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## **Insights into food system exposure, coping capacity and adaptive capacity**

### **Abstract**

**Purpose** - The purpose of this paper is to consider the concepts of exposure, coping capacity and adaptive capacity as a multiple structure of vulnerability in order to distinguish and interpret short-term coping responses and long-term strategic responses to food system vulnerability.

**Design/methodology/approach** - This paper applies an abductive approach for qualitative analysis of data, which was collected through eighteen semi-structured interviews among Finnish food system actors.

**Findings** - The findings suggest that coping capacity and adaptive capacity are indeed two different concepts, which both need to be addressed in the examination of food system vulnerability. Public and private food system governance and related decision-making processes seem to focus on building short-term coping capacity rather than strategic adaptive capacity. In fact, conservative and protective policies can be counterproductive in terms of building genuine adaptive capacity in the food system, highlighting institutional and policy failures as limiting adaptive capacity and affecting future vulnerability.

**Originality/value** - This paper is the first to provide evidence on the multiple structure of food system vulnerability. It simultaneously considers the external aspect (vulnerability drivers) and internal factors, including short term coping capacity and more strategic adaptive capacity, as key determinants of vulnerability.

**Keywords** - Food system, Vulnerability, Coping capacity, Adaptive capacity

**Paper type** - Research paper

### **1. Introduction**

Understanding food system vulnerability has become increasingly important in the face of accelerating food demand, competition for depleting resources, the failing ability of the environment to buffer increasing anthropogenic impacts, failing confidence of consumers and civil society in the food system, and the lack of democratic distribution of power and open governance across food supply chains (Vermeulen et al., 2012; Lang and Heasman, 2015). Basically, vulnerability is a measure of possible future harm, which refers to the forward-looking aspect of vulnerability (Hinkel, 2011), such as the vulnerability of food systems to future shocks (Fraser et al., 2005). The characterisation of vulnerability requires a simultaneous consideration of external exposure as well as coping and adaptive capacity of

the affected system, and underlines the multiple structure of vulnerability (Birkmann, 2013). Dealing with unexpected changes calls for understanding on natural and social vulnerability drivers but also on vulnerable (natural, social or technical) systems (Khazai et al., 2014; Paloviita et al., 2016). An "outside-in" look can reveal a new array of opportunities and threats (Porter and Reinhardt, 2007), but the actual exploitation of an opportunity requires adaptive capacity.

Vulnerability is a highly theoretical, contextual and place-specific concept (Cutter et al., 2003) that does not denote an observable phenomenon (Hinkel, 2011). For example, vulnerability to climate change is not evenly distributed, because there are major heterogeneities in wealth, adaptive capacity and food access (Vermeulen et al., 2012). Food systems and food supply chains, in turn, are broad systems with complex interdependencies, including economic, environmental and social dimensions. The increasing interconnectivity and complexity that characterise the present food system makes farms, organizations, supply chains and consumers vulnerable to any kind of disturbance generated around the world. The global food supply chain is a paradigmatic example of networks on which disruption spreads rapidly through the food system (Andreoni and Miola, 2015). For example, the rapid rise of food commodity prices in 2007 and 2008 represented a crisis for the global food system (Rosin, 2013).

The purpose of this paper is to consider the concepts of exposure, coping capacity and adaptive capacity as a multiple structure of vulnerability in order to distinguish and interpret short-term coping responses and long-term strategic responses to food system vulnerability. Multiple structure of vulnerability refers to the consideration of susceptibility, coping capacity, exposure and adaptive capacity, instead of narrower conceptualisations of vulnerability, which refer to vulnerability as an internal risk factor or a dualistic approach of susceptibility and coping capacity (Birkmann, 2013, p. 39). We approach the food system as a set of four food system activities related to producing, processing and manufacturing, retailing and distributing, and consuming, following the grouping by Ericksen (2008). We focus on the multiple structure of vulnerability (Birkmann, 2013), by analysing perceived exposure, coping capacity and adaptive capacity across the food system activities. Based on eighteen semi-structured interviews conducted among the key actors of the Finnish food system, we provide evidence on the multiple structure of vulnerability, by simultaneously considering the external side (exposure) and internal side of vulnerability (coping capacity and adaptive capacity) in the context of food system vulnerability. The results illustrate the complex interlinkages between the vulnerability of different food system activities.

