Plastic Packaging, Food Supply, and Everyday Life

Adopting a Social Practice Perspective in Social-Ecological Research

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Abstract: This article presents practice-theoretical conceptions of societal relations to nature as a fruitful alternative to common system approaches in social-ecological research. Via the example of plastic food packaging, two different practice-theoretical approaches to food supply are discussed regarding their suitability for relating the material properties of packaging to their everyday use by producers, retailers, and consumers: (1) the network approach (portraying food supply as a network of practices; these practices include material elements that interrelate with other elements like competence or meaning) and (2) the nexus approach (investigating the interrelation between social practices and material arrangements in which they take place). Depending on the given research interest, both perspectives have their pros and cons: the network approach is stronger in understanding the everyday use of technologies, while the nexus approach encourages the integration of infrastructures and environmental contexts that are not directly observable within the practice.

Keywords: everyday life, materiality, practice theory, provisioning systems, social ecology

Studying Plastic Packaging in Food Supply as an Everyday Life Sustainability Problem

The global plastic waste problem, arising from the increasing use of single-use plastic items, is prominently visible in accumulations of marine litter in oceans, rivers, and beaches around the globe. Its importance as one of today's central sustainability issues is reflected in the growing interest in it shown by science, media, economics, and politics (Kramm and Völker 2017). However, measures so far remain mostly incremental, while the amount of global plastic waste is still growing (Geyer et al. 2017). One reason for the difficulty in dealing

with these problems effectively is the strong connection of rising waste levels and transformative dynamics of everyday life practices. Plastic food packaging as a major source of plastic waste is deeply connected to our modern lifestyles and consumption patterns, as, for example, food to go or convenience food. Its use and disposal are essential parts of contemporary food supply, reflected in the everyday practices in economic markets and private households. Summing up, ecological problems related to plastic packaging and waste are deeply connected to the everyday use of plastic items by consumers and professionals in the food system. Hence, these problems cannot be solved solely technically by improved waste management or recycling technologies, as potential transformations must be linked to wider practices of food supply.

From such a perspective, the use of plastic packaging must be studied in connection to the way in which societies organize their provision of food, and particularly to the way in which food is cultivated, processed, distributed, and consumed. What people eat and the ordinary ways in which they do so are essentially important for the need of plastic packaging in food supply. Accordingly, fundamental transformations in the supply system to reduce plastic consumption are not possible without targeting such practices. Social-ecological innovations must therefore be suitable for everyday use and prove to be successful in day-to-day practices (Stieß and Hayn 2006: 211). Considering its embeddedness in social life, as well as in ecological processes, waste from plastic packaging is a social-ecological issue that affords inter- and transdisciplinary cooperation. The concept of societal relations to nature (SRN) provides a useful framework for studying such issues, as it explores the interrelations of ecological and societal processes. SRN has been broadly discussed in social ecology (Becker and Jahn 2006; Becker et al. 2011; Görg 2003, 2011), but is mostly applied to research on a macro or systems level (Hummel et al. 2017; Liehr et al. 2017; Mehring et al. 2017), while application to concrete practices remains scarce.

In this article, we will use the case of plastic packaging in food supply practices to show how practice theory can help to better understand everyday dimensions in the regulation of SRN.¹ Importantly, we do not seek to merge social ecology and practice theory theoretically, as they have heterogeneous ontologies and different theoretical and disciplinary affiliations. Rather, we combine their perspectives to investigate specific sustainability problems. Ecological problems of plastic waste are closely connected to the material characteristics and qualities of plastic items. Littering, recycling rates, and toxicological impacts (Zimmermann et al. 2019) are very heterogeneous for different types

of plastic packaging. How everyday practices interfere with different material circumstances is thus a crucial concern of our research. In this article, we will discuss two different ways of conceiving the materiality of social practices, which can help to reveal different scopes of plastic packaging in food supply. Our rather pragmatic use of theoretical approaches (and empirical methods) reflects the transdisciplinary claim of dealing with concrete “real-world” problems, which is characteristic for social ecology (Hummel et al. 2017). This is also fitting for a practice-theoretical strand (e.g., Nicolini 2012; Shove et al. 2012) that emphasizes the practical, empirical, and policy-oriented application of practice theory (Schmidt 2016). So, instead of contrasting their ontologies, we discuss how the concepts of SRN and social practices can be combined as tools in a theoretical toolkit for examining social-ecological problems like plastic pollution.

The remainder of the article is structured as follows: first, we provide a brief sketch of social ecology by introducing the concept of SRN. We then present social-ecological provisioning systems as a prominent perspective in the empirical investigation of SRN (systems approach). This is followed by an introduction to practice theories and their conceptualizations of materiality regarding social practices. Based on this, we present two possible approaches (network approach and nexus approach) for studying the regulation of SRN from a practice-theoretical perspective. In the final discussion, we summarize the possibilities and limitations of the discussed approaches for empirical studies in social ecology. Throughout the article, we will use practical examples from our research on plastic packaging in food supply to support conceptual considerations.

