



## Integrated governance for the food–energy–water nexus – The scope of action for institutional change



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### ABSTRACT

Despite a major, policy-driven increase in research on the food–energy–water (FEW) nexus in recent years, research addressing the required changes in policy structures and processes for an effective, integrated governance of FEW nexus resources is still in its infancy. This paper adapts the Institutional Analysis and Development Framework to the requirements and challenges of FEW nexus governance and sets a special focus on action situations, actors, and institutions. The analysis thus contributes to the debate about the practicality and benefits of a comprehensive FEW nexus policy approach. Two different conceptual FEW nexus frameworks are developed, which span the spectrum of possible integration options. The first one describes a holistic integration framework that defines the FEW nexus as a single, fully integrated system. The second one represents vertical policy integration and is largely based on existing structures and a reframing of the present institutional setting. After their theoretical derivation, the two hypothetical frameworks are analyzed with respect to their strengths and weaknesses in governing the FEW nexus using two sample cases of integrated FEW nexus governance in Germany. The results show that effective FEW nexus governance requires a combination of both integration options.

### 1. Introduction

Factors such as population growth, urbanization, and the impacts of climate change put major pressures on our planet's natural resources, especially on water, food, and energy resources [1]. Nevertheless, poor access to these resources is often a governance problem rather than a problem of availability [2–4] caused, for example, by corruption, over-regulation, or sectoral fragmentation [5,6]. The adoption of the United Nations (UN) Sustainable Development Goals (SDGs) or the key concept of the green economy are the result of ongoing debate in science and politics with respect to dealing with global changes and addressing resource scarcities within planetary boundaries. The emergence of the food–energy–water (FEW) nexus can also be seen as an outcome of this debate [7–10]. Its main goal is to reveal the connections between the three resources and to manage them in an integrated manner. Hence, the FEW nexus does not focus on the sectors themselves but rather their interlinkages in order to create or benefit from synergies and to avoid trade-offs [11–16]. Accordingly, the nexus approach aims at providing a more coordinated and structured way of integrating food, energy, and water concerns [14,17–19]. In recent years there has been a major, policy-driven increase in research on the nexus concept [10,18,20,21].

It appears within a broad range of different conceptualizations, especially in the respective sectors. Whereas many articles refer to inter-connections between two of these sectors, for example the water–energy nexus [22–24], others include an economic dimension [25–27]. The concept often remains water-centered given its origin in the water sector as a redevelopment of existing integrative approaches, such as Integrated Water Resources Management (IWRM).

Different sector combinations aside, in terms of specific research objectives, most nexus literature has to date focused either on physical and technical interconnections or specific case studies that rarely consider policy concepts [7–9,18]. Little research has sufficiently addressed the changes in policy structures and processes required for effective, integrated governance of the nexus resources [7,10,28–30]. However, a nexus governance concept seems indispensable given that the water, energy, and food sectors are mostly governed and managed separately in “silos” [7,10,14,20,29,31–33]. This often leads to trade-offs and isolated policies, neglecting the overall goal of sustainability [34]. To successfully achieve complementary and coordinated FEW nexus governance, adaptive solutions and a sound understanding of practical implications are necessary [11,35]. So far, suitable institutional arrangements have not been developed [7,14,36]. As Al-Saidi and Elagib

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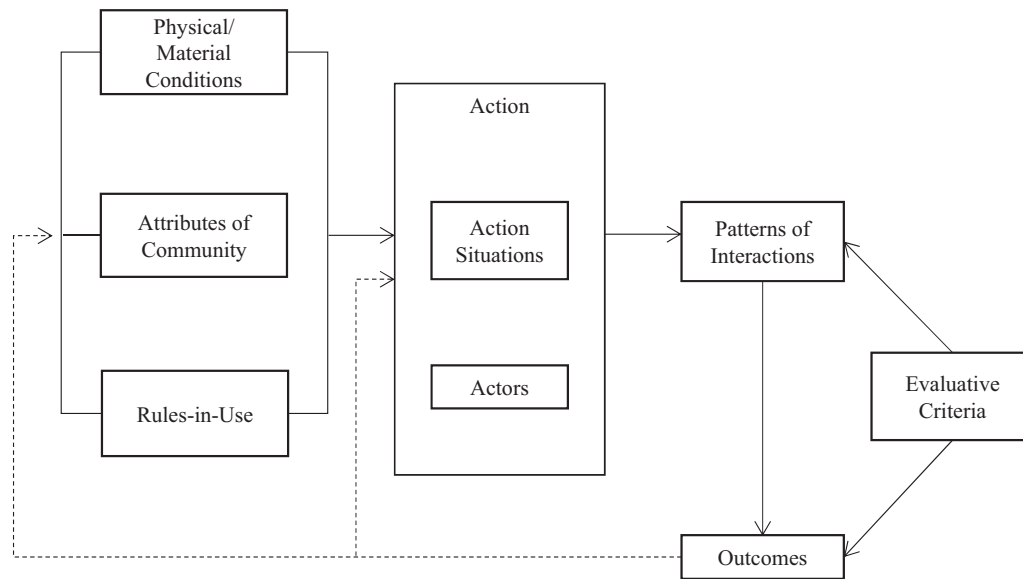


Fig. 1. IAD framework.

