Global Environmental Change 48 (2018) 136–150

Contents lists available at ScienceDirect

Global Environmental Change

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

Misfit between physical affectedness and regulatory embeddedness: The case of drinking water supply along the Rhine River

Karin Ingold[a,b,c,*], Andreas Moser[d], Florence Metz[a,c], Laura Herzog[a,f], Hans-Peter Bader[e], Ruth Scheidegger[e], Christian Stamm[d]

[a] Institute of Political Science Research, University of Bern, Switzerland
[b] Environmental Social Science Department, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland
[c] Oeschger Centre for Climate Change Research, University of Bern, Switzerland
[d] Environmental Chemistry, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland
[e] Systems Analysis, Integrated Assessment and Modelling, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland
[f] Luxembourg Institute of Socio-Economic Research (LISER), Luxembourg

ARTICLE INFO

Keywords:
Micropollutants
Social-ecological misfit
Drinking water
Mass flow analysis
Social network analysis
Policy studies

ABSTRACT

One open question in environmental sciences is whether effective management of natural resources depends on the fit between the bio-physical and the governance system. To address this question, we investigate water quality in transboundary rivers and ask to what extent a fit between the area covered by the physical extent of pollution and the area in which this pollution is addressed through management and policy regulation can be observed. We adopt a spatial approach and argue that the visualization of social-ecological overlap and misfit supports science and practice when taking decisions about how best to explain or address ineffectiveness and cause-effect mismatches in transboundary river management.

We focus on drinking water supply in the international river basin of the Rhine focusing on micropollutants. These persistent trace compounds have potential toxic effects on humans and ecosystems, which makes them a relevant type of pollution that needs to be taken into consideration. Based on a combination of mass flow and social network analysis, we can conclude that the Rhine River is characterized by large social-ecological overlap, but that some parts of the catchment area still lack integration.

1. Introduction

This paper takes up the idea that effective environmental management depends on the degree to which a governance system fits, i.e. aligns with the characteristics of the biophysical system (Young, 2002; see also Folke et al., 2007; Treml et al., 2015; Sayles and Baggio, 2017). Applying this idea to quality issues in surface waters, we ask whether there exists a misfit between the area covered by the physical extent of pollution and the area in which this pollution is addressed through management and policy regulation. We argue that fit between those two areas is particularly challenged in transboundary settings where pollutants originate, occur and spread in certain areas of water bodies that may transgress political borders. In such a situation it is possible that polluters, water users and other actors affected by pollution are not part of the same country and jurisdictions, and thus exposed to different or lacking water quality policies and regulations.

One persistent and therefore potentially transboundary water quality issue is micropollutants in water bodies. As this water quality problem is very complex it gives rise to lacking or uncoordinated policies and regulations. Micropollutants remain largely unregulated, but are of emerging political concern due to their potential negative impacts on the environment (Brodin et al., 2013; Kidd et al., 2007; Petrie et al., 2015) and their potential implications for human health (Cunningham et al., 2009, 2010). These chemicals challenge existing management and regulatory structures, because they differ from previous pollution problems: there are thousands of different compounds with different environmental effects, a multitude of possible anthropogenic sources (pharmaceuticals and personal care products from households, plant protection products from agriculture, biocides for material production on buildings, etc.), and a variety of entry points into water bodies (Kolpin et al., 2002; Schwarzenbach et al., 2006; Ternes, 1998). Their effects are generally not acute, often only poorly understood and may result from the interplay of the chemical mixtures (Backhaus and Faust, 2012; Stamm et al., 2016). The issue of micropollutants illustrates the complexity of environmental problems stemming from the interrelations between the social-economic and environmental spheres.

* Corresponding author at: Institute of Political Science, University of Bern, Fabrikstrasse 8, CH-3012 Bern, Switzerland.
E-mail address: karin.ingold@ipw.unibe.ch (K. Ingold).

https://doi.org/10.1016/j.gloenvcha.2017.11.006
Received 28 October 2016; Received in revised form 27 October 2017; Accepted 12 November 2017

Drinking water supply is particularly sensitive to emerging issues of water quality, because of their immediate impact on human health (WHO, 2011). Where drinking water provision depends on surface waters (e.g. bank filtration) the impact of micropollutants becomes a crucial issue and up- and down-stream interdependencies between states reveal the political and transboundary implications of safe drinking water supply. This is why we focus on drinking water supply affected by micropollutants within the transboundary and international catchment area of the Rhine River. In this setting we define that a misfit is occurring whenever drinking water supply in the Rhine is affected by micropollutants, but suppliers can or do not reach out to the actors causing the pollution, neither through direct contact nor indirectly through responsible authorities. We go one step further, visualizing the area of pollution on one side and the area covered by management and regulation strategies addressing micropollutants on the other. If the two areas do not overlap a clear social-ecological misfit is identified.