Social Ecology and the Concept of Societal Relations to Nature

Contemporary approaches in social and human ecology have a long and multifaceted genealogy dating back to the Chicago School in the 1920s, founded mainly by the works of Robert E. Park, Ernest W. Burgess, Roderick D. McKenzie, and Louis Wirth (for an overview, see Fischer-Kowalski and Weisz 2016). Despite heterogeneous theoretical and conceptual affiliations, these approaches share a concern with the interaction of social aggregates and their material, technical, or natural environment (Lejano and Stokols 2013). In the face of a new type of social-ecological problems like climate change, the depletion of

the ozone layer, and land degradation, the concept of SRN has been developed as a framework for studying the complex relations between nature and society in their historical development (Becker and Jahn 2006; Görg 2003, 2011). The SRN concept was further refined in different schools of thought in Austria and Germany, sharing a common research focus but applying heterogeneous theoretical and conceptual assumptions (for a comparison, see Kramm et al. 2017).

In this article, we mainly refer to SRN as they are conceptualized in the research program at the Institute of Social-Ecological Research in Frankfurt. SRN are defined as evolving relations between nature and society. Thus, the research focus is a strictly relational one. It attempts to overcome the duality of nature and society—a duality that became manifested in the great divide between the natural and social sciences. A limited perspective where SRN are either studied in terms of the natural or the social sciences alone will result in either naturalistic or culturalist approaches, which fail to properly understand the complex interrelations between nature and society (Becker et al. 2011). It is important to note that SRN are not thought of as relations between abstract spheres of nature and society, but are manifested in real-world phenomena that can be related to empirical observations (Hummel et al. 2017). These phenomena refer to the historically specific regulation of SRN, emerging around the individual and collective organization of how basic needs like nutrition or shelter are satisfied. These needs are, on the one hand, physiologically predetermined but, on the other hand, formed by culturally specific symbolic systems, cognitive models, power structures, and property relations (Hummel et al. 2008: 42). Regulations can be studied as culturally and historically specific patterns that transform over space and time. Such patterns can be referred to as “patterns of regulation” (*ibid.*). They encompass practices and mechanisms connecting social and natural elements, structures, and processes. The temporal and spatial changes of these patterns of regulation may be described as social-ecological transformations (Becker et al. 2011). Societies have to regulate their relations to nature in order to sustain social life. If regulations become unsustainable, for example, due to an overexploitation of resources, and a society is unsuccessful in changing its patterns of regulation, living conditions will deteriorate, or the society will even collapse.

Patterns of regulation always have material and symbolic attributes. In the most general of terms, the material side accounts for the flows of matter and energy, while the symbolic side refers to information and meanings (Hummel et al. 2017: 16). Therefore, patterns of regulation

are subject to causal material effects and to symbolic processes like information flow or the construction of meaning. They are embedded in a larger societal context. Studying patterns of regulation in a specific problem context affords the integration of different forms of knowledge from different sources. Including not only knowledge from different scientific disciplines, but also from experts and laypersons, transdisciplinary methods have been established to enhance the knowledge base of social-ecological research. Transdisciplinarity as we understand it here is defined as “a critical and self-reflexive research approach that relates societal and scientific problems; it produces new knowledge by integrating different scientific and extra scientific insights; its aim is to contribute to both societal and scientific progress” (Jahn et al. 2012: 8–9). As transdisciplinarity is problem-oriented research, it uses concepts and methods always in relation to “real-world problems” (Klein et al. 2001) and their affordances. As a consequence, different research problems need different emphases in their empirical approaches to SRN. In this article, we will show how different conceptions of the regulation of SRN can reveal different aspects of plastic packaging and its embeddedness in everyday practices of food supply.

Food Supply as a Social-Ecological Provisioning System (Systems Approach)

So far, the empirical investigation of SRN has been developed within a systems theory framework (Mehring et al. 2017). SRN are operationalized as provisioning systems (Figure 1; Hummel et al. 2017: 20–21; Janowicz 2008: 48ff.). Broadly speaking, “provisioning” refers to any benefit that a society draws from natural resources. Provisioning systems can be conceptualized as social-ecological systems, which align natural and social elements and processes (Liehr et al. 2017). On the resource side, a provisioning system encompasses natural elements, such as rivers, forests, grasslands, plants or animals, and the services they provide. On the user side, these elements and services are linked to social actors and processes associated with the management of ecosystems and the processing, distribution, consumption, and disposal of products obtained from ecosystem services (Hummel et al. 2017). Resource and user sides are not in direct relation, but mediated by four contextual factors: knowledge, practices,² institutions, and technology. These factors facilitate how humans manage ecosystems and how ecosystems provide societal services and disservices (Liehr et al.

Figure 1 ■ Systems approach: Food supply as a social-ecological provisioning system (Figure taken from Hummel et al. 2017: 21). Copyright by ISOE-Institute for Social-Ecological Research, Frankfurt/Main, Germany. Used by Permission.