The outline of the paper is as follows. The next section describes the theoretical background and provides a literature review on vulnerability, coping capacity and adaptive capacity in the framework of the food system vulnerability. The research design, data collection and analysis are described after the literature review. This is followed by the presentation of exposure, coping capacity and adaptive capacity across food system activities in relation to particular vulnerability drivers, which are based on the empirical data and analysis. Finally, the discussion and conclusion are presented.

## **Theoretical Background**

### *Interdependencies and interconnectivity in the food system*

Operationally there is no global food system but rather, a set of partially linked food supply chains, varying from local to global supply chains (Vermeulen et al., 2012). Food supply chains, in turn, are interconnected inter-organisational networks embedded within an environment characterised by many uncontrollable vulnerability drivers (Peck, 2005). Moreover, there can be cascading interaction between vulnerability drivers with different spatial and/or temporal scopes (Khazai et al. 2014). In case of hybrid events where there is more than one vulnerability driver or there is a set of interconnected risks facing food systems, there may be interdependency between, for example, poor governance and climate change impact. Interactions also occur between (inter-system interaction) and within (intra-system interaction) systems. For example, the food system as a social functional system (comprised of food system activities) or as an organisational system (comprised of inter-organisational networks) is highly dependent on natural systems, which provide water, ecosystem services and other crucial inputs. Within the social food system, the food supply chain as an inter-organisational network is crucially dependent on functional system activities, such as agriculture, food industry, food distribution and consumption. One outcome of multiple connections between food system actors and activities, and associated feedback loops, is that interventions to decrease one type of vulnerability can increase a different vulnerability (Sundkvist et al., 2005).

### *Food system vulnerability*

To answer the question "Vulnerability of what?" Khazai et al. (2014) make a distinction between natural systems, social systems and technical systems. In fact, the food system depends on all these subsystems, as demonstrated in the food system vulnerability matrix by

Paloviita et al. (2016). Analytically, however, it makes sense to analyse the vulnerability of different subsystems, such as a food supply chain, a sector or an organisation by simultaneously addressing the interdependencies with other subsystems. The food system as a whole is affected both by global environmental change and societal change in institutions, resource accessibility, economic conditions and other multiple stressors (Ericksen et al., 2010, p. 72). Eakin (2010) argues that food system vulnerability research has dominantly focused on vulnerable agriculture, the single functional sub-system, instead of a broader functional system that includes activities such as food processing and manufacturing, distribution and consumption. Fraser et al. (2005) propose an alternative framework for assessing food system vulnerability based on landscape ecology's "panarchy framework". Their framework emphasises the available social wealth in the system (how poverty affects food security), connectedness in the system (pathways through the food system and the spread of disturbances) and existing diversity in the system (diverse means of access to food). They argue that increasing the number of food entitlements, reducing connectedness in the food system and diversifying the sources of food reduce food system vulnerability. This view is supported by Vermeulen et al. (2012, p. 211), who argue that "policy incentives for diversification of types of farms across the region could enhance the society's adaptive capacity in much the same way as on-farm diversification strengthens a farmer's adaptive capacity". Bohle et al. (2009) suggest reframing vulnerability from a systems-oriented perspective to more actor-centred and agency-based perspectives. In addition, Ericksen (2008) highlights the role of human agency and interventions in understanding social and ecological vulnerability. Dealing with vulnerability is a process that must be managed by actors with different goals, power and priorities (Lebel et al., 2006). Ultimately, society has to struggle with the competing objectives of food system actors, especially with the growing influence of private sector actors in all food system activities (Ericksen et al., 2010, p. 74).

