



## **Identifying typical patterns of vulnerability: A 5-step approach based on cluster analysis**

Diana Sietz (1), Matthias Lüdeke (2), Marcel Kok (3), Paul Lucas (3), Walther Carsten (2), and Peter Janssen (3)  
(1) Wageningen University and Research Centre, The Netherlands, (2) Potsdam Institute for Climate Impact Research, Germany, (3) Netherland's Environmental Assessment Agency, The Netherlands

Specific processes that shape the vulnerability of socio-ecological systems to climate, market and other stresses derive from diverse background conditions. Within the multitude of vulnerability-creating mechanisms, distinct processes recur in various regions inspiring research on typical patterns of vulnerability. The vulnerability patterns display typical combinations of the natural and socio-economic properties that shape a systems' vulnerability to particular stresses. Based on the identification of a limited number of vulnerability patterns, pattern analysis provides an efficient approach to improving our understanding of vulnerability and decision-making for vulnerability reduction. However, current pattern analyses often miss explicit descriptions of their methods and pay insufficient attention to the validity of their groupings. Therefore, the question arises as to how do we identify typical vulnerability patterns in order to enhance our understanding of a systems' vulnerability to stresses? A cluster-based pattern recognition applied at global and local levels is scrutinised with a focus on an applicable methodology and practicable insights. Taking the example of drylands, this presentation demonstrates the conditions necessary to identify typical vulnerability patterns. They are summarised in five methodological steps comprising the elicitation of relevant cause-effect hypotheses and the quantitative indication of mechanisms as well as an evaluation of robustness, a validation and a ranking of the identified patterns. Reflecting scale-dependent opportunities, a global study is able to support decision-making with insights into the up-scaling of interventions when available funds are limited. In contrast, local investigations encourage an outcome-based validation. This constitutes a crucial step in establishing the credibility of the patterns and hence their suitability for informing extension services and individual decisions. In this respect, working at the local level provides a clear advantage since, to a large extent, limitations in globally available observational data constrain such a validation on the global scale. Overall, the five steps are outlined in detail in order to facilitate and motivate the application of pattern recognition in other research studies concerned with vulnerability analysis, including future applications to different vulnerability frameworks. Such applications could promote the refinement of mechanisms in specific contexts and advance methodological adjustments. This would further increase the value of identifying typical patterns in the properties of socio-ecological systems for an improved understanding and management of the relation between these systems and particular stresses.