2017). The model is designed so that it is scale-independent, which has the implication that an analysis is not limited to a specific spatial or temporal scale. A given research problem and a certain constellation of the transdisciplinary research process decides which components are regarded and in what depth. Provisioning systems can be conceptualized for different areas, such as food provision, energy, or water supply (Liehr et al. 2017; Mehring et al. 2017).

The Role of Plastic Packaging in the Mediation between Natural Resources and Cultural Diets

The food provisioning system captures the ways in which societies organize and regulate their nutrition. It connects natural objects (ecosystems, plants, animals) to the societal realms, through the utilization of resources and benefits drawn for ecosystems. Importantly, the societal realm—or “user side”—of the system includes both: the production, processing, and distribution of food, as well as the purchasing, preparing, and eating of food (Hummel et al. 2017: 20). Coming back to the problem of plastic waste and the interrelation of its ecological consequences and societal causes, the concept allows the consideration of very different processes and practices.

Conceptualizing plastic packaging as part of a food provisioning system shifts the focus from end-of-pipe solutions in waste management

to the functional integration of single-use plastic packaging in societal food supply. The approach enables observing the role of plastic in the way in which food supply is organized, aligning natural and social elements. In this view, the food provisioning system is seen as a mediator between the biological need to eat and its cultural constitution. Studying food provisioning systems in their local and historical peculiarity can help assess potentials and barriers for social-ecological transformation. Such a perspective reveals how the growing use of plastic packaging in the provision of food is related to developments in the mediating factors of knowledge (e.g., new knowledge on food hygiene), practice (e.g., food-to-go practices as a cultural trend), institutions (e.g., the power of the plastic industry and big supermarkets), and technology (e.g., processed food and cheap production of single-use plastic packaging). The systemic observation of these context factors enables a comprehensive picture of how the SRN of food supply are regulated in specific historical and cultural contexts.

Strengths and Weaknesses of the Systems Approach

The concept of the social-ecological provisioning system is a useful tool for structuring complex problem situations in social-ecological research. It is a common model to describe, analyze, and model SRN. Provisioning systems enable an integrated analysis of how ecosystem-based benefits support society under changing conditions. This approach has proven fruitful for the empirical analysis of interactions between natural processes and their societal regulation, for example, in the context of land use or integrated water. And it enables policy guidance for the combination of technological and social innovations in sustainable system transformations (Liehr et al. 2017). Research on food provisioning systems can help to reveal how packaging technology is connected to the dynamic relationship between natural processes (e.g., food decay) and the societal regulation of supply (e.g., the rise of supermarkets).

Nonetheless, there are some shortcomings or pitfalls in the current concept of provisioning systems. One central difficulty is to consider the unstructured variability and resistance of everyday life (Certeau 1984) in the regulation of SRN. By separating (individual and collective) actors from practices and knowledge, the provisioning system approach can hardly analyze how the activities and decisions of these actors related to the management and use of natural resources are structured by collective routines, expectations, and social norms. It also falls short when accounting for the intimate way in which natural objects and technical

artifacts enable, maintain, and constrain the organization and reproduction of everyday life. An example is the influence of coffee-to-go cups on the morning rhythms of people commuting to work by public transport. Theories of social practices provide an alternative framework for studying the dynamic interrelations between social actors, technologies, and their physical environment. In our opinion, practice-theoretical approaches and especially their way of treating the interrelation between materiality and social life can help to better grasp the concrete and ordinary activities that play an important role in the regulation of SRN.

Grasping Materiality in Everyday Life: A Social Practice Approach to Social-Ecological Problems

Practice theory is a fragmented body of theories that have historical and conceptual similarities; thus, there are different scholarly traditions for the so-called practice turn in social science (e.g., Gram-Hanssen 2010a: 176; Nicolini 2012: 1; Reckwitz 2002a: 243). Specifically for consumer studies, practice theory was (re)introduced in the 2000s by Elizabeth Shove, Mika Pantzar, and Alan Warde with the aim to understand more routine and ordinary consumption rather than conspicuous consumption (Shove 2003; Shove and Pantzar 2005; Warde 2005). This was based on practice theory as formulated by Theodore Schatzki (1996) and Andreas Reckwitz (2002a). Their practice theory approaches have a common ground in Anthony Giddens's (1984) structuration theory and the theory of practice by Pierre Bourdieu (1990) and their efforts to overcome the structure-agency dualism.

Given the plurality of practice theories, social practices can be understood as dynamic concepts that are interpreted in different ways. Nevertheless, one general understanding of practice is that a practice is "a routinized behavior in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood" (Reckwitz 2002a: 250). In contrast to many other social theories, practice theory includes materiality in its conceptualization of social life (Schatzki 2010). Their material awareness makes practice theory attractive for social-ecological thinking and studies on the regulation of SRN. In practice theory, the importance and relevance of including materiality or material structure, products, things, or technology (technical structure) has been discussed by various authors (e.g., Brand 2014; Gram-Hanssen 2010a, 2010b; Reckwitz 2002b; Rinkinen et al. 2015; Schatzki 2010; Shove 2003, 2017; Shove and Pantzar 2005; Watson and