#### *Coping capacity and adaptive capacity*

Coping capacity and adaptive capacity are integral characteristics of vulnerability, as "vulnerability is related both to the differential exposure and sensitivity of communities to stimuli such as climate change and also to the particular adaptive capacities of those communities to deal with the effects or risks associated with the exposures" (Smit & Wandel 2006). This definition of vulnerability can naturally be applied to other vulnerabilities as well. Adaptive capacity and coping capacity are different concepts, although some authors have used them interchangeably (see Gallopin, 2006, on this), and a clear-cut differentiation

between coping and adaptation is difficult, if not impossible, to achieve (Birkmann, 2013, 22). From a conceptual point of view, however, it is useful to distinguish the differing nature of coping and adaptation processes (Birkmann 2013, 32). While coping capacity is defined as the ability to use available skills and resources to manage adverse effects, adaptive capacity - in contrast - is seen as a function of the strength, attributes and resources available to a system (IPCC, 2012). Hence, coping can be viewed as a short-term approach dealing with capacities and survival in the light of extreme events (Vogel and O'Brien, 2004) as well as the protection and conservation of the current system and institutional settings (Birkmann, 2013, 23), e.g. protection of short-term food security or income. In contrast, adaptive capacity as a constantly unfolding, progressive and long-term process of learning, experimentation and change (Kelly and Adger, 2000) requires planned and strategic actions (Vogel and O'Brien, 2004) and modifications in behaviour (Ericksen et al., 2010, 117). Hence, adaptive capacity calls for changes in the rules, norms and structures that lead to crises, which emphasise the institutional dimension of vulnerability.

Different modes and constraints in governance and the capacity or incapacity of formal organisations, such as governments and corporations, to deal with risks can lead to policy mismatches (Birkmann, 2013, 30). In turn, institutional and policy failures can limit adaptive capacity and at the same time coping strategies and adaptive responses affect future vulnerability by changing the context and outcomes of vulnerability (Leichenko and O'Brien, 2008). Hence, Eakin (2010, p. 80) distinguishes between the manifestation of harm and innate characteristics of the system itself that predispose it to vulnerability. Ultimately, the inner conditions of a society, community, business entity or an individual related to their capacity to anticipate, resist, cope with, and recover from outside-in impacts are crucial (Birkmann, 2013, p. 63; Bohle, 2001). Consequently, high adaptive capacity does not guarantee successful management of change or reduction of vulnerability, because higher level institutional and policy reforms are also needed (Adger et al., 2007). Overall, in vulnerability research, it is important to address different factors of vulnerability and their interplay, such as linkages between exposure, coping capacity and adaptive capacity (Smit and Wandel, 2016; Birkmann, 2013, 26).

#### *Vulnerability drivers*

Khazai et al. (2014) use the term "driver" as an abstract term to answer the basic question: Vulnerability to what? In their ontology, driver can refer both to instantaneous events and long-term processes with external and internal causes. For example, Misselhorn et al. (2010,

p. 88) make a distinction between drivers that act quickly and those that act more steadily over a longer period of time. Moreover, Khazai et al. (2014) make a distinction between "natural" and "social" drivers, where natural drivers refer to geophysical, hydrometeorological (such as climate change) and biological/ecological drivers, whereas social drivers refer to anthropogenic impacts, social inequality, governance and war or conflict (Khazai et al., 2014).

In this study, we selected three different types of vulnerability drivers for empirical examination in order to demonstrate the multifaceted nature of vulnerability. First, hydrometeorological changes were selected as an example of both instantaneous events (e.g. extreme weather events) and long term processes (climate change), which are clearly associated with external causes due to exogenous "natural" vulnerability drivers. Climate change and weather extremes have received significant academic attention recently (e.g. Linnenluecke and Griffiths, 2010; Linnenluecke et al., 2012; Pinkse and Gasbarro, 2016; Paloviita and Järvelä, 2015; Beermann, 2011) due to their impacts on organisations, supply chains and food systems, and they are probably the most studied vulnerability driver in the food system context. However, as there has been a shift in focus from "natural" drivers to chronic or underlying socioeconomic drivers related to politics and economics, such as institutional and policy failures (Ericksen et al., 2010, p. 71), we also selected two vulnerability drivers as examples of internal "social" causes: policy and consumption patterns. Policies are associated with the dual system of food system governance, private and public, which can increase or decrease the coping capacity and/or adaptive capacity of the system.

