Food Security
https://doi.org/10.1007/s12571-018-0770-y

ORIGINAL PAPER

Governance of food systems across scales in times of social-ecological change: a review of indicators

Aogán Delaney[1] · Tom Evans[2] · John McGreevy[3] · Jordan Blekking[2] · Tyler Schlachter[2] · Kaisa Korhonen-Kurki[4,5] · Peter A. Tamás[6] · Todd A. Crane[7] · Hallie Eakin[8] · Wiebke Förch[9] · Lindsey Jones[10] · Donald R. Nelson[3] · Christoph Oberlack[11,12] · Mark Purdon[13] · Stephan Rist[11,12]

Received: 30 June 2016 / Accepted: 8 February 2018

Abstract
Governance of food systems is a poorly understood determinant of food security. Much scholarship on food systems governance is non-empirical, while existing empirical research is often case study-based and theoretically and methodologically incommensurable. This complicates aggregation of evidence and generalization. This paper presents a review of literature to identify a core set of methodological indicators to study food systems governance in future research. Indicators were identified from literature gathered through a structured consultation and sampling from recent systematic reviews and were classified according to governance levels and the food system activity domain they investigate. We found a concentration of indicators in food production at local to national levels and with less literature investigating how food governance affects food distribution and consumption. Many indicators of institutional structure were found, while indicators capturing social agency and indicators of cross-scale dynamics were moderately represented but critical perspectives on governance were lacking. These gaps present an opportunity for future empirical research to investigate more comprehensively the diverse components of food systems and how governance arrangements at different scales affect them.

Keywords Food systems · Governance · Food security · Research methods · Evidence synthesis · Socio-ecological change

1 Introduction

Despite huge technological advances and the use of large amounts of external inputs in much of the world's agricultural production, hunger and malnutrition remain a reality. Godfray et al. (2010) argue that achieving zero hunger, a UN Sustainable Development Goal, requires drawing on social and natural sciences to reorient global policies to look beyond maximizing food production. In shifting attention to the three additional dimensions of food security, namely access, utilization, and stability of food (FAO 1996), both practitioners and researchers have begun to adopt a systems approach to

✉ Aogán Delaney
aogan.delaney@gmail.com

[1] Independent Consultant Researcher, Luxembourg City, Luxembourg
[2] Department of Geography, Indiana University, Bloomington, IN, USA
[3] Department of Anthropology, University of Georgia, Athens, GA, USA
[4] Helsinki University Centre for Environment, HENVI, Helsinki, Finland
[5] Center for International Forestry Research, CIFOR, Bogor, Indonesia
[6] Research Methodology Chair Group, Wageningen University, Wageningen, the Netherlands
[7] International Livestock Research Institute, Nairobi, Kenya
[8] School of Sustainability, Arizona State University, Tempe, AZ, USA
[9] CGIAR Research Program on Climate Change, Agriculture and Food Security, Nairobi, Kenya
[10] Overseas Development Institute, London, UK
[11] Centre for Development and Environment, University of Bern, 3012 Bern, Switzerland
[12] Institute of Geography, University of Bern, 3012 Bern, Switzerland
[13] Département de science politique, Université de Montréal, Montreal, Canada

Published online: 26 March 2018

food. The food systems approach takes account of the complex interactions between food production, food distribution, food consumption, environmental impacts, and social justice outcomes (Horton et al. 2017). This aims to address what the productivist paradigm fails to, such as drops in the purchasing power of consumers despite higher yields and the multiple social, economic, and environmental factors impacting upon (and impacted by) food (Ericksen et al. 2009; Ingram 2011; Vermeulen et al. 2012). One trend, for example, argues that food should be analyzed in relation to the broader conceptual goal of food sustainability (Eakin et al. 2017; Esnouf et al. 2013; Koohafkan et al. 2012; Lang and Barling 2012; Maye and Kirwan 2013; Paillard et al. 2011), a concept that recognizes the range of diverse, sometimes conflicting (Clapp 2017) food systems outcomes, including environmental sustainability, resilience, and intra- and intergenerational equity (Alrøe et al. 2016; Colonna et al. 2013; Landert et al. 2017; Lang and Barling 2012; Zanella et al. 2015).

It is also increasingly recognized that governance forms an integral part in the functioning of food systems, enabling complex systems to respond to external factors. This is particularly significant with the rise of value chains that connect producers and consumers across jurisdictions and that are subject to interconnected social, economic, and environmental interactions across scales (Ericksen et al. 2009; Termeer et al. 2010; Vermeulen et al. 2012). Thus, any serious attempt to address world hunger will need to take account of the influence that governance has on food systems. Indeed, the FAO, in a 2011 workshop called for the compilation of case studies to identify "causal linkages between governance principles and better food security outcome" (FAO 2011, p. 8). Thus the design of food system interventions should be built on evidence of the role that different governance arrangements have on food systems, food security, and environmental outcomes.

Research on food systems governance (FSG) and food security governance has been conducted for some time (e.g., Makhura 1998; MacRae 1999), but it is only since the food price crisis in 2008 that research began to increase in frequency and to adopt explicit conceptualizations of governance, food systems, and food security (Candel 2014). However, the field has yet to arrive at a coherent synthesis of scholarly output, with reviews producing thematic overviews of the state of the field rather than aggregation of evidence (Bizikova et al. 2014; Candel 2014; Hospes and Brons 2016; Purdon 2014). As such, we have a limited understanding of what governance arrangements are suited to different social and ecological conditions to produce given food systems outcomes. Moreover, the tendency in recent decades towards multi-scale and networked forms of governance raises its own set of knowledge gaps.

This set of problems is both aided and frustrated by the fact that FSG is a topic of interest in multiple disciplines. The literature benefits from insights from a wide range of disciplines, which at the same time poses a challenge as any synthesis must be sensitive towards the diverse epistemological anchoring of socio-ecological research. Disciplinary foundations will necessarily result in some research projects focusing on a set of FSG indicators that are excluded from research grounded in other disciplinary perspectives. Unfortunately, research is not always communicated and engaged with across disciplines, leading to a range of disjointed concepts and methods being used to study the topic. Yet, embracing this challenge, recognizing complexity, and strategically communicating in interdisciplinary research can produce novel knowledge synthesis (Hirsch et al. 2011; Newell et al. 2005). Interdisciplinary scholarship can likewise inform dialogue on governance across different scales and epistemologies, a growing concern for governance related to global social and ecological issues (Miller and Erickson 2006; Miller et al. 2008).

Ten years after the food price crisis (von Braun 2009), which stimulated an increase in scholarship on food systems governance, the time is ripe for a synthesis of empirical findings towards more generalizable conclusions and recommendations. Unfortunately, the state of existing scholarship does not support this laudable aim. Scholarship tends to be concentrated on theoretical development rather than on empirical research, while existing research is often based on single-case studies and utilizes heterogeneous theories and indicators (Bizikova et al. 2014; Candel 2014; Hospes and Brons 2016; Purdon 2014). As a result, only some dimensions of food systems governance have received sufficient attention in peer-reviewed literature to facilitate cross-site synthesis. The dearth and incommensurability of evidence weakens possibilities for synthesis and generation of global conclusions (Dupuis and Biesbroek 2013; Purdon 2014; Steinberg 2015). As a result, we cannot identify what governance arrangements tend to mitigate or address food insecurity effectively. Indeed, to understand what is *effective* governance, research is required that can be aggregated in a meta-analysis to derive generalizable conclusions on causality. To this end, enhanced empirical research that is built on comparable indicators is needed.

With a view to addressing pertinent knowledge gaps in the domain of food security, an interdisciplinary working group (WG) was formed by the Consultative Group on International Agricultural Research (CGIAR) Research Program on Climate Change, Agriculture and Food Security (CCAFS). Following on from initial preparatory research (Bizikova et al. 2014; Purdon 2014), the WG conducted a formal, structured meta-analysis, reported on in this paper, with the objective of laying the foundations for a more consolidated second generation of commensurable research on FSG that will support subsequent comparison and aggregation of results. Prior reviews of food governance have highlighted important issues in FSG research. However, these prior reviews did not use a

systematic methodology. Our work has used a structured meta-analysis approach to develop a more objective review than has previously been developed. It does this through proposing core indicators to be used in future research, which we assemble from a review of literature, structured around the research question:

How can food systems governance be researched?