Shove 2008; Wilhite 2008). The common ground of these attempts is to capture materiality, objects, and things always in relation to social practices. This relation can have different forms: Jenny Rinkinen and colleagues make a distinction between an active role of materiality as “useful, meaningful and actionable objects-as-tools, on the one hand, and of a more passive material milieu on the other” (2015: 880). They state that practices are tied to a materiality that is in the foreground as an active and constituting element of the practice, and another type of materiality that is rather in the background as an environment that is more a setting for practices than an active element within them. In contrast, Shove (2017: 155) distinguishes between three main roles that things play in practices: things can act as infrastructure that enables practices, they can be used as devices in practices, or they can figure as resources that are used up in practices. Regardless of these different roles, materiality is never fixed, objective, or neutral, but something that has to be studied, as it matters to practices. For Shove (2017: 165), this is the central distinction of practice-theoretical approaches in contrast to traditional concepts of resource economics or energy demand.

As part of the regulation of SRN, practices have to be thought of as related to the biophysical world and its dynamics. Practices rely on natural resources and can transform their material environment. For example, eating as an everyday activity is bound to land use and the consumption and transformation of biomass. Thus, everyday life practices are influenced by material circumstances and have the power to transform ecosystems.

In the following sections, we will present two possible pathways for how practice-theoretical concepts could contribute to the study of SRN and their regulation. We will use empirical examples from a study on the role of packaging in the food provisioning system. In these examples, we take food supply as a central reference for the organization of social practices and investigate plastic packaging as a central material device in these practices. A main difference between these two pathways is the way in which materiality matters in practices: materiality as an element of practices on the one side, and materiality as an arrangement that relates to practices on the other side (Shove 2017: 156). We will refer to these two conceptualizations as “network approach” and “nexus approach.” The network approach conceptualizes supply as a network of practices that share material elements, while the nexus approach centers on the interrelation between practices and material arrangements. Importantly, the differentiation between network approach and nexus approach does not represent distinct practice-theoretical

schools or paradigms, but an attempt to discuss different ways of including practice-theoretical perspectives into the social-ecological investigations of SRN. It is a pragmatic distinction based on the focus on things. These can be, on the one hand, part of networks of practices and, on the other hand, material arrangements, which derive from practices while simultaneously confining their conditions. Both perspectives emphasize different aspects of the relation between materiality and everyday life that can facilitate the understanding of unsustainable plastic packaging use in food supply.

Food Supply as Network of Practices (Network Approach)

One way to conceptualize materiality in practice theory is to define it as a constitutional element of practices (Bartiaux et al. 2014; Gram-Hanssen 2010b; Shove et al. 2012). As such, it stands in a nonhierarchical relation to other elements of practices.³ This idea of materiality as an element (or actor) that matters in practices is inspired by science and technology studies (STS). For Shove and colleagues (2012), the material dimension of practices entails objects, equipment, infrastructure, the built environment, natural resources, as well as the human body. These material elements are characterized by their physical presence in time and space; they form the “hardware” of practices (Röpke 2009: 2490). However, this rather broad definition of materiality as physical presence contrasts with a strong empirical focus on technology, infrastructures, and objects/things of (daily) use. Kirsten Gram-Hanssen (2010b) and Françoise Bartiaux and colleagues (2014) emphasize this more specific focus on materiality also in their definitions, as they use the term “technology” instead of “materiality” for defining the material side of practices. What all of them share is that technology—or rather, the use of technology—plays a major role in the understanding of social practices. However, even though these approaches are technology-centered, they do not share a technologist determinism (“engineering paradigm”), but are rather interpretative and relational (Schweber and Leiringer 2012). In their practical examples, the concept of materiality is introduced to better understand the use of technology (e.g., standby use of appliances, use of washing machines, heating in a building, building renovation, or driving a car). Of special interest is the interaction of human behavior with the functionality and appearance of these applications. In her work on the standby use of electronic appliances, Gram-Hanssen (2010b) provides insights into the interplay of norms, habits, and everyday

Figure 2 ■ Network approach: Food supply as a loose network of supply practices (Figure created by the authors, based on an illustration by Shove et al. 2012: 25).

routines of the household members on the one side, and the design, configuration, positioning, and steerage of the appliances on the other side. She shows how the material characteristics of the devices provide opportunities for changing consumer routines. In research on homeowners' energy retrofits (Bartiaux et al. 2014), materiality is captured via the age of the housing stock, type and technical standards of buildings, physical features of the house, its materials, and the available products on the market, all of which influence different renovation practices and their final outcome in terms of energy savings.

A conceptualization of packaging in food supply that treats materiality as an element of practices would focus on practices as a constituting element in the regulation of SRN. Food supply could then be conceptualized as a network, bundle, or complex of practices (Shove et al. 2012) that are engaged with the supply of food (network approach; Figure 2). In contrast to the systems approach (see Figure 1), the focus changes from users and resources to social practices as a central element of study. Accordingly, practices would be the domain where the different social and natural elements meet and interrelate. In such an approach, materiality is one element of these supply practices and can be studied in relation to other elements as meanings and competences.

