinguish a stable and an unstable ecological system?

What is the definition of ecological stability?
(constancy, resilience, reference state, persistence, disturbance?)

Answer: it depends...

- *on what you are talking about* **(...** i.e. on the definition of your system: elements, border...)
- *on the scale you have in mind...*
- *on the temporal extent you consider...*



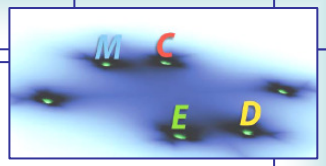
Ecological Stability concept

To a large extent, the discussion on ecological stability is arbitrary. Definitions are frequently diverging and incompatible.

"*Stability* is, as we will see, one of the most nebulous terms in the whole of ecology." (Grimm & Wissel, 1997)

The discourse on stability to a large extent became unproductive and finally ended when the contributors turned to other topics - without having achieved consensus.

See:
Grimm V, Wissel C (1997) Babel, or the ecological stability discussions: An inventory and analysis of terminology and a guide for avoiding confusion. Oecologia 109:323-334

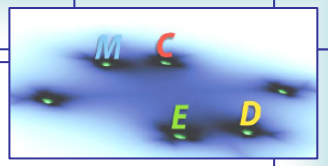


Ecological Stability concept

How to deal with the situation?

- **Stability** *cannot* be
  defined as **a property of nature**. If this attempt is made, there is a significant danger that the result becomes too context-specific, not generalisable and even contradictory with regard to related cases

- **Stability** *can* be
  defined as **a model property** – thus referring to the elements and relations which were focused, investigated and represented.



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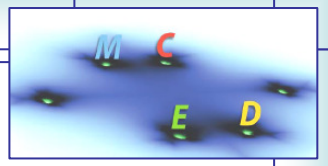
  defined as **a model property** – thus referring to the elements and relations which were focused, investigated and represented.

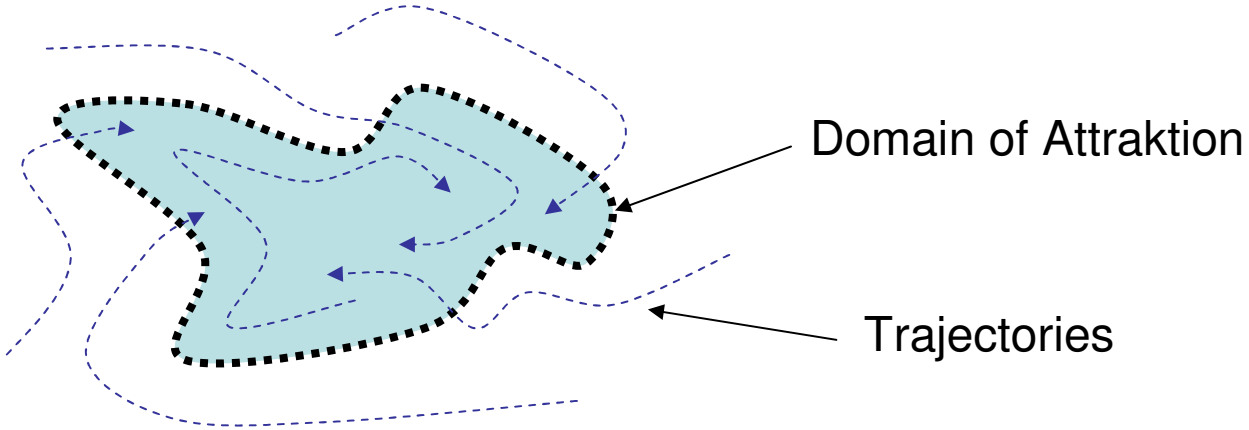
Helmut Schwegler developed an interesting stability-terminology, see

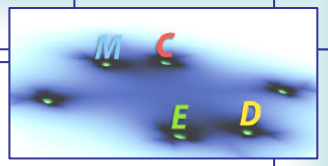
Schwegler, H. 1985:
Ökologische Stabilität. Verhandlungen der Gesellschaft für Ökologie 3: 263 – 270
Roth, G. Schwegler, H. 1981:
Self-organising systems. An interdisciplinary approach. Campus (Frankfurt/ M.)



Ecological Stability concept

- **Stability** can be quantitatively specified as the **range of conditions** under which the state of **the model system remains in a certain domain of the state space** which is not left due to internal interactions, regardless whether the model approximates a stationary state, a limit cycle or follows a chaotic regime.