Consumption patterns, in turn, reflect decision-making processes among consumers. For example, a shift in consumption patterns to vegetarian diets can make meat and dairy supply chains extremely vulnerable. On the other hand, energy and resource-intensive and high waste-producing consumption patterns can make natural systems vulnerable. Nevertheless, Misselhorn et al. (2010, p. 107) argue that understanding the vulnerability drivers is not enough, because understanding their dynamic interactions and synergies over time and through space is also needed. The following sections investigate this multiple structure of vulnerability in the context of the Finnish food system, referring to both external vulnerability features to various food system activities (exposure) and those vulnerability factors that are related to internal coping capacity and adaptive capacity.

## **Research Design, Data Collection, and Analysis**

### *Research Design*

Food system vulnerability is an abstract concept and measuring it in the whole food system level is extremely arduous. Hence, the research topic was approached by first selecting three concrete vulnerability drivers, which refer to external and/or internal causes of vulnerability, as explained in the previous section. First, hydrometeorological changes, including climate change, heavy rain, drought, floods, heat waves and snow storms, together represent an exogenous "natural" vulnerability driver (Khazai et al., 2014). Second, the aim was to analyse vulnerability from a societal perspective, focusing on endogenous processes of "social" drivers (Khazai et al., 2014), which refer, for example, to decision-making processes in corporations, governments and among consumers. Hence, two vulnerability drivers, namely private and public policies and consumption patterns, were selected as potential internal contributors to creating vulnerability in different parts of the food system.

In the case of the first driver, hydrometeorological changes, the food system as a whole was researched as a vulnerable system because hydrometeorological impacts typically affect (directly or indirectly) all activities of the food system. In terms of two other vulnerability drivers, focus was deliberately narrowed down to their impact on particular food system activities: the vulnerability of agriculture to public and private policies, and the vulnerability of food industry to changing consumption patterns. The purpose of this delimitation was to achieve deeper understanding about the vulnerability factors of given activities, which would not have been possible if the chosen vulnerability drivers were examined only in relation to the food system as a whole. However, thematic broadening from these predetermined drivers and activities was allowed during the interviews as far as the discussion remained within the scope of food system vulnerability.

### *Data Collection*

The researchers conducted face-to-face semi-structured thematic interviews in Finnish, with 19 interviewees in 18 different Finnish organisations (in one organisation we conducted a group interview of two interviewees). Eight interviewees were from private sector organisations, six from public sector organisations, three from interest groups and two represented expert organisations. Among interviewees from private sector organisations, there were five interviewees from the retail sector and three interviewees from food industry companies. Public sector organisations included a ministry, a national agency, a regional agency and three research organisations. There were three interviewees from two interest groups representing agricultural producers and the food industry. Half of the organisations visited were located in Helsinki, while the other half resided in various regions of Finland. All



the interviewees were in a leading position within their organisation or had special expertise related to the topic. Interviews were mostly conducted in August 2015, but four interviews related to hydrometeorological changes were conducted in 2013 related to a previous research project on climate change adaptation in food supply chains. The interviews were recorded and transcribed. We presented a loose definition of vulnerability to the respondents, defining it as a potential future harm to a specific organisation/ sector/ food system. During the interviews, however, we extended the definition of vulnerability beyond the likelihood of experience harm towards coping capacity and adaptive capacity.