For the example of plastic packaging in food supply, the approach leads us to a focus on specific practices in which packaging is used.

Looking at its practical functions in the course and interplay of practices, packaging is studied as an entity that makes a difference in these practices. This means that packaging directly influences the possibilities of concrete human actions. This perspective frames food supply not as a system that can be described from the outside, but rather as a loose network of connected practices that can be studied from within by following these connections and relations. References for this line of thinking are not only found in practice theory, but also relate to science and technology studies, including those of Bruno Latour (2007) and Michel Callon (2007), as well as the ethnomethodology of Harold Garfinkel (1984) and subordinated fields like workplace studies (Bergmann 2006; Knoblauch and Heath 1999). Starting from specific situations in defined spaces, practices are studied in their interrelations among each other, and in relation to material spaces, infrastructures, and objects. The meaning of things gets shaped in its attachment to concrete events and practices (Scheffer 2017: 99). For the understanding of the role of technologies, this means focusing on situations in which these technologies are handled (Knoblauch and Heath 1999: 167). According to the network approach, the regulation of SRN could be studied on the level of single practices, as these practices are an assemblage of heterogeneous elements that are partly referred to as social (e.g., cultural norms) as well as natural (e.g., material properties).

Plastic Packaging as an Element of Workplace Practices in Food Supply

An example of conceiving materiality as an element of practices is the analysis of packaging as a “code of practice” for workplace practices at a supermarket (Sattlegger forthcoming). In the work of the supermarket staff, one central affordance is the appreciation of freshness and intactness of products. Packaging facilitates such product assessment practices, acting as a central indicator of product quality and freshness.

The inspection of packaging and sealing is a central part of practices like shelving products in the supermarket. While the evaluation of quality for fresh and unpacked products affords specific skills and experiences in dealing with food, the evaluation of packed goods is guided and guaranteed by packaging. Via the expiration date, packaging tells the supermarket staff (and consumers) how long the product is fresh enough for selling (or buying) it. Plastic packaging is also a simple indicator for the intactness of quality. As the intact packaging is a guarantee of freshness, it facilitates the evaluation practice of employees.

For them, it is much easier to judge if the plastic foil is broken than to decide if an apple with small bruises is still fresh enough to be sold to consumers.

Plastic packaging also transforms market interactions, replacing trust-based human interactions with standardized human-artifact interactions. The information provided on product packaging mediates the exchange of information between the realms of production and consumption. As social distance in the supply chain grows, this exchange is increasingly standardized—social trust and loyalty is replaced by quality standards, product certification, and brands. Packaging allows transferring such information between numerous practitioners without requiring direct conversation. Direct interaction is replaced by the handling of “intermediating artefacts” (Latour 2001: 248). This is not only present in the direct physical handling of products, but also on a more abstract level of work organization: packaging units define units of work for pieceworkers, as well as retail units in the supermarket warehouse.

The network approach enables revealing how elements of meaning or competence are bound to the materiality of practices and how they have to be adapted to changes in the material realm to sustain the functioning of practices. Changes in packaging generate new affordances for *Frischekompetenz*⁴ (freshness competence) or the valuation of quality (Sattlegger forthcoming). Materiality here is not a passive infrastructure or setting for actions, but an active element of practical accomplishment. For the work on social-ecological problems, the direct observation of the practical role of packaging in practices of supply allows for deducing practical constraints of packaging use and barriers for packaging reduction.

Strengths and Weaknesses of the Network Approach

A clear advantage of the network approach is its potential to describe practices as a comprehensible interplay of people and things, actions and technologies. Defining materiality as an element of practices facilitates a straightforward description of human-technology interactions. Conceived as an element of practices, technology is always linked to its use by humans (Morley 2017: 81). For sustainability research, this observation of technologies as things under use rather than abstract technical applications is an important advance. It gives space to an everyday user perspective and allows assessing the actual use of these items instead of their functions and sustainability gains in theory. Framing materiality as an element of practices is a way of bringing together knowledge of

technical engineering and the social studies of everyday life. Such an approach, which also understands unplanned or unintended patterns of use, can guide a more realistic and feasible product design or regulation policy that takes the everyday seriously. In this way, it is a pragmatic, understandable way of dealing with materiality that helps to connect everyday interactions to material infrastructures.