To operationalize this research question, the following two sub-questions are formulated:

- What indicators are used in current research to operationalize (aspects of) food systems governance?
- What aspects of food systems governance are not currently operationalized?

In the following section, we elaborate on knowledge gaps and develop our analytical framework.

2 Governance of food systems: Analytical framework

An FSG framework is essentially a merger of theories of governance with theories of food systems. Although concepts of governance have a long history in multiple disciplines, it is the development of a systems theory for food that marks a breakthrough on which current theoretical knowledge is built, and is therefore an appropriate place to begin discussion. The food systems approach emerged as a response to several factors, namely the spatio-temporal "modernization" of food production, the persistence of food insecurity despite total increases in food yields, and the recognition of how food influences and is influenced by social, economic, and environmental change (Ericksen 2008; Ericksen et al. 2009; Ingram 2011; Vermeulen et al. 2012). Drawing key literature together, Ericksen defined a food system as: the interactions between and within biogeophysical and human environments which determine a set of activities; the activities themselves (from production through to consumption); outcomes of the activities (e.g., contributions to food security, environmental security, and social welfare); and other determinants of food security (which partly arise from the interactions mentioned above) (Ericksen 2008, pp. 234–235).

If the concept of food systems acknowledges the interactions impacting on and mediating between food production and eventual food security or sustainability outcomes, the adoption of governance frameworks reflects the realization that such activities are not random but organized, dynamic, and contested, resulting from the interaction of different actors' agendas, strategies, and capacities within the food system. Governance sets the rules by which resources and systems are managed and governance research broadly considers the ability of a diversity of actors (state and non-state) to collectively exert their agency to order the world around them through both formal and informal means (Larson and Petkova 2011; Liverman and Kapadia 2012). Applied to the domain of food systems, governance has been defined as the "formal and informal interactions across scales between public and/or private entities ultimately aiming at the realization of food availability, food access, and food utilization, and their stability over time" (Candel 2014, p. 598). While this definition is particularly salient to the objective of *food security*, in the context of global change, governance also must consider dynamics that affect and are affected by processes occurring outside the formal boundaries of food-related activities (Ericksen 2008).

The complexity of food systems creates challenges for governance research. Beyond a focus on the production, processing, distribution, and outcomes, a systems approach requires incorporating the socioeconomic and environmental drivers and feedbacks (Ericksen 2008). This broadens the scope of assessment, which as our analysis will show, remains a key constraint in current research endeavors. An expanded conceptualization of governance must include the actors and activities of domains related to food system activities, for example, land use, conservation, energy and water resource management, poverty, and human development, amongst others. FSG mechanisms are equally diverse and include cross-scale and cross-domain instruments and processes. A full accounting of these mechanisms is not possible here, however, as with other governance domains, they can be analyzed through a "governance triangle" (Rhodes, 1997). This divides mechanisms into three related areas that include the state (public regulation mechanisms); civil society (participatory and democratic mechanisms); and market (market regulation mechanisms, including prices and rules) (Lamine et al. 2012). The challenge of FSG in an era of global change thus entails not only directing capacities to achieve food security outcomes but also to simultaneously achieve competing goals in environmental and social welfare domains. In the face of increasing uncertainty and dynamism in both environmental and social spheres, the ability of actors to steer the food systems to enhance resilience, facilitate adaptation, or to instigate transformation becomes a central governance concern (Ericksen et al. 2009; FAO 2012; van Bers et al. 2016; von Braun 2009; Wahlqvist et al. 2012).

A further challenge to FSG pertains to the diversity of food systems that exist. Based on research by Rastoin and Ghersi (2010) on the historical evolution of diverse food systems, Colonna et al. (2013) present a typology to represent the most recurrent food systems found at the global scale. Through a set of structural, functional, and outcome-related variables, these authors allow characterization of the main features of local food systems, based on types of economies, levels of technology, and value chain integration. Others have questioned the linearity of production-consumption models and highlighted the circularity of food cycles (Jurgilevich et al. 2016).

While we recognize the diversity of food systems, tailoring governance analysis to the full diversity of existing food systems is beyond the scope of our work. In this paper, we leave for a next step the question of whether indicators might need to be tailored to specific forms and expressions of food systems. The concept of scale, by contrast, is more immediately important. Drawing again on developments in political science and public administration (e.g., Hooghe and Marks 2003), arguments for a "scale-sensitive" (Termeer et al. 2010) approach to governance have been made in response to both practical concerns with targeting interventions (Altieri and Toledo 2011; De Schutter 2014; Kay 2009; Moragues-Faus et al. 2017) and also for empirical reasons (Eakin et al. 2009; Juhola and Westerhoff 2011; Purdon 2015; Termeer et al. 2010). In our study, we understand *scale* to refer to "spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon," while level refers to "units of analysis that are located at the same position on a scale" (Gibson et al. 2000, p. 218). These concepts are recognized as important because environmental problems, including but not limited to food security, cut across remits of traditional organizations and institutions and manifest differently at different geographic levels and are considered to require multi-scale governance arrangements (Adger 2001; Biermann et al. 2012; Dubbeling et al. 2017; Eakin et al. 2009; Moragues-Faus et al. 2017; Termeer et al. 2010).

We structure our review around a classificatory framework derived from FSG theory as outlined above. We adopt a two-dimensional matrix composed of five levels of governance (local through global) and three activities of food systems (production, distribution, and consumption). We also add a governance category to take account of explicitly cross-scale interactions or arrangements, while both dimensions also contain "universal" categories for indicators that apply to governance outside of discrete levels, and for a food system in its entirety, respectively. This framework is illustrated in Fig. 1, with key terms from throughout the paper defined in Table 1.

We emphasize that in using this simplified FSG framework, we are not ignoring the conceptual developments described earlier. Rather, we seek to report on the methodological state of the field at a level of detail so as to be consistent with all current developments. Therefore, we work within a framework that recognizes the minimum contributions that are common across most theories.

3 Methods

Our review was structured around the following sub-research questions:

- What indicators are used in current research to operationalize (aspects of) food systems governance?
- What aspects of food systems governance are not currently operationalized?

With the term *operationalization*, we follow the definition provided in Table 1. Our central unit of analysis when looking at operationalizations is the *indicator*, also defined in Table 1.

3.1 Literature gathering

We gathered literature through a structured consultation using the Delphi method (Linstone and Turoff 1975) and through drawing from the bibliographies of three recent systematic reviews on similar topics. Although database search is a frequently replicated method of literature gathering in reviews, we chose a consultative approach to identify relevant publications based on multidisciplinary expert knowledge of the field and because we have a purposive sampling rationale that is thematically or theory-driven rather than seeking statistical representation of a decidedly non-homogeneous body of literature. Delphi is a method of structured communication that facilitates knowledge elicitation among a group of experts (Linstone and Turoff 1975). Its goal is the elicitation of "tacit knowledge" of collectively held expertise and is characterized by a series of structured questionnaire-based rounds and the sharing of responses among the group with the possibility for adjustment of responses across multiple rounds as participants are shown arguments made by others. With a sufficient number of expert informants, such an exercise can capture salient literature that keyword search methods might miss. Alternatively, an expert informant process may miss very recently published literature that a keyword search catches.

A panel of 15 experts was drawn from the WG formed by CCAFS and external contacts including researchers from political science, economics, geography, and anthropology.[1] Participants were asked to nominate topical areas of relevance to the review, to suggest references to literature suitable for the review, and to answer subjective quality appraisals and topical relevance questions. Over the course of three rounds, 136 references were compiled. An additional set of reports was drawn from the bibliographies of three recent systematic reviews (Bizikova et al. 2014; Candel 2014; Hospes and Brons 2016). A list of all empirical articles ($n = 54$) from these three reviews was reviewed by the WG from which we selected 16 articles considered to be relevant, innovative, or path-breaking in terms of methods used. We also drew four new references published since 2013 (i.e., published after the searches in the systematic reviews were executed). Thus, 156 references were brought forward for screening. Our goal was more to acquire a sufficient amount of literature to develop a synthesis while acknowledging that the time required to conduct the synthesis

[1] This 15 member panel included 10 of the authors of this paper, plus five additional experts.