### *Analysis*

We applied an abductive data analysis, referring to dialogue between data and theory, with emphasis on "theory matching" or "systematic combining", which focus on refining existing theories (Dubois and Gadde, 2002). Our data analysis was guided by Birkmann's (2013) conceptualisation of vulnerability as a multiple structure and the grouping of food system activities by Ericksen (2008). After reading the transcriptions of all the interviews repeatedly and thoroughly, we successively matched the conceptual framework of the multiple structure of vulnerability, the groups of food system activities and the collected empirical data. Given the desire to produce abductive research, our literature review, empirical analysis and the theory matching were conducted in an intertwined manner. When formulating the final results, we tried to respect parsimony (Eisenhardt, 1989) in a sense that the number of empirically derived themes and factors was radically decreased during the analytical process. In the analysis, we focused on three different layers of vulnerability: exposure, coping capacity and adaptive capacity. Susceptibility (or sensitivity), which is commonly referred as a factor of vulnerability, was not separately addressed in the analysis, because it was initially assumed that the selected systems are more or less susceptible/ sensitive to studied exposures. As Smit and Wandel (2006, p. 286) argue, "exposure and sensitivity are almost inseparable properties of a system".

### **Perceived food system vulnerability**

#### *Exposure*

Food system exposure to climate change and extreme weather events was clearly acknowledged by the interviewees. However, due to the long-term process of climate change, respondents had difficulties to explicitly address the character, magnitude or rate of exposure

faced by different food system activities in the future. Agriculture's exposure to hydrometeorological changes was perceived higher compared to other food system activities.

Food system exposure to policies, regulations and overall governance was highlighted by the majority of the respondents. Finnish regulative policies were largely criticised by many interviewees due to the complexity they create in the business environment. It was generally understood that the directives and the legislation stem from European Union (EU) level decisions, but interviewees recognised a tendency in Finland to further complicate and tighten the legislation at the national level. Heavy bureaucracy stemming from excessive authoritative control was criticised and associated with increased costs and loss of time, as well as unfairness in the allocation of costs between authorities and enterprises. Finnish regulative policies were also associated with the unawareness of the decision makers about the impacts of their decisions. Respondents representing the agriculture and food industries argued that they are adversely affected by both public policies at the EU/ national level and private policies defined by a powerful retail sector. In terms of private sector policies, interviewees agreed that the retail sector has a strong negotiation position towards suppliers due to its leadership and gatekeeper position in the food system. Representatives of the agricultural sector perceived the retail sector's negotiation behaviour as a dictation policy and increased profits and margins of retailers were judged as unearned by some interviewees.

Moreover, the growing importance of private labels, which are promoted by retail sector policies, was considered problematic for food producers and the food industry by some respondents. Respondents from the retail sector, in turn, perceived the Finnish legislative and administrative environment as more stringent compared to other EU countries and hence, unfair. Informants strongly requested for fairness in national legislation and awareness among decision makers about the actual impacts of their decisions. The embargo on Russian was mentioned as an example of exposure to international policy. As the negotiations between Russia and the EU failed, Russia slapped a ban on a range of food imports from the EU, including Finnish dairy products. As a consequence, the Finnish dairy supply chain was adversely affected, since Russia was formerly a very important export market.

Compared to hydrometeorological changes and policies, food system exposure to consumption patterns received less concern. Respondents from the food industry perceived changes in consumption patterns as a window of opportunity, rather than vulnerability. For instance, the low carbohydrate diet trend (that thrived in the 2010s) was experienced as an opportunity to try new products that matched consumer preferences, even if many of these innovations were available for only a relatively short period. It needs to be acknowledged,

though, that the data did not include interviews from small bakeries that were hit hardest by the low carbohydrate trend; interviewing them could have raised different views in this matter. Some concerns were expressed about the cheap food culture that has dominated Finland over the past decades. On the other hand, cheap food culture was strongly associated with the policies implemented by large retail corporations through their price drop policies. A price drop campaign launched by the largest Finnish retailer group in 2015 was mentioned in many interviews, mainly with negative connotations. Interviewees in both the agricultural and the food sectors perceived that the price drop campaigns had harmful impacts on primary producers, domestic manufacturers and food culture. Hence, policies that push food prices down to decrease consumer vulnerability might increase the vulnerability of agricultural or food industry activities: they just ‘shift’ the vulnerability impact from one food system activity to another. Also, a shift from hypermarket culture to diverse multi-channel culture was associated with changing consumption patterns. Hence, large retailers may be exposed to a shift from centralisation to decentralisation. While majority of the food is purchased through super- and hypermarkets, an emerging trend in the popularity of smaller food stores, alternative distribution channels and shorter food supply chains was recognised.