However, a viewpoint on materiality that conceptualizes the interrelations of the natural and the social sphere within social practices has some drawbacks for empirical use in social-ecological research. The network approach stresses the importance of materiality as it plays a relevant role in practices. All relevant elements have to be traced and observed directly in their involvement. That makes it difficult to include findings from other disciplines in practice-theoretical observations: cleanliness and hygiene are portrayed as a part of practices and not related to a microbiological analysis of cleanliness. Furthermore, in empirical investigations, the idea of an encompassing interconnectedness of elements is limited by practical constraints: hidden or invisible forms of materiality that are not directly observable in the process are easily overseen in such studies. This risks a shortcut in conclusions that misses the interplay of different practices, dynamics, and processes. An example is that the focus on technology use overlooks material relations that are more on the production side. If materiality is considered on the level of single practices only, the ecological impacts of these practices will remain invisible, if they are not directly observable in the practice itself and do not influence the action in the first place. The questions that arise are as follows: Are these environmental impacts still part of the practice? How is it possible to account for them? In theory, the network approach provides the potential to include all these materialities, but the empirical strategy of following links and connections between elements has practical limits. In the majority of existing studies, natural processes and dynamics are left out, and materiality is mainly related to technology and its use. If we want to study the SRN of food supply as networks of practices, it is important to extend the view in two directions. First, we have to strengthen the inclusion of practices at sites of production or disposal. Second, we have to relate the material elements that are part of observed practices and networks to other material and ecological processes that are important for sustainability relations.

Summing up, the network approach is strong in observing specific practices at the micro level of social organization, while material effects that are not directly observable in the course of practices are hard to integrate into the analysis. It is a big challenge to make broader

connections of networks of supply practices traceable without losing the power of such flat ontologies⁵ (Latour 2007) by falling back on explanations by means of contextual factors or more stable structures. The nexus approach, based on Schatzki's concept of material arrangements, is an attempt to better integrate the embeddedness of single practices into a biophysical environment.

Studying Food Supply as a Nexus of Practices and Material Arrangements (Nexus Approach)

A slightly different way to conceptualize materiality in practice theory is to see it as an arrangement that provides the setting for practices. For Schatzki (2010), human coexistence is a combination of practices and material arrangements (practice-arrangement nexus). Practices can be defined as organized human activity, such as spatially and temporally located nexuses of sayings and doings. Material arrangements are a combination of interconnected material entities that form the context where practices take place (Schatzki 2010: 128ff.). Practices and material arrangements are characterized by interdependency; practices are influenced by the material arrangements and at the same time reshape these arrangements (Galvin and Gubernat 2016: 186; Schatzki 2010). For Schatzki (2010: 125–126), materiality includes physicality, composition, nature, and environment. All social phenomena occur as part of a vast and dynamic network of social practices and material arrangements. This means that material and technical arrangements become socially relevant only in their interconnection with social practices. Schatzki (2010: 139ff.) points out that there is a tight link between materiality and practices. He describes four possible connections between material arrangements and practices: causality, prefiguration, constitution, and intelligibility (for more detail on these different types, see Schatzki 2010).

Janine Morley (2017) proposes a similar approach in her article on the role of technologies within and beyond practices. She claims that if we reduce materiality to its role as a “tool-like” element within practices, we lose sight of certain other forms of material influence within technological systems. Machines can take over human work and displace practices, or they can influence the way in which practices persist or change without directly participating as elements within their performance. For Morley (2017: 83), the inclusion of these more indirect material agencies in practice-theoretical approaches is important

for a better understanding of automatization technologies. She picks up Lewis Mumford's (2010) distinction between tools and machines to demonstrate the different relationships between artifacts and practices. Via examples like central heating or fully automated factories, Morley demonstrates how materialities have to be considered as extended processes, which form a background relation (or a material arrangement) to larger systems of practices.

While Schatzki's work is mainly conceptional, there are a few authors applying his approach to material arrangements in empirical studies; an example for the field of sustainability is the study on rebound effects from Ray Galvin and Andreas Gubernat (2016). In their case study on computer use in a university research cluster, they examined the relation of local work practices to technical changes in the energy efficiency of the research cluster. Galvin and Gubernat argue that Schatzki's development of practice theory—and especially his concept of material arrangements—offers an ideal framework for rebound studies. They state that the interplay of practices and arrangements provides a fuller picture of the social dynamics of rebound effects, while traditional rebound studies simply argue that single individuals respond rationally to the knowledge of an energy efficiency increase (Galvin and Gubernat 2016: 188). The concept of material arrangements provides a counterpart for practices that can be explained by itself. This allows for zooming out of concrete practices and describes the specific context in which these practices are located. Michael Jonas's (2014) practice-theoretical analysis of the development of a research cluster for micro-system technology in Dortmund (Germany) is a good example of how specific and local material arrangements are highly relevant for the course of practices. Such a contextualization allows for including different types of materiality in the analysis and thereby offers more potential to introduce nature as a relevant physical environment of practices. An attempt to utilize this broader view on materiality is the case study of the social practices of flood (risk) management by Christiane Stephan (2018). It gives hints of how natural ecosystems and their changes are highly relevant for the conduct of practices and vice versa.

If we conceptualize material arrangements as counterparts or settings of practices, our perspective on SRN and their regulation again differs significantly. In this view, food supply could be described as a practice-arrangement nexus (nexus approach; Figure 3). Compared to the network approach, the concept of arrangements allows for a stronger focus on infrastructures and institutions as relevant parts of food supply. In this manner, the supply nexus can be framed as an

Figure 3 ■ Nexus approach: Food supply as a practice-arrangement nexus.

interrelation between material arrangement of supply (including natural resources and technical infrastructures) on the one side, and practices of supply (reflecting the reproduction and everyday use of these infrastructures) on the other side. In contrast to the network approach, the focus is not so much the interplay of different elements within practices, but the relation of material surroundings, infrastructures, and devices to social practices. This allows for describing the difficulties of acting against the logic of material arrangements and everyday routines. Ideas of sociotechnical path dependencies (Arthur 1989) or the sociotechnical transitions of supply systems (Cohen and Ilieva 2015; Crivits and Paredis 2013) fit perfectly into this line of thinking.