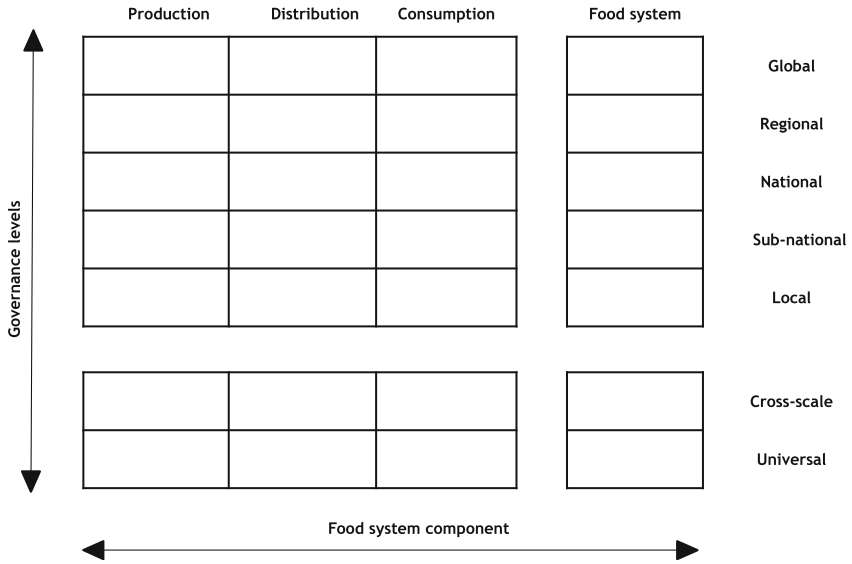

Fig. 1 Food systems governance indicator matrix (from Delaney et al. 2016a)

analysis itself meant that very recently released literature would not be included (i.e., articles published in 2015 or later).

Two criteria were applied for full inclusion in the review: articles must be (1) accessible and citable; and (2) empirical. This approach avoids the limitations of a keyword based search which we initially explored but found that the manuscripts returned from these keyword based searches were often conceptual in nature and lacked empirical data. We also recognized that keyword searches were omitting important manuscripts with which the working group members were familiar. One hundred and thirty-three references were accessed either through our academic library, open access, or

Table 1 Definition of key terms employed in the review of indicators of governance of food systems

Key term	Definition
Food system	The interactions between and within biogeophysical and human environments which determine a set of activities; the activities themselves (from production through to consumption); outcomes of the activities (e.g., contributions to food security, environmental security, and social welfare); and other determinants of food security (Ericksen 2008, pp. 234–235).
Food security	When all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food. Food security is composed of four dimensions: food availability, access to food, food utilization and stability over time (FAO 1996, FAO et al. 2013).
Governance	The ability of a diversity of actors (state and non-state) to collectively exert their agency to order the world around them through both formal and informal means (Larson and Petkova 2011; Liverman and Kapadia 2012).
Food systems governance	Governance of food systems refers to the ability of actors to steer the food systems to achieve food security, enhance resilience, facilitate adaptation, or to instigate transformation and involves not only the actors and activities of the food system itself but also the actors and activities of related domains such as land use, conservation, energy and water resource management, poverty, and human development. (Ericksen et al. 2009; FAO 2012; von Braun 2009; Wahlqvist et al. 2012).
Scale and level	*Scale* refers to "spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon," while *level* refers to "units of analysis that are located at the same position on a scale" (Gibson et al. 2000, p. 218).
Indicator	There is no consensus about what constitutes an indicator as distinct, for example, from questions on a data collection instrument or sub-constructs in a conceptual framework, nor are there stable reference points from which to create a definition, with different research designs conceptualizing, instrumentizing, and reporting at different levels of abstraction. In this paper, we label as an "indicator" a construct or instrument in an operationalization, at a defined harmonized level of abstraction.
Operationalization	The "act of generating data to empirically represent or measure a construct, including both the intermediate steps of conceptual decomposition and the final act of measurement" (Delaney et al. 2016b, p. 7).
Governance construct	A defined object, concept, or idea relating to governance appearing in a research question or theoretical framework (Crane et al. 2017).
Agency	Governance actors' or organizations' capabilities and/or actions in responding to change and/or undergoing self-transformation.
Institutional structure	Observable properties, relationships, or patterns by which institutions are organizationally arranged.

shared upon request, 65 of which were then excluded as non-empirical. Two additional articles were coded as non-empirical but subsequently re-included in the review as they constituted reviews of methods and contained descriptions of indicators of relevance. This left 68 records included in the full review (66 empirical plus two methods reviews). Details of these included records are listed as supplemental material (available online). The entire search and screening process is recounted in a technical report (Delaney and Tamás 2016), in particular in Appendix D of the report.

3.2 Data extraction

Research question (RQ)-level *governance constructs* were taken as the bases for operationalization and identification of indicators. Tracing conceptual deconstruction of RQ-level constructs down to items on data collection instruments enables a transparent description and analysis of its operationalization (Delaney et al. 2016b, Crane et al. 2017). Indicators were then identified from these descriptions of operationalizations. Reports were coded by a team of seven reviewers according to a structured coding framework.[2] Abstracts were screened to exclude non-empirical papers. Next, an RQ was identified, and in that RQ, any constructs equivalent to, or as a special case of, "governance" were identified (note that we did not specify a definition for *governance* because there are many different conceptualizations used and choosing one definition would likely exclude many papers, especially those from fields where explicit governance concepts have not yet been adopted). Non-empirical articles, articles without RQs, and those that did not contain a governance construct were excluded. For each governance construct, conceptual deconstruction was then coded from RQ-level constructs down to items on data collection instruments. Where reported, data collection methods, data analysis methods, a theoretically based justification of inference from results to conclusions, and discussion of limitations were also identified. This information was compiled into structured summaries for each article. In cases where we retrieved some but not all information from reports, we also took the step of following cited works and of contacting authors.

3.3 Analysis

The structured summaries were loaded into Atlas.ti, a qualitative analysis software package, for analytical coding. We first identified indicators at an agreed-upon harmonized level of conceptual abstraction (see below). In some papers, this conceptual level corresponded to RQ-level constructs, while in other papers we coded the lowest levels of conceptual deconstruction used in those papers (i.e. constructs that were directly operationalized in the paper's methodology). Those articles not containing this conceptual level were removed from further analysis. Indicators were then classified according to three dimensions:

- Governance level: local; sub-national; national; regional; global; cross scale; universal; and "NotGov" (to denote constructs that were not indicators of governance).
- Food system activities: production; distribution; consumption; food system (indicators with application across food systems as a whole); miscellaneous (to denote indicators that did not easily fit into any of the four discrete components); and "NotFS" (to denote constructs that were not used to study governance of food systems).
- Phenomena being empirically studied (to distinguish, for example, indicators of participation from indicators of deliberation).

Coding for phenomena was open, but a startlist of codes, developed during a workshop held by the WG as part of the design of this review, was used as a guide:

> Participation; information use; information accessibility; salience; political settlements; agency; long-term policy; political representation; authority; learning; state capacity; accountability; political leadership; dialogue; multi-value; networks; coordination; centralization; facilitation; transparency; uncertainty management; social inclusion; flexibility; resilience/robustness; diversity; polycentricity; trust; commitment; fairness; legitimacy

This list was developed based on concepts from literature on environmental governance (not specific to food systems) that participants found important to the structuring and function of social-ecological systems which in many cases constitute a larger literature (e.g., common-pool resources) than that on food systems governance specifically. Classification of governance levels and food system activities was made according to where the indicator was operationalized and data collected from. For example, indicators from a study that collects data from members of a provincial agricultural cooperative would be classified as "sub-national" and "production." Classification of phenomena was done based on examining what data was collected and/or how indicators were conceptually defined, where possible. Reporting did not always allow a clear and even picture to be assembled, and the phenomena being studied by an indicator had to be inferred in some cases. Once all indicators had been identified from the structured summaries and classified, they were assembled into the FSG classificatory framework displayed earlier in Fig. 1. The set of

[2] This team includes four authors of this paper, plus three research assistants.

indicators was examined and mergers made iteratively in order to consolidate the results.