#### *Coping capacity*

Our results indicate that the Finnish food system actors were more concerned about short-term coping capacity than long-term adaptive capacity. The main strengths, attributes or resources identified within the Finnish food system that can reduce food system vulnerability are 1) national emergency supply, 2) agricultural subsidy system, 3) global food supply chain networks, and 4) food aid for low-income citizens. All these resources deal with the protection or conservation of the current food system and institutional settings. First, the work of The National Emergency Supply Agency, an organisation working under the Ministry of Economic Affairs and Employment and which is tasked with planning and measures related to developing and maintaining food supply security, was generally associated with reduced vulnerability to short-term crises and weather extremes. Second, some respondents suggested that the most important task of agricultural policy is to provide an economic safety net for farms, which struggle with many outside-in impacts, such as weather and market changes. Hence, the safety net created by the subsidy policy of the EU and national administration can decrease uncertainty in farms to a certain degree. This point of view was augmented with a general perception that traditional agricultural policy is replaced little by little with environmental policy. However, subsidy mechanism built in the agricultural/environmental

policy to cope with vulnerabilities cannot be considered to promote the long term adaptive capacity, since farmers will be given planning security up to five years only due to limits of the Common Agricultural Policy (CAP). Third, global food supply chain networks were generally considered as a resource to cope with food system vulnerability. Essentially, imported food was associated with the process of globalisation and free markets and in some interviews, Finland was described as an island, which should not forget international procurement channels. However, global food supply chain networks are a useful resource only as long as the national purchasing power is sufficient. When the global food prices rise and the national gross domestic product falls, a national food system may face increased vulnerability. Hence, due to perceptions on future food scarcity, reliance on global food markets alone can be considered as a short-term coping capacity rather than adaptive capacity. Fourth, respondents from the retail sector identified their cooperation with charity organisations as a resource to cope with food waste and food insecurity. They donate edible yet unsalable food to low-income consumers through charity organisations, which was generally viewed to advance climate change mitigation and save costs. Charity policies appear as an attempt to integrate the three dimensions of sustainability: social (helping low-income households), environmental and economic. The interpretation here is that charity policies can be associated with coping capacity rather than adaptive capacity, since they may discourage to make more fundamental changes in the ‘wasteful’ and inefficient food supply chain.

#### *Adaptive capacity*

This paper notes that while majority of the food system is mainly concerned with coping capacity, the retail sector can be clearly associated with planned and strategic actions required by adaptive capacity. For example, the largest retailer organisation in the Finnish food system was complimented by the representatives of the agriculture sector in terms of its perseverance and commitment to its goals. Large retailing organisations have built their dominant position over 20-25 years by systematically following their long-term strategy. Retailer organisations were also credited for introducing the culture of efficiency in the Finnish food system. Food retailers were commonly considered leaders of the food system and the gatekeepers between production and consumption. It was admitted that this leadership position results from a long term, target-oriented policy. As a consequence, the retail sector is able to take a larger share of the final consumer price, which, in turn, leads to a lower share of the price along the upstream supply chain. Consequently, long-term planned and strategic actions implemented by retail organisations can be associated with high adaptive capacity. At the same time, however,

vulnerability of the upstream suppliers and dependency of downstream customers has increased.