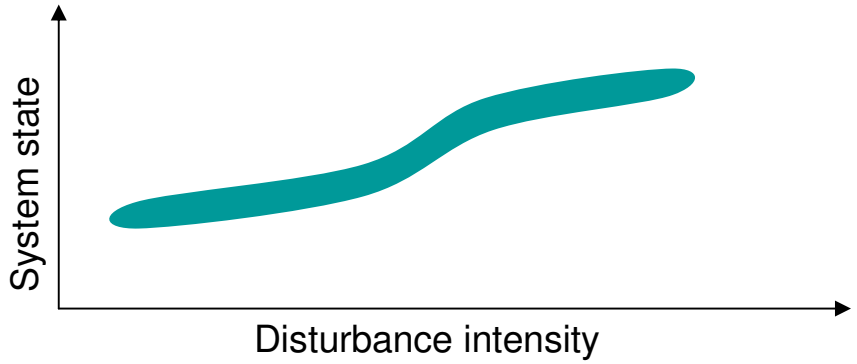


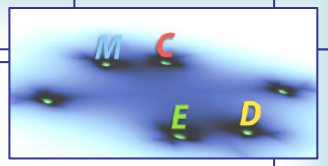


Ecological Stability concept

- **Stability properties** can be
  quantified with regard to the effect of an external influence **(disturbance)** on the state of the system. Different properties) can be distinguished.

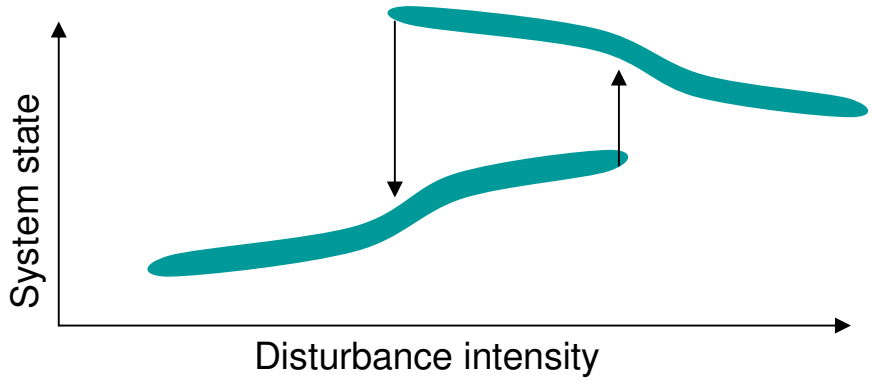
- **c-Stability** ("climax"-stability)
  as a result of a disturbance, the state of the model remains within a particular domain of attraction, only quantitative changes occur as a reversible adaptation to the disturbance

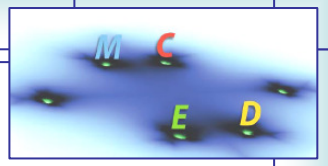




Ecological Stability concept

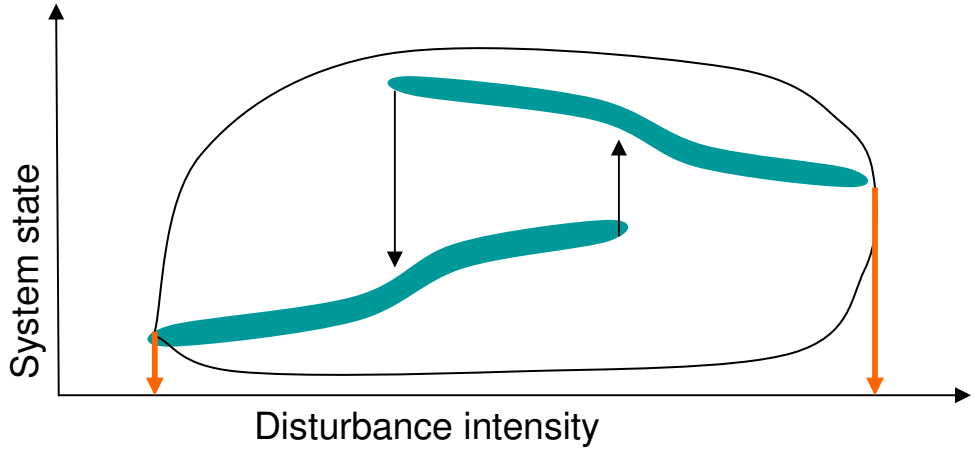
- **t-Stability** ("transition" stability)
  if beyond a certain extent of disturbance intensity a succession towards a new type of c-stable settings takes place, it can be considered as a different stability property. It is linked to hysteresis: Only beyond a certain threshold the system transits to a different set of states and frequently attains a different structural composition (alternative stable states).