4 Results

Of the 68 reports brought forward for coding, 52 contained a governance construct in its research question (RQ), with two papers containing two governance constructs. These articles were therefore coded to generate 54 structured summaries of operationalizations. In bringing forward these 54 for analysis, 35 contained the minimum information required to identify indicators that could be classified according to our framework. In total, 111 unique indicators were extracted from the literature in this way. After synthesizing equivalent indicators, their number totaled 41. These are presented in Table 2, grouped for readability purposes into loose categories.

The underlying indicators can sometimes vary considerably, and merging these primary indicators under synthesized headings necessarily involves some degree of judgement in order to make the collection of results interpretable and to identify salient patterns. To take one illustrative, but by no means unique, example, Table 3 summarizes the different definitions used for the indicator 'participation and multi-stakeholder engagement'. Interested readers are referred to the technical report for the project (Delaney and Tamás 2016), for full details of further operationalization in terms of data collection and analysis of these and all other indicators.

When coded according to governance level and food system activity, counts were taken of distribution across food system activities and across different governance levels. The distributions can be seen in Fig. 2. Distribution across governance levels is limited to food production indicators, as these comprise the vast majority of indicators. During classification, a number of indicators were classified as *miscellaneous*, that is, not fitting any of the three discrete food systems components, but yet not corresponding to food systems as a whole. While they don't fit into discrete cells as they are operationalized in the articles from which they were taken, they are nonetheless included in the charts in Fig. 2 as they are relevant FSG indicators and their presence highlights limitations with the use of the FSG analytic framework. Other indicators ($n = 39$) were classified as *NotFS*, that is, not relating to food systems, having come from articles that are topically proximate to food (e.g., climate adaptation in rural areas; landscape management; forestry), but that had no relation to food at lower conceptual and methodological levels. These have been omitted from analysis. The implications of our results are discussed in the next section.

5 Discussion

One thing to note at the outset is that the indicators that emerge from our analysis of the literature are extremely diverse in terms of the scale of reference, the nature of the phenomena, the nature and method of measurement, and even the research questions they seek to address. As such, it is much too early to derive measurements of food systems governance that are clearly validated through wide empirical application. Indeed, the indicators or measurements tend to be rather generic in their scope and open to a broad range of interpretation in their implementation. This is not surprising as it is symptomatic of a very young field that examines a complex, multifaceted phenomenon from diverse disciplinary perspectives.

It might even be argued that the highly generic and widely interpretable nature of the indicators used make them – and analysis of them – less than useful. For example, Wambugu et al. (2015), Cooper and Wheeler (2015), and Pesqueira and Glasbergen (2013) all identify problems with participation. As these refer to different kinds of problems – gender-based exclusion and lack of institutional support, inclusion only of wealthier farmers and elite capture, and participation only in 'invited spaces' rather than from below, respectively – it is difficult to relate these to one another, as the various forms of exclusion are evidently not examined across all three sites and the papers end up talking past each other. In large part this results from the different methods used and conceptualizations underlying their study of 'participation', as outlined in the results section. While certainly important in understanding barriers to participation in the specific contexts, it is difficult to draw any broader conclusions from the three studies beyond the rather generic observation that participation *can* face different barriers in different places.

However, as the field matures and seeks greater engagement with policy applications, it will benefit from internal dialogue that acknowledges and reaches across its diversity to move toward greater specificity and clarity in the ways that measurements are operationalized and reported. This is emphatically not an argument for standardization of research methods. Rather, outlining the parameters of the field's vast heterogeneity should stimulate conversations about its strengths, weaknesses and gaps and tradeoffs. While it is important that indicators selected for a particular study are suitable to the context of application, on the other hand, non-comparability of research designs can hinder practical goals such as resource allocation, prioritization, or multi-site tracking. This conversation, in turn, should help refine conceptual and methodological toolkits available to practitioners in the field.

Only eight of the identified indicators have been used in numerical ways in our sample. This illustrates the challenges

Table 2 Indicators of food systems governance analyzed in the review, after synthesis

Category	Indicator name	Description of indicator	Type of variable
Agency	Adaptive capacity	Capacities of institutions or actors to adapt in response to external change	Ordinal[a] Unclear[b]
	Leadership	Leadership qualities in stimulating action and articulating vision	Ordinal[c] Open-ended[d]
	Learning	How institutions or groups learn from past experience, enabling better responses in future	Ordinal[c] Open-ended[e,f] Narrative[f] Unclear[g]
	Non-state self-organizing	Self-organization and actions by non-state actors and institutions	Open-ended[d,h] Unclear[b]
	Reflexivity	Capability to deal with unstructured problems in multiple realities	Open-ended[i] Narrative[j]
	Resilience/robustness	Capability to flexibly adapt in response to changes without losing identity	Open-ended[i] Narrative[f,j]
	Responsiveness	Capability to observe and respond effectively and legitimately to pressing issues	Open-ended[i] Narrative[j]
	Revitalization	Capability to unblock unproductive patterns and reanimate governance process	Open-ended[i] Narrative[j]
Contextual factors	Rule of law	Quality of law enforcement	Numeric[k] Unclear[l]
	Country size	Size of country where governance institutions are situated, measured in terms of population	Unclear[m]
	Political stability	Chances of change in government form	Numeric[k]
	Public social commitments	Programs and expenditures by government with social benefits. Indicators are hypothesized to positively correlate to positive FSG	Numeric[k,m]
	Resources	How resources (e.g., technological, financial, legal) are generated and utilized	Ordinal[c] Open-ended[e] Numeric[m]
Democracy	Accountability	Whether governance actors must explain decisions and actions and are subject to sanctions for poor decisions/actions	Narrative[f] Unclear[l]
	Corruption	Abuse of public power	Numeric[k,m]
	Deliberation	Extent to which process facilitates open discussion and reflection among actors with differing viewpoints and understandings	Open-ended[n] Narrative[f]
	Discursive framing	How issues or concepts come to be constructed, framed, and understood by governance actors	Narrative[o] Unclear[p]
	Electorally democratic	The institution is characterized by "free and fair" elections	Numeric[k,q] Narrative[f]
	Empowerment	Not defined	Narrative[f]
	Fairness	A collection of methods examining aspects related to fairness (e.g., equitable distribution of benefits and risks)	Ordinal[c] Narrative[f,r] Unclear[l]
	Gender-sensitivity	Collection of methods examining issues related to gender in governance (e.g., decision-making competences in hands of women)	Open-ended[s] Narrative[r]
	Legitimacy	Political acceptance of decisions or institutions	Unclear[t]
	Participation and multi-stakeholder engagement	Collection of methods examining how and extent to which institutions engage multiple stakeholders and/or citizens in decision-making	Categorical[u,v] Open-ended[d,e] Narrative[f,r] Unclear[l,p]
Institutional structure	Centralization	Extent to which governance is hierarchical or horizontal	Unclear[w]
	Common-pool resource management design	Assessment of institutional design of common-pool resource governance structures	Numeric[x] Unclear[y]
	Cross-scale interaction	How and the extent to which actors and bodies interact across different scales of governance	Categorical[u] Open-ended[d,s] Unclear[z] Numeric[m]

Table 2 (continued)