A flexible hybrid of global and local procurement strategy, requiring procurement channels at the international, national and local level, was an emergent theme in interviews. Designing a hybrid procurement strategy can be interpreted as a resource for adaptive capacity within the retail sector in order to increase diversity of supply. Interviewees in the retail sector were the main informants of this theme, but it was supported by many other interviewees. The availability of domestic food was associated with self-sufficiency and domestic food supply chains were clearly perceived as a critical in reducing food system vulnerability at the national level. However, 100% self-sufficiency was not considered necessary due to existing global supplier networks. Relations with local producers comprised a part of risk management among retailers. Local retailer entrepreneurs and regional co-ops of the large retailer groups emphasised their willingness to procure locally produced food and their headquarters also encouraged procuring local food. The flexibility of local suppliers was seen as the main advantage of local supplier networks.

In contrast to food retailers, adaptive capacity was less characteristic of other food system actors. Some factors related to farmers' adaptive capacity surfaced. For example, new entrepreneurial culture, learning contractual practices and juridical issues as well as business and marketing skills of farmers were emphasised as crucial resources in order to decrease vulnerability. On the other hand, one interviewee argued that farmers apply too much congenital thoughts from father to son, which leads to traditional and learned operating models in farms. The interviewee emphasised adjustments of existing structures and need for changes in agricultural practices, especially in the context of climate change. In terms of adaptive capacity in the food industry, factors such as employee commitment, flexibility, organisational culture and proactive product development were raised. Consumers' adaptive capacity, in turn, was associated with personal responsibility, increased awareness and food skills.

#### *Institutional and policy reforms*

High coping or adaptive capacity is insufficient to ensure reduction of food system vulnerability, since at a broader level enabling institutions and policies are also needed. From a food system vulnerability perspective, our data shows that institutional and policy reforms to decrease food system vulnerability include complex questions due to interdependencies in the food system. First, different policy segments are increasingly intertwined, such as

agricultural policy and environmental policy. One interviewee suggested a shift from animal-based food production towards more plant-based production, based on climatic impacts. This will eventually lead to increased vulnerability of dairy and livestock farmers as well as of meat and dairy supply chains, not to mention potential biodiversity impacts. In addition, another interviewee suggested the integration of food policy and defence policy, demanding that issues related to food supply should be discussed along with NATO, defence budgets and vulnerability to war. Second, food supply chain activities are interconnected, which means that private policies implemented by powerful food industries and the retail sector have potential vulnerability implications. In our data, both primary producers, food manufacturers and consumers were perceived vulnerable to the policies of the retail sector. For example, consumers were perceived to be dependent on retailers and thus vulnerable to private food policies (like price fluctuations and grocery store siting decisions), mainly due to the lack of consumer control in the food system. One interviewee suggested a more balanced policy approach in terms of efficiency and food system vulnerability. The maximization of efficiency in the food system can increase food system vulnerability, whereas policies integrating moderate efficiency goals and sufficient adaptive capacities for dealing with future crises and harms represent a more long-term approach.

The data presented here reveals that it may be difficult to define common food policy due to a conflicts of interest, which were frequently reported by the respondents. According to some respondents, vulnerabilities of other actors in the food system were neglected or even exploited by the most powerful actors. There are trade-offs between rural livelihood and environmental goals, between primary producers, food manufacturers and food retailers, between efficiency and vulnerability, between cheap food and affordability, between private and public goals, between economic, environmental and social goals and between centralisation and decentralisation. However, perceived exposures in different parts of the food system are real, which require short-term coping responses and preferably, long term adaptive capacity. The general finding is, however, that current policies, both public and private, related to the food system have failed to encourage long-term strategic planning and improvement of adaptive capacity. Only actors with significant financial resources, such as large retail organisations, have been truly able to increase their adaptive capacity.

## **Discussion and Conclusion**

While there has been extensive research on food system vulnerability, the overall understanding of the multiple structure of vulnerability in the food system has remained

underexplored. Food system vulnerability was investigated in this paper through three separate vulnerability drivers, namely hydrometeorological changes, policies and consumption patterns. While each vulnerability driver introduces a different and specific type of exposure in the food system, the data found that the responses to exposure, associated with coping capacity and adaptive capacity, are relatively general in nature. It is thus argued that improving general adaptive capacity through learning, experimentation and change can decrease vulnerability to multiple vulnerability drivers. The advantage of this research is that we deal with all major food system activities: producing, processing, retailing and consuming; the interviewees represented primary production, food manufacturing, the retail sector as well as expert and research organisations and government agencies.