Source: Adapted by authors based on Ostrom [45].

[7] point out: “Nexus governance is the missing link in the nexus debate.”

Addressing this gap, the scope of action for institutional change is outlined in this paper by exploring different pathways for achieving an integrated FEW nexus governance framework and possible design options. The Institutional Analysis and Development (IAD) framework provides the methodical basis for doing so. In order to focus on the necessary institutional change processes within the scope of resource governance, we refer to the IAD framework as it is incorporated in the Management and Transition Framework (MTF), where it is combined with the concept of social learning. This concept is used to develop two different FEW nexus frameworks, which span the spectrum of possible integration options. The paper further contributes to ongoing discussions on how to achieve comprehensive FEW nexus policy integration by analyzing these two frameworks with respect to their strengths and weaknesses in governing the FEW nexus using two sample cases of integrated FEW nexus governance in Germany: the German Sustainable Development Strategy 2016 and Section 90 of the Renewable Energy Sources Act.

The rest of this paper is structured as follows: At first the conceptual framework is introduced (Section 2). In Section 3, the MTF-based IAD framework is applied and major problems concerning policy integration and institutional change are identified. Two different FEW nexus frameworks are then developed in Section 4. These two frameworks are tested using two examples of policy integration among the FEW nexus sectors in Germany (Section 5). In the subsequent discussion (Section 6), the two frameworks are compared and analyzed with respect to their implications and practicability.

## 2. Conceptual framework

### 2.1. The MTF-based IAD framework

The idea behind the nexus approach is not new [7,18,33,37,38]: some of the interlinkages between the three systems have a long history and are well understood. Examples include the water requirements of cooling systems in energy plants or water pollution by fertilizers used in agriculture. What is new about the nexus is its comprehensive perspective on interconnections between all three resources in a fully integrated understanding of the system [7,10,12,39]. This poses new challenges for governance structures and processes, since policies are

usually developed around sectoral fields. An integrated FEW nexus governance framework thus needs to address changes in the prevailing institutional setting. Therefore, a framework focusing on institutional analysis within socio-ecological systems (SES) is required. In this paper, the IAD framework, as it is incorporated in the MTF, serves as the foundation. The MTF was developed to analyze complex resource governance systems – namely water systems – and trace their emergence [40,41]. An important asset is therefore its ability to draw on the development of water systems over time and to delineate how systems change. The MTF uses a trajectory approach and provides an assessment of the current state of the water system against the backdrop of its historical development [2,40,42].

When discussing the FEW nexus and its major challenge of sectoral “silo-thinking”, the problem of sectoral policy integration arises first and foremost. In order to address this issue, a particular focus is set on the role of the IAD framework within the MTF. Originally, the IAD framework was developed by Elinor Ostrom et al. to analyze collective choice processes and social interactions within SES. Nevertheless, it can be used for analyzing any kind of social interaction, for example within firms and families as well as communities and political systems [43]. The MTF, however, provides a framework specifically tailored to institutional change within complex resource governance systems. Within the MTF, the IAD framework was combined with the two approaches of adaptive management and social learning. Whereas adaptive management and social learning processes highlight the role of institutional change [2], the IAD framework was included to stress and account for the role of actors, actor networks, and institutions [42,44].

The IAD framework broadly categorizes SES into three parts (Fig. 1). The first part (on the left, Fig. 1) frames the context of action and consists of the three elements of physical/material conditions, attributes of community, and rules-in-use. The second part (middle) contains the action situations and their actors. The third part (on the right) describes patterns of interactions and outcomes as well as the evaluative criteria used to assess them.

The element of an action situation describes the focal point of the IAD framework. Action situations are thereby defined to describe “the social spaces where individuals interact, exchange goods and services, solve problems, dominate one another, or fight [...]” [44]. Based on this definition, the choice and determination of action situations for the FEW nexus, and their appropriate level of aggregation are highly case-specific [40]. Actors of an action situation can be individuals or actor

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