Category	Indicator name	Description of indicator	Type of variable
	Governance frameworks	Framework setting out rules influencing how governance functions and behaves	Open-ended[s] Categorical[u] Unclear[z]
	Holistic	Extent to which governance seeks continuous improvement of a wider range of goals (e.g., environmental integrity, economic resilience, good governance)	Unclear[l]
	Implementation-supporting conditions	Conditions whose presence suggests the implementation of a food system strategy or program is more likely (e.g., pressure from public, commitment of actors, institutional barriers preventing or mechanisms supporting policy change)	Numeric[m] Open-ended[AA,BB]
	Informal governance	Unofficial or social or norms that influence governance processes	Open-ended[s,CC] Unclear[z,DD]
	Institutional mainstreaming	The extent to which issues are integrated into wider, non-sectoral-specific institutions	Open-ended[AA,EE] Narrative[r]
	Legal framework	A legal framework in place regulating (aspects of) food systems	Narrative[r] Categorical[v] Unclear[FF]
	Networks	Governance is characterized by networks between actors and bodies	Open-ended[d] Unclear[p,z]
	Policy framework	Policy formulated for the governance (aspects of) food systems.	Open-ended[GG] Narrative[r,GG] Categorical[v]
	Polycentricity	The extent to which institutions have multiple centers or authorities	Open-ended[d]; Narrative[f]
	Scale-specific responsibilities and competences	This group of methods examines how responsibilities and competences are distributed across specific levels of governance. This includes, among others, national governments assuming domestic responsibility as part of international agreements, support given to local-level units, or possibilities for autonomous action at specific scales	Ordinal[c] Open-ended[i,s,AA,HH] Categorical[v] Narrative[f]
	State capacity	The capacity of a state to implement decisions	Numeric[k,m]
Performance	Effective	Governance can fulfill an initiative's objectives	Unclear[t]
	Favorable initial policy change	Examines initial policy changes that might be indicative of further governance action to come	Categorical[u,v]
	Outcomes of similar programs	Examination of outcomes of previous programs that might be indicative of further governance performance	Unclear[II] Numeric[m]
	Use of knowledge and science	Examines how scientific research is used in governance of food systems (e.g., whether programs are independently evaluated, linkages between governance bodies and scientific institutes, sharing of knowledge across governance bodies)	Narrative[r] Open-ended[d,AA] Categorical[u]

Note that descriptions are given to aid interpretation. They cannot in all cases capture the particularities of all indicators in a given set. For full descriptions, see the technical report for this project (Delaney and Tamás 2016). [a] Leith et al. 2012; [b] Jacobi et al. 2015a; [c] Gupta et al. 2010; [d] Cooper and Wheeler 2015; [e] Eakin et al. 2011; [f] Lebel et al. 2006; [g] Wilder et al. 2010; [h] Jacobi et al. 2015b; [i] Candel et al. 2015; [j] Termeer et al. 2013; [k] Mandemaker et al. 2011; [l] Jawtusch et al. 2013; [m] Lesnikowski et al. 2013; [n] Schouten et al. 2012; [o] Boons and Mendoza 2010; [p] Pesqueira and Glasbergen 2013; [q] Acemoglu et al. 2009; [r] Wambugu et al. 2015; [s] Galiè 2013; [t] von Geibler 2013; [u] Donovan et al. 2010; [v] Korhonen-Kurki et al. 2014; [w] Gereffi et al. 2005; [x] Huntjens et al. 2012; [y] Poteete and Ostrom 2004; [z] Juhola and Westerhoff 2011; [AA] Bizikova et al. 2015; [BB] Brownhill and Hickey 2012; [CC] Spielman et al. 2008; [DD] Osbahr et al. 2010; [EE] Sietz et al. 2011; [FF] Kabubo-Mariara 2007; [GG] Osbahr et al. 2008; [HH] Quinn et al. 2011; [II] Minde et al. 2008.

of quantifying food system governance in meaningful metrics. Using quantitative metrics, based on social conventions of how to code observed governance dynamics in ordinal or numerical scales, has definite benefits: it may simplify communication, make use of the power of numbers, support comparative analyses, and aid in monitoring performance (Dupuis and Biesbroek 2013; Purdon 2014; Steinberg 2015). At the same time, quantification of governance in meaningful metrics is challenged by the unforeseen dynamics of flexible and adaptive strategies adopted by diverse actors and may hide more than it clarifies about, for example, context-specific belief systems, values and motivations, and assets that underlie actors' assessments and strategies, a point that is returned to below. These insights highlight the

Table 3 Definitions of the indicator 'participation and multi-stakeholder engagement' found in reviewed papers

Source	Original term	Construct definition
Cooper and Wheeler 2015	Diversity of state and non-state multi-stakeholder engagement and interaction	None found
Donovan et al. 2010	Continuous multistakeholder consultation process	"Stakeholder consultation methodology and management shall be developed (institutionalization, transparency, independence, equitability)" (Donovan et al. 2010, p. 24)
Eakin et al. 2011	Participation, empowerment and accountability	"Enhanced responsiveness of government to citizens as customers/clients; decentralized decision making to where problems are experienced" (Eakin et al. 2011, p. 342)
Jawtusch et al. 2013	Participation	"Participation in SAFA refers to the need for outreach to, and ensuring the potential for involvement of, interested parties, in particular those who are materially affected. This includes the ability to actively take part in decision making. Sub-themes included are: Stakeholder Dialogue; Grievance Procedures; and Conflict Resolution" (FAO 2014, p. 90)
Korhonen-Kurki et al. 2014	Inclusiveness of the policy process	"There is a high degree of participation and consultation of key stakeholders (including private sector), civil society, and indigenous people. Legal provisions supporting the right of indigenous people and communities to participate are in place" (Korhonen-Kurki et al. 2014, p. 177)
Lebel et al. 2006	Participation	"Public participation allows differences in interests and interactions with other issues to be brought forward for public scrutiny" (Lebel et al. 2006, p. 5)
Pesqueira and Glasbergen 2013	Creation of connecting spaces	"The creation of connecting spaces which create opportunities for less privileged groups to participate in the networked structure of the arrangement. This implies that Oxfam is able to activate grassroots interests and form alliances that open up opportunities to empower less powerful groups to participate in the RSPO arrangement" (Pesqueira and Glasbergen 2013, p. 298)
Wambugu et al. 2015	Participatory and collaborative processes	"We focus on the inclusivity of the planning and implementation processes of the climate-smart practices through: a) the variety and levels of actors in the landscape, b) what levels and sectors they represent (if applicable), d) the presence and nature of local representation, i.e., descriptive versus substantive, and e) how resources, knowledge and decision-making powers are shared among the actors" (Wambugu et al. 2015, p. 260)

importance of using mixed methods in the emerging research field of food systems governance, creating space for methodological interplays among different epistemologies across quantitative and qualitative research traditions (Bierman et al. 2012; Hirsch et al. 2011; Miller et al. 2008; Newell et al. 2005).

5.1 Governance levels and food system activities operationalized

Despite the development of both food security and food systems frameworks and the recurrent suggestions to expand the study of food beyond a narrow focus on food *availability* (FAO 1996;

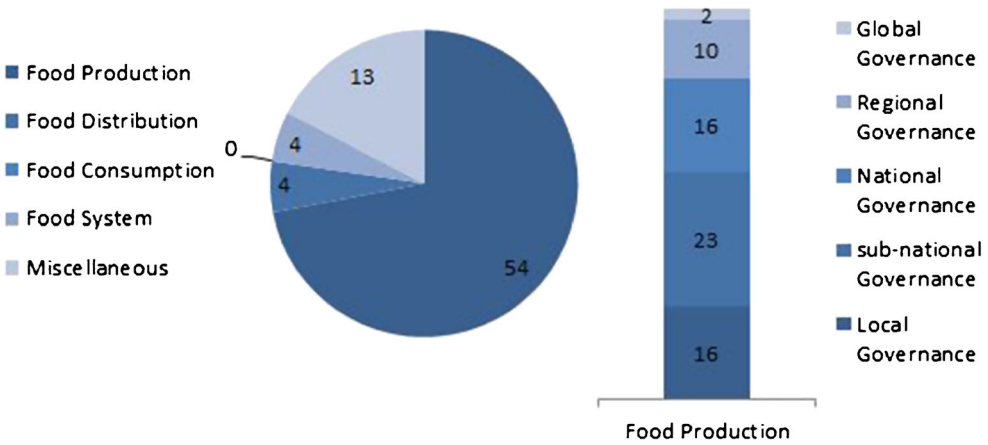

Fig. 2 Distribution of indicators ($n = 72$) found across food system activity (left) and distribution of indicators for governance of food production ($n = 54$) across governance levels (right). Note that some indicators were operationalized at more than one governance level or more than one food system activity

Ingram 2011; Vermeulen et al. 2012), the indicators we have identified in this review are heavily concentrated in the *food production* sector. Within production, national-level, sub-national, and local-level governance appear well-studied. A tempting conclusion would be that this reflects traditional conflating of the study of food with that of agriculture, and that agriculture itself is still conceived of as a domestic, within-country issue. However, this conclusion cannot be inferred simply based on distribution of indicators.