The major contribution of this paper relates to the methodology of food system vulnerability research and to making the concept of vulnerability more operational. It shows that applying multiple structure of vulnerability and distinguishing between exposure, coping capacity and adaptive capacity can be analytically fruitful. Exposure is typically directly associated with a specific vulnerability driver, whereas coping capacity (and especially adaptive capacity) refer to more generic strengths, attributes and resources of the food system or its subsystems. In addition, distinguishing between coping capacity and adaptive capacity is important, because the former represents short-term protection and conservation of the current system and institutional settings, and the latter long term strategic actions and change. Finally, as high adaptive capacity is not sufficient to decrease vulnerability, institutional and policy reforms should be addressed. With the multiple structure of vulnerability applied in this study, the multifaceted nature of vulnerability is highlighted, including internal chronic factors such as institutional and policy failures as well as other structural and deep-rooted issues of contemporary food supply chains.

The findings have implications to both public and private food policy. First, the concept of vulnerability as a multiple structure shifts the focus of vulnerability away from a single vulnerability driver to the characteristics of the food system itself. This emphasises vulnerability explicitly as a social phenomenon related to a system of different goals, power and priorities. Second, vulnerability shifts within the food system and between the subsystems should be addressed by both public and private policies. Public policies need to consider vulnerability shifts between economic, environmental and social dimensions of vulnerability, while private policies need to address vulnerability shifts within the food supply chains, since actors in the food supply chains are in very different positions in terms of their adaptive

capacity. This is also related to the strategic management of internal and external supply chain risks, which involves conflicts of interests (Manning and Soon, 2016).

Furthermore, the results presented here come with several caveats. First, the study investigated perceived food system vulnerability instead of actual measured vulnerability. However, when approaching vulnerability as a social phenomenon, perceptions are important. Hinkel (2011), for example, argues that vulnerability cannot be measured because it does not denote an observable phenomenon. Second, it remains unclear to what extent the evidence would generalise beyond the Finnish context. There are obviously remarkable national differences in terms of exposure to climate change, policies and consumption patterns. However, it is likely that national food systems dominated by only a few very powerful retail companies experience similar vulnerability issues. Methodologically, nevertheless, the findings can encourage the application of the vulnerability concept as a multiple structure. Although differentiation between coping capacity and adaptive capacity in this study is strongly interpretative, it was based on the dialogue between data and theory. Finally, the data is limited to 18 interviews only and three vulnerability drivers. That is why the respondents of the study were carefully selected from different levels of food system governance and from different food system activities. The three vulnerability drivers provide snapshots of perceived vulnerability in a specific point of time but do not represent the whole gamut of factors that influence food system vulnerability. For example, the study was made before the massive vegetarian food trend began in Finland and thus at least meat and dairy companies might now have different perceptions on vulnerability to consumption patterns.

Future work could extend this analysis along several lines. One area is food system resilience research, which is closely related to the concept of adaptive capacity, remembering that resilient food systems are characterised by the ability to build capacity for learning and adaptation (Berkes et al., 2003; see also Gallopin, 2006). This could be related, for example, to exploring windows of opportunity provided by vulnerability drivers for change and innovation across the food system. Furthermore, from a food security research perspective, it might be useful to investigate adaptive capacities needed within the food system to feed everyone sustainably, equitably and healthily (Sustainable Development Commission, 2009). The ability of agro-food supply chains to effectively cope with and adapt to vulnerabilities considerably affects people's access to food and food security (Falkowski, 2015). Finally, food supply chain management research could extend its reach towards vulnerability shifts along the food supply chain and their consequences to supply chain resilience.



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