Environmental Innovation and Societal Transitions 20 (2016) 75–85

Contents lists available at ScienceDirect

Environmental Innovation and Societal Transitions

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

Not only peasants' issue: Stakeholders' perceptions of failures inhibiting system innovation in nutrient economy

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ARTICLE INFO

Article history:
Received 5 February 2015
Received in revised form 4 November 2015
Accepted 5 November 2015
Available online 28 November 2015

Keywords:
Wicked problems
System innovation
Failure framework
Nutrient economy
Circular economy

ABSTRACT

System innovation is often postulated as being able to solve "wicked problems." However, it is unclear whether system innovation truly fits into the prevailing innovation system. When the Finnish government committed Finland to becoming a role model for nutrient recycling in 2010, it underscored the need for systemic change in the food system. As opposed to the existing linear and open-ended food system, a circular nutrient economy would require both structural and functional changes in both production and consumption, by means of technological, institutional, and social changes across numerous sectors simultaneously. We collected stakeholders' perceptions of the barriers to the transition towards a more sustainable nutrient economy. The results were mapped into a failure framework that indicated that the policy-governance interface lacks directionality and coordination, while the enterprise-market interface creates inadequate demand articulation. Furthermore, the resilience of deep-rooted structures was found to be critical and deserves more attention.

1. Introduction

In addition to advancing new technologies and practices, innovation unfortunately also plays a significant role in introducing distortion into the earth system, which has been shown in the well-known study of planetary boundaries (Rockström et al., 2009). The values driving innovation likely differ from those of globally accepted development targets, such as sustainability development (Westley et al., 2011). Innovation systems do not necessarily lead to sustainability transitions because of the ingenuity gap between the demand for appropriate solutions and the supply. The reasons for this are two-fold: (1) the current nature of technological innovation is intrinsically inimical to sustainable development, and (2) there is a lag between an emerging crisis and the availability of a technological response (Westley et al., 2011). The determination of dynamic planetary boundaries has led to consideration of the direction of change due to innovations and other stimulus (Leach et al., 2012). Consequently, there is a requirement for the direction of innovation to be actively and deliberately steered away from unsustainable trajectories, leading to more explicit interest in the normative direction (Smith et al., 2010). System innovations have been offered to solve "wicked problems" related to unsustainability (Smith et al., 2010). They involve major changes in the entire production and consumption systems, in the material flows and institutional structures of these and, in particular, in actors' behavior (Weber and Hemmelskamp, 2005; Smith et al., 2010). In system innovation, the direction

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http://dx.doi.org/10.1016/j.eist.2015.11.001
2210-4224/

of innovation is explicitly addressed in the form of a long-term vision that is iterative and reflexive over time (Kemp and Rotmans, 2004). A shared vision is important in system transitions, as it is endorsed by the key actors having the potential to provide a basis for overcoming problems for which there are no set rules and institutions (Quist and Vergragt, 2006).

One of such wicked problems is caused by food system, which is responsible for transgression of planetary boundaries of nitrogen and phosphorus with 74% and 80% share respectively (Kahiluoto et al., 2014). In Finland the unsustainability of agri-food systems has been particularly imminent, since Finland possesses an extensive coastline on the Baltic Sea which is notoriously one of the most polluted seas in the world. Pollution has affected the fish stocks, biodiversity, and recreational conditions for the vast number of Finns owning summer cottages on the coast. Concerns about Baltic Sea pollution arose already in the 1960s, and the first transnational environmental protection commitment, Convention on the Protection of the Marine Environment of the Baltic Sea Area, was enacted in 1974 (Hakala and Välimäki, 2003). However, 40 years later, the sea ecosystem has not notably recovered (Finnish Environmental Institute, 2012), despite the trend of decreasing fertilizing rates in agriculture (MTT Agrifood Research Finland, 2010, 2009). In 2010, the Finnish Council of State committed to transforming Finland into a benchmark country for nutrient recycling, yet thus far, overall governance of nutrient management has been weak (National Audit Office, 2008).