Plastic Packaging as Part of Food Supply Infrastructures that Preconfigure Practices

Viewing food supply as a practice-arrangement nexus, packaging is part of the arrangements in which practices take place. We can describe how the provisioning system is technically bound to the material qualities and function of packaging, as well as how producers and customers are habitually used to the handling of packaging. An example is the need to adapt the material infrastructures of the salesroom to the habits and routines of consumers; zero-waste stores have to deal with the

way packaging has shaped shopping routines and product selection in supermarkets. Further, they have to deal with the packaging options wholesalers provide them in the procurement of their products. They also have to cope with standards and work guidelines regarding the handling of heavy goods like bulk packs. From this angle, the interrelations between single practices and a bigger supply infrastructure in which they are embedded come into view. The focus on materiality is not on the single material object, like in the observation of packaging as an element of practices, but embraces a more integrated view on packaging as part of a material infrastructure of the provisioning system. Packaging is then portrayed as integrated in a whole set of material devices, like, for example, manufacturing machinery, packaged goods, supermarket shelves, transport vehicles, and shopping carts. This interconnected assemblage of things induces a frame for the course of practices.

This rather contextual perspective of materiality allows not only for the integration of different things, but also of different perspectives on the materiality of the same thing. The nexus idea combines the direct observation of linkages within social practices with searching for linkages on a broader level, leading to other systems of knowledge. A sociological perspective on packaging as an indicator of freshness in a specific practice can be combined with a technological perspective on a packaging's functionality for the sake of preservation and its influence on standards of supply chain logistics; from the cultural idea of freshness, we can relate it to its biochemical measurement. This broader view allows for a better understanding of the biophysical world as an environment or setting for practices that underlies its own dynamics.

Practices can then be studied in their effects and dependency on technical infrastructures, as well as on the ecosystems in which they are embedded. For the analysis of plastic packaging waste, this means relating practices of use and disposal of packaging to their ecological effects in different material surroundings and ecosystems. The replacement of conventional plastic species by biodegradable ones for use in packaging is an interesting case in this regard. Here, a nexus perspective allows portraying practices of use in relation to material arrangements of available infrastructures like waste bins, the cleanliness of the surroundings, the visibility of human impact throughout the landscape, and material properties of the packaging. Drawing on the concept of material arrangements, the study of practices can then be connected to an analysis of degradation rates and ecological effects of different plastic species in various physical environments in order to understand how these social

practices are influencing and transforming ecological processes. In this regard, the nexus approach is open to an interdisciplinary integration of knowledge from different disciplines.

Strengths and Weaknesses of the Nexus Approach

Framing materiality as arrangements, a study of practices can be better connected to social-ecological, technical, or natural scientific concepts of supply. The perspective facilitates a search for alternative practices regarding existing material arrangements, as well as analyzing the acceptance of alternative infrastructures in light of dominant practices. Material arrangements can be a useful boundary concept that allows for a connection of sociological observations of everyday practice and natural scientific investigations of environmental impacts and ecological processes. Material arrangements are part of the biophysical world, and their dynamics are simultaneously relevant for the course of everyday life. The idea of a practice-arrangement nexus is a good starting point to widen the scope for different types of material dynamics in SRN and should be adopted and concretized in empirical frameworks.

However, the integration of this broader and (compared to the network approach) more structural account of materiality also raises some difficulties: first, how can we consistently and pragmatically deal with the complexity and infinity of arrangements without oversimplifying social life? This includes, for example, the definition of system boundaries and the demarcation of relevant arrangements. In recent empirical applications, these decisions often seem quite random. Reinforcing the focus on material structures brings the danger of oversimplifying variations of practices and everyday life. Second, how can we include contextual or external influences in the explanation of practices without overinterpreting them or obscuring situational explanations? This question reflects the epistemological critique of science and technology studies, especially those of Latour (2007: 99), who accuses traditional sociology of a contextualization of reason that leads to an explanation of life via predefined categories instead of empirical findings.