We argue that only an interdisciplinary approach, including natural sciences (to identify the physical extent of pollution) and political science (to assess the governance system), is able to grasp the potential (mis)fit between physical and political realm. In order to carry out such interdisciplinary research we combine mass flow and policy analysis. In a first step, we focus on the sources of emissions of the selected compounds and the extent to which pollution spreads in a watershed. We concentrate on four selected compounds with different spatial use patterns (two herbicides and two pharmaceuticals) and investigate their sources and spatial distribution impacting upon drinking water. Moreover, we assess the impact of the selected pollutants on two of the most important drinking water suppliers along the Rhine River, i.e. the cities of Basel and Düsseldorf. Together they supply about 820,000 people. Both are heavily affected by water pollution from locations upstream.

In a second step, we address the political challenges associated with water pollution and water protection policy. We do so by assessing the regulation and the management networks: the fist producing potential policy solutions the second management strategies to tackle the issue of micropollutants. To capture both networks, we study a variety of public and private, international and regional actors involved in water quality issues. A special focus on water suppliers will allow us to evaluate their ability to react to pollution challenges through direct and indirect ties that they maintain in the management and regulation networks of water quality in the Rhine. Finally, and through GIS visualization, we identify potential overlaps and misfits between the areas of the physical extent of pollution and the areas where this pollution is addressed by management and policy regulation. We conclude this paper with a discussion of the interdisciplinary and analytical steps presented and outline some recommendations for future research as well as for practice concerning water quality management in general and potential consequences of social-ecological misfit in particular.

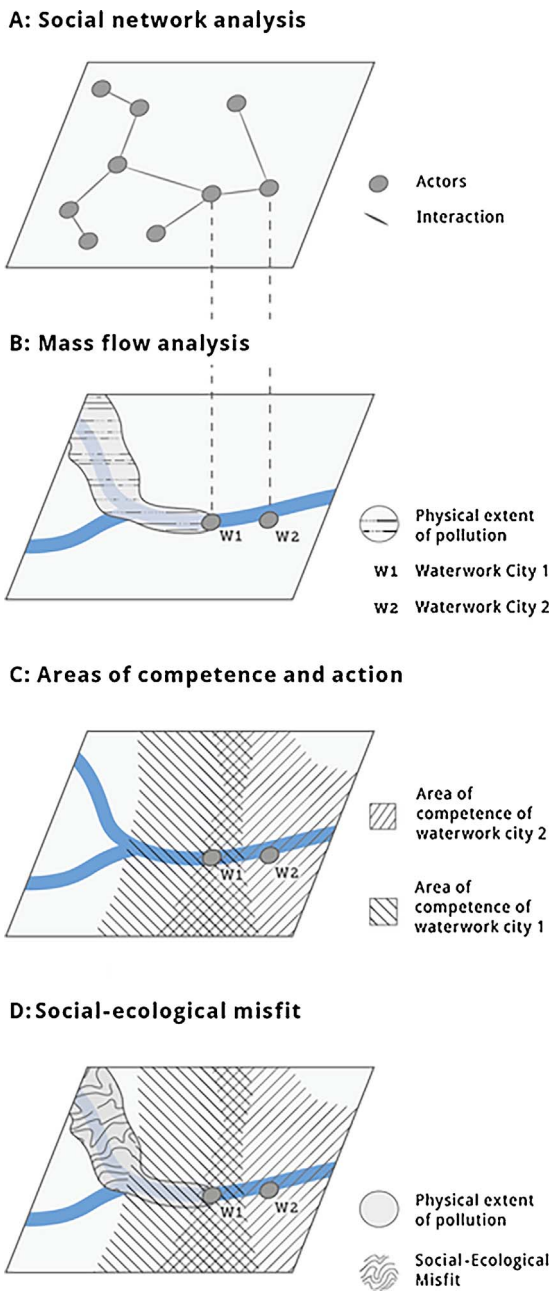

Fig. 1. Steps leading to the identification of social-ecological misfit.

2. Concepts, theories and research design

One major challenge when dealing with natural resources and environmental issues is to adapt the spatial scale of governance (including access and use of natural resources, policy design or regulation) to the physical extent of the specific environmental problem. If these areas do not match well, one can talk about social-ecological misfit due to the different challenges arising from the interdependencies between ecological and governance systems (Galaz et al., 2008). As Treml et al. (2015: 263) state, effective natural resource management depends, to some extent at least, on how the characteristics of the governance system align with the characteristics of the ecosystem it is trying to govern (see Bodin et al., 2014; Sayles and Baggio, 2017).

2.1. Social-ecological misfit: definitions

From a purely environmental perspective the appropriate scale of governance (including management or regulation units) can be defined by the spatial boundaries within which physical, chemical or biological processes, different uses and (management) actions have an effect on the resource of interest. The physical extent is here defined as the area affected by the source of pollution, covering the entry point of substances into the stream, up to its downstream occurrence in the river network (see part B in Fig. 1).

Actual political or legal units rarely match this physical extent of the pollution. We argue that this is also true for transboundary water pollution in general, and for the case of micropollutants in particular. Here, different jurisdictions (or areas of competences, see part C in Fig. 1) within the same hydrological catchment area tend to produce diverse policy solutions and implement divergent instruments to tackle identical problems.

Finally, where the physical extent of pollution does not overlap with the areas of competence of actors involved in water supply management or policy regulation, a so-called social-ecological misfit can be