In contrast to the heavy concentration of indicators in food production, all other activities are practically empty. Even these small numbers in *distribution*, *food system*, and *miscellaneous* are misleading. Of the four indicators operationalized across *food systems*, three were taken from one article (Pesqueira and Glasbergen 2013), while 11 out of 13 indicators classified as *miscellaneous* are drawn from only two articles (Candel et al. 2015; Gupta et al. 2010). Relative sparseness might be attributable to our sampling of the literature. Our interest is in food systems in relation to environmental change, and agriculture is where environmental impacts are most often created and felt. Moreover, the WG and expert panel are drawn from networks surrounding CCAFS and CGIAR, which has a specific interest in agricultural production. Similarly, research on distribution might have been overlooked because it is called "value chain analysis" rather than *governance* and is concerned with private-sector objectives in place of food security or sustainability goals, while governance of food consumption falls under the umbrella of food *policy* or *standards*. However, near total absence seems to suggest that research on these components of the food system is not being adequately engaged by the food systems or governance communities of scholars.

Indeed, the most frequently cited journals in the systematic review by Hospes and Brons (2016) focused on environmental science or agriculture—areas likely to focus on food production. Journal subject foci more likely to address distribution (e.g., planning, management, or business) and consumption (e.g., health and nutrition) appeared far less frequently. Literature in their review was gathered by database search using strings derived from two concepts: *food system* and *governance*. It is, therefore, likely that the underrepresentation of distribution- and consumption-focused research is a symptom of such research not having adopted food systems and governance concepts. Another possible explanation is the analytical framework we used. This framework tries to both work with systems-approaches but at the same time categorize indicators into discrete cells. This explanation is substantiated by the significant number of indicators that did not fit this framing and were classified as *miscellaneous*.

We also found a relatively low number of indicators for cross-scale governance, all of which are found in the food production component. It is precisely with the complexity recognized in systems dynamics that the cross-scale governance of food becomes most relevant. There are numerous pathways through which a catalyst (e.g., policy change) can cascade down to impacts at local levels and also pathways through which local-level events (e.g., drought) have implications at higher levels. However, the results suggest that we lack methods to research cross-scale governance and are therefore ill-equipped as yet to study and understand this phenomenon.

Combined, these patterns suggest that methodological developments in FSG works (including field data collection protocols and sheer volume of empirical research) have yet to catch up with theoretical advances. The set of indicators offers a wealth of options for fine-grained study of governance of food production, but little assistance for the study of food distribution or consumption governance. This uneven distribution has consequences in terms of what can be adequately researched. Ingram (2011), for example, argues that regional scale is the appropriate scale for understanding food systems because it incorporates complex cross-sectoral interactions but still retains the geographic and cultural specificity that is lost in analysis at higher scales. However, using only the methods found does not allow ideas such as these to be empirically tested, refuted, or refined.

5.2 Governance properties operationalized—Overview

A synthesis identifying simple presence or absence of indicators across a set of case studies is less helpful than an evaluation of how different indicators have been incorporated in past research. We therefore move to explore the kinds of phenomena examined by this set of indicators. A large share of indicators examine the structure of governance institutions. These range from straightforward descriptions of legal, policy, and governance frameworks to those that examine more relational properties such as degrees of centralization, polycentricity, participation and engagement of cross-sectoral stakeholders, network properties, how competences are situated in nested hierarchies, or relations that cross scales. A number of studies also contain indicators that look at aspects of informal governance. Charges have been levelled that FSG research is overly concerned with technical aspects of governance (Candel 2014; Purdon 2014), so it is expected that a large share of indicators are concerned with institutional structure. A welcome set of results considering this are agency-related indicators. That is, indicators that examine governance actors' or organizations' capabilities to respond to change or to transform the governance arrangements of which they are a part. Notable here are those that focus on learning. Encouragingly, some indicators are used to examine self-organizing of non-state actors, a phenomenon that will likely be of increasing importance given arguments, although nuanced and contested, for a shift away from the centrality of the (nation-)state. Worryingly, however, four well-

conceptualized agency indicators (Reflexivity; Resilience/robustness; Responsiveness; Revitalization) are derived from only two articles that share an overlap in authorship (Candel et al. 2015; Termeer et al. 2013) and are concentrated at regional-level governance, suggesting that the breadth of agency-oriented indicators is less than what appears on first reading.

Of these structural and agency-oriented indicators, some can be observed to have explicit scale dimensions (e.g., Centralization, Cross-scale interaction, Non-state self-organizing). It is essential that issues of scale be examined as food security and environmental problems cross borders and are manifest at different scales (Adger 2001; Biermann et al. 2012; Dubbeling et al. 2017; Eakin et al. 2009; Morague-Faus et al. 2017; Termeer et al. 2010). However, methodological incorporation of this awareness, while welcome, is not sufficient. As shown in Table 4, many "scale-aware" indicators are still operationalized at, and collect data from, particular levels. To take just two characteristic examples, data for cross-scale interaction indicators operationalized by the constructs "formal dialogue with the EU" and "participation in institutions of global governance" were both collected at the national level (Donovan et al. 2010; Lesnikowski et al. 2013). Relatively few authors take the next step of operationalizing these indicators in a multi-level study. Indicators that do not examine multi-level dynamics with data *collected from multiple levels* do not allow examination of the vital question of how food systems are impacted by cross-scale dynamics.

Another set of indicators relates to democracy. These include long-standing characteristics of liberal democracy, for example, Electoral democracy, Accountability, Corruption, and Legitimacy. There are also some that reflect a more recent trend of "deepening democracy" (Cornwall and Coelho 2007; Fung 2004), for example, Deliberation, Participation and multi-stakeholder engagement, and Gender-sensitivity. This would appear to provide a useful balance for research into democratic qualities of governance. Notably, however, some come from methodological toolkits for the study of "good governance" (Jawtusch et al. 2013; Mandemaker et al. 2011). While "good governance" is often professed to increase food security (FAO 2011) the empirical basis for this relationship is problematic at best (Azmat and Coghill 2005; Grindle 2004). More importantly, these indicator sets carry norms that have been criticized as Western-centric (Blunt 1995; Hermes and Lensink 2001), a point that is returned to below.

A smaller set of indicators could be described as oriented towards assessing the implementation of governance reforms. These include, for example, examining whether initial policy changes have been made (Donovan et al. 2010; Korhonen-Kurki et al. 2014), or assessments of similar, related programs (Lesnikowski et al. 2013; Minde et al. 2008). One could also take some democracy indicators and use them as assessment indicators (e.g., Fairness, Empowerment, Gender-sensitivity). Indicators such as these would make an important part of a methodological toolkit as they are necessary for evaluative purposes. However, proportionally, their number is small and they are oriented to evaluating *implementation* rather than *impact* of governance change. Indeed, a proper impact evaluation design would use dependent variables from outside the domain of governance (e.g., food security levels; environmental impact). Dependent variables such as these were outside the scope of this review as they have a much longer history of use in the study of food and as a consequence there is more consensus around such concepts and how they should be measured.