Discussion and Conclusion

In Table 1, we summarize and compare the three discussed conceptual frameworks for investigating how plastic packaging is part of the societal regulation of food supply. The system approach portrays the

	Studying SRN as Social-Ecological Provisioning Systems (Systems Approach)	Studying SRN as Bundles of Practices (Network Approach)	Studying SRN as a Nexus of Practices and Material Arrangements (Nexus Approach)
Relation between Materiality and Social Life	Provisioning systems as a mediator between the resource and user sides of provisioning systems	Materiality as an element within social practices	Materiality as a setting for social practices
Empirical Strength in the Study of Social-Ecological Problems	Understanding the way in which societies use and transform natural ecosystems to fulfill societal needs (e.g., use of natural resources)	Understanding the everyday use of infrastructures, technologies, and things (e.g., use devices)	Understanding the interdependency of everyday practices and material environments (e.g., infrastructures)
Practical Example Regarding Our Studies on Plastic Packaging	Studying packaging as part of how societies regulate the appropriation of biological resources for food supply (e.g., packaging as a technology that transforms the availability of food in everyday life)	Studying plastic packaging as code for action in supermarket work practices (e.g., packaging as an indicator for controlling freshness of products)	Studying the relation between the material properties of packaging and practices of consumption (e.g., packaging as an enabler of shelf life changes consumption patterns)
Challenges in the Empirical Adaption to Social-Ecological Problems	Integrating dynamics and unpredictability of everyday life in the analysis	Integrating relevant context that is not observable in practices	Dealing with the complexity of practices and the delimitation of material arrangements

Table 1 ■ Summary and Comparison of the Three Discussed Approaches to SRN.

mediation between biological needs and symbolic accounts of supply that is provided by the provision system. The network approach is powerful in the investigation of how material devices, objects, technologies, and organisms are elements of everyday practices of food supply. The nexus approach highlights how material surroundings make up the setting for supply practices. Relating to Shove's (2017) distinction between the three roles that things play in practice, the network approach might be strongest for an explanation of usage devices, and the nexus approach could bring advantages for looking at infrastructures, while the systems approach is most appropriate if we are interested in resources. We conclude that it is not a question of either/or, but a question of given problem settings that defines the fitting of each approach for social-ecological research. In our opinion, practice-theoretical conceptualizations of materiality and its role in everyday life can enrich and enhance the understanding of how SRN are regulated in different ways by carving out direct material connections within everyday life practices, as well as their embeddedness in a material environment.

Summing up, practice-theoretical considerations can be applied to improve a social-ecological understanding of everyday life activities as part of the regulation of SRN. Practice theory and social ecology share a relational approach, linking social practices to materiality, stressing that physical elements and processes play a key role in maintaining social life. Both approaches highlight the close links between symbolic and material elements. Practice theory fits well into the pragmatic and empirical approach to studying the regulation of SRN in concrete and observable examples. It is in line with the idea that the relations of society to nature can only be studied in particular fields, such as the regulation of food supply, where natural, hybrid, and social elements are connected in concrete processes of interaction (Becker et al. 2011: 87). Considering everyday life in a way that is inspired by practice theory has great potential to enhance the analysis of societal processes and dynamics in social-ecological studies. For a further conceptual debate and research in this sense, we draw the following conclusions.

Conceptualizations of social practices put the focus on the intersection of knowledge, technology, and everyday life activities. Reflections and findings from the network approach can be particularly useful to better understand the interaction of users and technologies in the appropriation of natural resources or to analyze the way in which different modes of knowledge and competences are incorporated in social practices more properly.

For investigating the regulation of SRN, practice-theoretical concepts have to be expanded and connected to approaches from the natural sciences. Attempts to grasp the materiality of social practices mark a point from which such endeavors can depart. A social-ecological understanding of food supply stresses the close links between physical resources and the organization of social life. The concept of material arrangements can be a boundary object that is simultaneously part of social life and natural processes, allowing the connection of everyday practices to physical preconditions and impacts. Infrastructures and material arrangements through which the appropriation of natural resources is regulated might be a starting point for studying provisioning systems as a practice-arrangement nexus.

In line with the advantages and disadvantages of the approaches discussed above (systems approach, network approach, nexus approach), we propose introducing social practices into social-ecological research in a pragmatic and case-specific way. The adoption of a practice-theoretical perspective should be done according to empirical affordances and by experimenting with different problem and research frameworks. We are convinced that—despite the different ontologies, methodologies, and research agendas of practice theories and social ecology—a better consideration of social practices in the conceptualizations and investigations of supply bears large potentials for making these studies more powerful and accurate in understanding the importance of everyday life in the regulation of SRN.

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Notes

1. The empirical examples in this article are derived from participant observations and interviews conducted by Lukas Sattlegger in the course of his PhD project in the junior research group PlastX at the ISOE–Institute for Social-Ecological Research.

2. Practices in this model are understood as human activities and actions in a wide sense. The term “practice” does not imply the specific meaning as in theories of social practices. It is one objective of this article to clarify how the social-ecological understanding of practices can be delineated in light of practice theory.

3. Shove et al. (2012) define three elements holding a practice together, which are *competence*, *meaning*, and *material*. The main distinction compared to Gram-Hanssen (2010b) and Bartiaux et al. (2014) is that they split the element competence in two, namely, *know-how and embodied habits* and *institutionalized knowledge and explicit rules*.

4. *Frischekompetenz* is a term used in supermarkets to describe the ability of representing freshness to consumers. It is linked to providing fresh, unpacked, and unprocessed food.

5. A flat ontology describes the social world as being at one level, without any hierarchy and without distinguishing between micro and macro phenomena/levels.

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