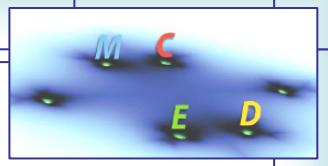




Ecological Stability concept

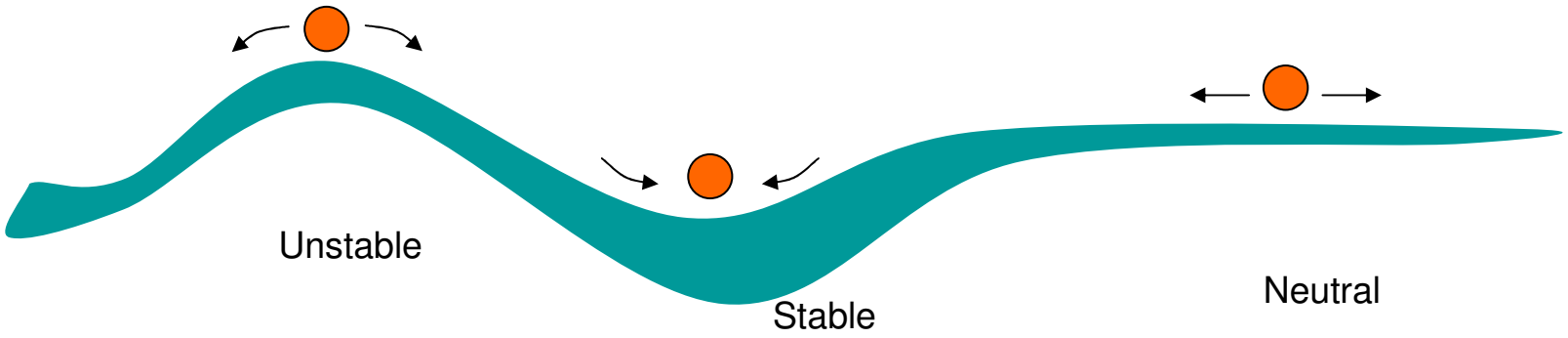
- **o-Stability** (stability of a systems “organisation”)
  If a disturbance can have an intensity which would cause an irreversible loss of operability, the range can be defined as the domain of organisation with regard to the particular disturbance. Once a disturbance has exceeded the range of o-stability, a re-organisation from within the system would not be possible.

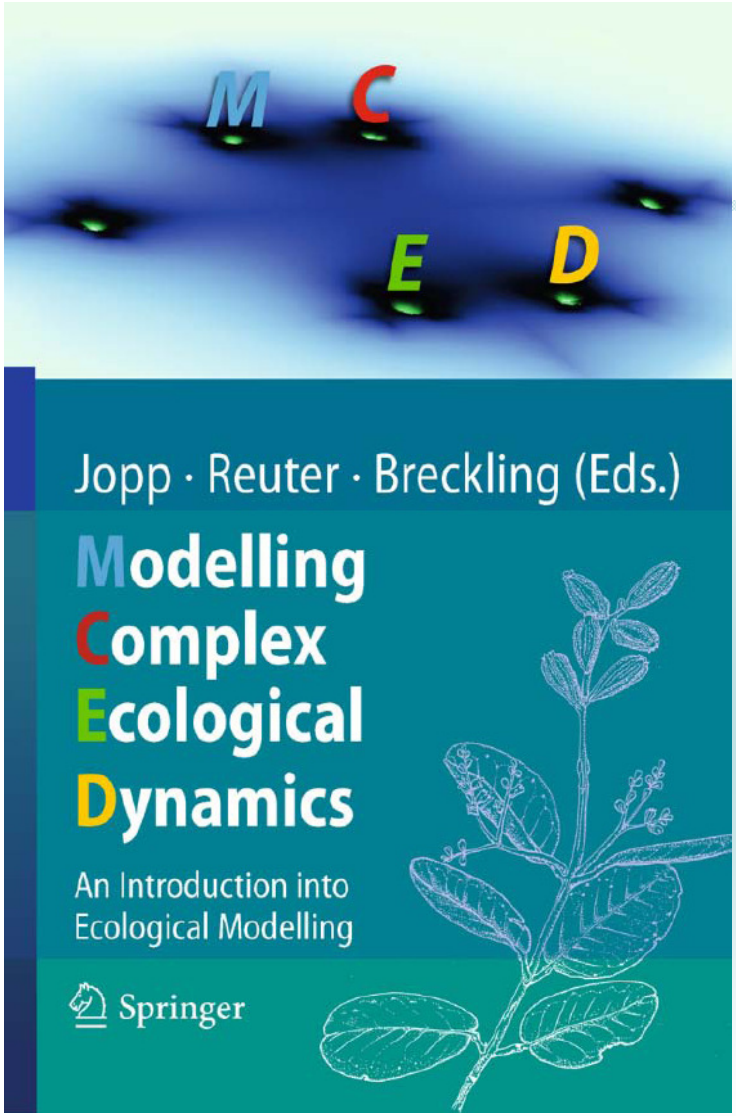




Stability

- Nature is diverse and dynamic. Stability properties are not an absolute property of nature but depend on the temporal and spatial view, on our understanding of considered components
  – and thus on the models we derive.





That was it
for now,

have a nice day

…