The national commitment made at the Baltic Sea Action Summit in 2010 cannot be met without systemic shifts at various levels, especially at the interface of agriculture and waste treatment regimes. Nutrient pollution has been addressed in the agri-environmental policy since the 1990s, becoming more central (after Finland joined the EU) through the agri-environmental subsidy scheme. This subsidy scheme is implemented extensively, as over 98% of agricultural land is subject to it, in comparison to the European average of 24%, making it an influential "steering tool" (Laukkanen and Nauges, 2012). Its origin dates back to the negotiations for joining the EU, resulting in a compromise between the two interest groups, environmental and agricultural ones (Aakkula et al., 2006). Now over several program periods, cooperation has become standardized, and both groups have demarcated their territories of agency (Kaljonen, 2010). In addition, dynamics of the demand side, i.e., consumption, should not be neglected, because despite agriculture being the biggest polluter (National Audit Office, 2008; Antikainen, 2007), it has little power in the overall food supply chain (Kotilainen et al., 2010). Dietary choices and consumer awareness have an impact by putting selective pressure downstream the food chain (Smith et al., 2005), and by creating market pull for eco-innovation (Rennings, 2000). The Finnish nutrient economy presents an interesting context concerning not only environmental governance, but also awareness raising of global food security issues in which the nutrient economy is instrumental (Kahiluoto et al., 2014). Recently, interest in a circular nutrient economy has been raised more explicitly at the EU level, too. Phosphorus was added to the EU's critical materials' list, and sustainable nitrogen and phosphorus management throughout the food system was central in the Commission's Circular Economy Package (IEEP, 2014), which is under revision at the time of the writing of this paper.

The paper is concerned with gaining understanding of what hampers transition to circular nutrient economy in Finland, particularly from the stakeholders' perspective. The interest lies not necessarily at the problem of unsustainability per se, but rather at the barriers perceived by stakeholders that resist and hinder achieving systemic change. Furthermore, a theoretical framework is applied to analyze whether these barriers arise due to underlying failures inhibiting system innovation in Finland. As the issue concerns various actors, a broad range of stakeholders is approached by a survey. The paper is organized as follows: Section 2 outlines our theoretical framework, Section 3 discusses the research methodology, Section 4 presents the results of the research, Section 5 discusses implications and author reflections; finally, Section 6 draws some conclusions.

2. Theoretical framework–failures of system innovations

2.1. Conceptual starting point–the nutrient economy

The existing literature lacks a detailed definition of the term "nutrient economy" as used in this study. Currently nutrient economy can be considered linear and open-ended, relying on heavy input-use and inducing pollution, in contrast to which, 'circular' nutrient economy aims at closing the material loops as much as possible by increasing cascading loops and by internalizing the stocks and flows of inputs and outputs into the system. As such, circular nutrient economy can be perceived as a particular case and an essential foundation in the more broader 'circular economy' concept (Ellen MacArthur Foundation, 2013). Herein, the term "nutrients" refers explicitly to the two main macronutrients: nitrogen and phosphorus. They are necessary for the production of food, but their excess discharge generates eutrophication in the surrounding water bodies, and nitrogen emissions contribute to climate change. Furthermore, the production of mineral fertilizers is reliant on finite resources, such as phosphate rock and fossil fuel-based energy (Dawson and Hilton, 2011). In contrast to "nutrient management," which is often used exclusively in agriculture and water sanitation contexts, the nutrient economy involves the entire value chain of nutrients, from their biophysical form to fertilizers, to plants and animals, to food consumed, and finally to the waste and excreta disposed by humans and then treated in sanitation plants. In addition, the term "economy" as used herein refers to all the instrumental elements (e.g., policy and market institutions) that govern nutrient flows between the different parts of the value chain. In other words, for the purposes of this paper, the nutrient economy is a system of connected activities between which nitrogen and phosphorus flow to support food production and consumption.