5.3 Governance properties operationalized—Implications

With this overview, some insights can be drawn in terms of what kind of phenomena are, and are not, represented. First is the welcome inclusion of agency in addition to institutional structure indicators. The governance dimension was introduced to food systems research in order to understand system-adaptation or transformation in response to environmental or economic stress. Yet, much research still has a tendency to reduce governance to a set of technical or institutional properties. The inclusion of agency-oriented indicators enables us to get beyond a purely technical understanding to capturing how governance actors themselves respond to or anticipate perceived threats and seek to restructure or

Table 4 "Scale-aware" indicators of food systems governance categorized according to governance level at which data is collected

Governance level	Indicators
Global governance	Centralization; Networks; Participation and multi-stakeholder engagement
Regional governance	Institutional mainstreaming; Scale-specific responsibilities and competences
National governance	Scale-specific responsibilities and competences
Sub-national governance	Holistic; Non-state self-organizing; Participation and multi-stakeholder engagement; Polycentricity; Scale-specific responsibilities and competences
Local governance	Holistic; Informal governance; Networks; Non-state self-organizing; Participation and multi-stakeholder engagement; Scale-specific responsibilities and competences
Cross-scale	Adaptive capacity; Cross-scale interaction; Non-state self-organizing; Polycentricity; Scale-specific responsibilities and competences

transform governance arrangements (see e.g. van Bers et al. 2016). Some weaknesses were observed, notably the clustering around one set of researchers and at specific governance levels. For example, indicators of reflexivity, responsiveness, and revitalization were concentrated at the regional level, whereas learning and non-state self-organizing were seen at lower levels (see Table 5). Operationalization of certain phenomena only at certain levels will only enable partial observation of, for example, top-down or bottom-up agency. In this light, using indicators of democracy or deliberation could be an important bridge for assessing how sometimes contradicting pressures from bottom-up and top-down driven forms of political agency cohere at the system-scale.

Secondly, if used in evaluation studies, most of the indicators found would be best used as independent variables, whereas we only have a small number of indicators that can be used for process assessment (e.g., initial implementation of policy change [Donovan et al. 2010; Korhonen-Kurki et al. 2014], or inclusion of stakeholders [Wambugu et al. 2015]). This raises a number of issues. While it was argued above that some of the democracy indicators might also be used for assessment purposes, it was also cautioned that these indicators carry implicit and explicit norms that should be examined carefully and critically prior to being prescribed in a core methodological framework. Furthermore, while impact evaluations, strictly defined, would require variables from the domain of food systems rather than governance (e.g., nutritional outcomes, access to food, environmental impacts), and hence fall outside the scope of this review, it is striking that implementation-monitoring indicators are so few when it is precisely this area where indicators would need to be most food system specific. This is probably a symptom of indicators being assimilated from existing governance research, with less methodological development specifically for the governance of food systems. Thus, the development or tailoring of indicators that examine, for example, mainstreaming of food systems approaches across sector-specific institutions, or particular nutritional targets adopted by policy, should be seen as a priority. A focus on food systems-oriented implementation or output indicators should not distract from the equal need for dependent variables to be used in future *impact* evaluation research. While this is outside the scope of this review, it is worth noting that many existing studies do not ask causal questions, or they evaluate governance according to implementation rather than impact variables (Minde et al. 2008; von Geibler 2013). Therefore, it needs to be stressed that without dependent variables that are operationalized outside of the domain of governance, or by using time-sensitive methods to analyze governance outcomes over time, the next generation of research will not produce findings that inform how governance can best address food system challenges.

Third, our findings confirm observations made by Candel (2014) that much research treats governance in functionalist terms. This is known as managerial bias, where research is done in such a way that highlights those features that interveners recognize as relevant, using frames that position interveners as relevant, and presenting results in a manner functional to intervention by funders (Roberts et al. 2005). This is completely to be expected given that our research goals themselves are functionalist and relate to addressing food security through governance interventions. However, it is important to be aware that such approaches are usually blinkered to issues like conflicts of interests, or insolvable "wicked problems" (Candel 2014; Purdon 2014). Even with the agency-oriented indicators, many of the methods found serve the purpose of monitoring the *capacity* of governance to deal with problems, which has a tendency to reduce agency to observable and quantifiable endowments. There is a strong tradition of critical research in disciplines such as political science, anthropology, political economy, or geography that, while not contributing to immediate measurable and solutions-oriented results, has nonetheless led over time to some significant paradigmatic changes. This tradition is for the most part absent here. While critical research might seem superfluous for applied evaluative research, it is important that methods be developed, or borrowed and adapted, to study any such area that is not well-represented by the present indicator set. If issues such as ideology, structural discrimination, orientalism, or governmentality continue to evade empirical observation, they will continue to be poorly understood even though they play significant roles in governance of food systems.

And fourth, indicators are more than measurements and carry meanings and implications when operationalized. The indicators reviewed are largely driven by theory rather than

Table 5 Agency indicators categorized according to governance level at which data is collected

Governance level	Indicators
Global governance	
Regional governance	Reflexivity; Resilience/robustness; Responsiveness; Revitalization
National governance	
Sub-national governance	Learning; Non-state self-organizing; Resilience/robustness
Local governance	Leadership; Learning; Non-state self-organizing
Cross-scale	Adaptive capacity; Cross-scale interaction; Non-state self-organizing

empirically driven. That is, existing concepts are applied in settings where they might not be meaningful. As an intuitive example, while transparency might be measured in the United States by online publication of meetings, this would have little meaning in a setting characterized by low Internet connectivity or high illiteracy. There is relatively little inductive work that seeks to identify phenomena that can function as indicators appropriate to a particular site. More frequently existing concepts are transposed to new sites to measure aspects of governance which have assumed but unconfirmed salience in those new empirical settings. Taking this further, the precise meanings of indicators, and hence of the norms they carry, can vary. For instance, what is considered a "visionary leader" (Gupta et al. 2010) in one context may be considered as autocratic in other contexts, or even in the same context. What is considered "effective implementation" (von Geibler 2013) by some may be considered by others as depriving actors of rights. A number of articles examine the self-organizing of non-state actors (Cooper and Wheeler 2015; Jacobi et al. 2015a, 2015b), which can be seen as a positive recognition that governments, states, and markets alone are not the only actors affecting food systems. However, when viewed in the context of a generalized retreat of the state in favor of the market, celebrating the autonomous acts of "the community" might instead end up furthering ideological interests. Understanding how different forms of FSG strengthen or weaken social and political movements and the achievement of agendas is an important phenomenon that requires study but is not captured by these indicators. Related is the crucial question of who has a voice in defining and giving meaning to such indicators, and in what kinds of research designs (quantitative, qualitative, or mixed methods) they are operationalized. Indeed, the proliferation of the term "governance" over "government" dates from the 1990s as the state was rolled back as part of post-Cold War neoliberal reforms. In light of the 2008 financial crisis and the rise of East Asian economies, this trend has reversed in certain disciplines, notably political science, where the state is increasingly seen as a necessary partner to development (e.g., Acemoglu and Robinson, 2012; Fukuyama, 2013; Stiglitz et al., 2013). Our review suggests that research to date is discipline-specific and cross-disciplinary engagement remains low, particularly for fields where governance or systems concepts are not yet commonly used. Notable also is the low engagement with political science, arguably the discipline that is best placed to study food systems *governance*. Looking forward, therefore, indicators should ideally be tested for salience in transdisciplinary and mixed methods research designs and teams.

5.4 Limitations

We note that our findings are subject to limitations. First, they are limited by how we sampled literature. This results on the one hand from the collective expertise, including biases, of the WG and the exclusion of books in favor of accessible publications. We also risk reproducing a bias among the FSG community in terms of which disciplines are engaged with and which not, while also neglecting research that has not yet adopted food systems and/or governance perspectives but that is nonetheless of relevance. Secondly, we have taken and presented methods at face value, without quality appraisals. Third, we have taken indicators from the conceptual frameworks for which they were designed and placed them in a framework for which they may no longer have validity. And fourth, description of indicators is partial (see an earlier report and technical report of this review for more detail [Delaney et al. 2016a; Delaney and Tamás 2016]), and adoption and replication of methods will require guidance from the authors who designed them.

5.5 Future steps

Taking the points discussed thus far into account, we outline some future steps beyond this project. A first priority is to pilot and validate the indicators described in this review. A second priority is for methodological development for sparsely represented food system activities and governance levels and for phenomena that are underrepresented. These include indicators for governance of distribution and consumption, either through development of new indicators or through more engagement by the FSG community with researchers already working on food consumption or distribution. It also includes scale indicators that are operationalizable *across scales*, agency at more levels than at present, indicators for process assessment—in particular, those with explicit food systems dimensions—and methods to give a more critical view of governance. This methodological development would ideally augment this review through sampling literature in areas that we have missed, although a clear understanding of what is considered food systems governance (e.g., food policy, food safety standards, supply chain management, food sovereignty, etc.) is required. Both of these steps, piloting and methodological development, should ideally be undertaken by interdisciplinary teams. This augmented set of validated indicators then needs to be integrated into FSG theoretical frameworks or typologies of food systems that are more formalized than the classificatory framework used here. It may also be useful to analyze the indicators with respect to epistemological plurality. This will require dialogue between methodologists and theorists. Following these immediate priorities is expected to result in a consolidated methodological framework for a second generation of research on FSG. Finally, in the medium to long term, these steps should lead to a body of research that supports a meta-analysis, the conclusions of which should be used to inform better interventions.

6 Conclusions

Research on governance of food systems shows a clear tendency of being disparate and lacking common methods that are sensitive to epistemic plurality. Combined, this results in a body of evidence that lacks commensurability, making it difficult to draw conclusions that have relevance beyond the specific sites where research has taken place. This paper has sought to transparently identify a core set of indicators used to study FSG in order to contribute to the foundations for a second generation of research that, it is hoped, will be comparable and will enable aggregation and secondary analysis of results. In this way, we hope to further recommendations for the establishment of an "analytical framework that allows the accommodation of diverse experience from field work and analytical studies" and that programs be designed in such a way "that allows measuring the effect that governance has on food security" (FAO 2011, p. 8). Through conducting a structured review and analysis of the literature, we have found a concentration of indicators of FSG in the production sector at local to national scales and a sparseness of methods used to study distribution and consumption. We must warn that this claim is tentative and reflects the literature included in our review which, as mentioned, is not representative. However, it is probably also symptomatic of two additional factors: a lack of cross-disciplinary engagement with fields that study governance of distribution and consumption, for example, management or health; and such fields have not yet adapted explicit *food systems* and *governance* concepts to frame their research. For these two reasons, there are likely to be research methods that are useful for the study of FSG but are not yet adopted by the community.

Among those indicators we found, there was an expected strong presence of indicators looking at institutional structure plus a welcome representation of agency-related indicators, which are important to get beyond purely technical analyses, which risk reducing governance to a set of observable legal and organisational properties. There are, however, reasons for caution, as many of these agency indicators were clustered around one set of authors, and operationalized only at certain governance levels. Furthermore, while we did find some indicators that examine cross-scale dynamics, many of these were only operationalized at one particular level. Unless researchers operationalize cross-scale indicators in research designs that specifically collect data from multiple levels of governance, cross-scale linkages will continue to be poorly understood.

Acknowledging that this review is subject to limitations discussed earlier, this research calls for four follow-up steps. First, the indicators described in this paper, and in more detail in the technical report for this project (Delaney and Tamás 2016), require piloting and validation. This would ideally be done by interdisciplinary research teams. Secondly, methodological development is required for areas and phenomena that are not well-represented by the indicators found in this review. This includes:

- indicators for governance of distribution and consumption;
- scale indicators operationalized *across scales*;
- agency indicators at different levels of governance;
- assessment indicators tailored for food systems; and
- methods for critical research on governance.

This methodological work would do well to consult with works missed in our review, particularly those researching food distribution and consumption, and those that are not framed by food systems or governance concepts. The set of indicators that result from this extension of our work will then require integration into theories of FSG and typologies of food systems that are more developed than the matrix used in this review, along with an analysis of the epistemological basis of research methods. Addressing these first steps will contribute to a consolidated methodological framework for future research on food systems governance. We recommend uptake of this expected framework; doing so is expected to increase the comparability of the next generation of FSG research. This should result, in time, in a body of comparable evidence that supports a meta-analysis from which empirically supported and generalizable conclusions can be drawn about how governance can further food systems goals.

Acknowledgements We acknowledge the CGIAR Fund Council, Australia (ACIAR), Irish Aid, European Union, International Fund for Agricultural Development (IFAD), Netherlands, New Zealand, Switzerland, UK, USAID and Thailand for funding to the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). The research for this article was funded by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), under the Priorities and Policies for CSA Flagship. This article builds upon an earlier version which appeared as a CCAFS Working Paper, number 167. This work was also supported by the US National Science Foundation (grant numbers BCS-1534544, SES-1360421, and SES-1360463) and some authors benefitted from support from the R4D project "Food Sustainability" funded by the Swiss National Science Foundation (SNSF 400540-152033). We would like to thank Katrien Termeer for helpful insights throughout the project. Thanks are also extended to all those who helped by suggesting literature during consultation, all authors who responded to requests during the review and to Patricia Lezotte of the Ostrom Workshop at Indiana University for invaluable assistance during drafting. We acknowledge the services of the Bibliothèque Nationale de Luxembourg for providing access to materials reviewed.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest. We disclose above the sources of funding that made this research possible.

Appendix: List of records included in full review

Table 6 List of records included in full review

Project ID	Short reference	Full reference
EGRef#002	(Adger et al. 2005)	Adger, W.N., Brown, K., and Thompkins, E.L., 2005. The political economy of cross-scale networks in resource co-management. *Ecology and Society*, 10 (2), 9.
EGRef#005	(Auld 2010)	Auld, G., 2010. Assessing certification as governance: effects and broader consequences for coffee. *The Journal of Environment & Development*, 19 (2), 215–241.
EGRef#010	(Biermann et al. 2012)	Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M.M., Bulkeley, H., Cashore, B., Clapp, J., Folke, C., Gupta, A., Gupta, J., Haas, P.M., Jordan, A., Kanie, N., Kluvánková-Oravská, T., Lebel, L., Liverman, D., Meadowcroft, J., Mitchell, R.B., Newell, P., Oberthür, S., Olsson, L., Pattberg, P., Sánchez-Rodríguez, R., Schroeder, H., Underdal, A., Vieira, S.C., Vogel, C., Young, O.R., Brock, A., and Zondervan, R., 2012. Transforming governance and institutions for global sustainability: key insights from the Earth System Governance Project. *Current Opinion in Environmental Sustainability*, 4 (1), 51–60.
EGRef#014	(Boons and Mendoza 2010)	Boons, F. and Mendoza, A., 2010. Constructing sustainable palm oil: how actors define sustainability. *Journal of Cleaner Production*, 18 (16–17), 1686–1695.
EGRef#017	(Candel 2014)	Candel, J.J.L., 2014. Food security governance: a systematic literature review. *Food Security*, 6 (4), 585–601.
EGRef#018	(Chibinga et al. 2010)	Chibinga, O.C., Musimba, N.M., Nyangito, M., and Simbaya, J., 2010. Climate variability: pastoralists' perception, practices and enhancing adaptive pasture use for food security in Choma district, southern Zambia. *In*: *RUFORUM Second Biennial Meeting*. Presented at the RUFORUM, Entebbe, Uganda.
EGRef#019	(Clapp 2003)	Clapp, J., 2003. Transnational corporate interests and global environmental governance: negotiating rules for agricultural biotechnology and chemicals. *Environmental Politics*, 12 (4), 1–23.
EGRef#020	(Cooper and Wheeler 2015)	Cooper, S.J. and Wheeler, T., 2015. Adaptive governance: livelihood innovation for climate resilience in Uganda. *Geoforum*, 65, 96–107.
EGRef#021	(Douxchamps et al. 2015)	Douxchamps, S., Wijk, M.T.V., Silvestri, S., Moussa, A.S., Quiros, C., Ndour, N.Y.B., Buah, S., Somé, L., Herrero, M., Kristjanson, P., Ouedraogo, M., Thornton, P.K., Asten, P.V., Zougmoré, R., and Rufino, M.C., 2015. Linking agricultural adaptation strategies, food security and vulnerability: evidence from West Africa. *Regional Environmental Change*, 1–13.
EGRef#022	(Drimie and Ruysenaar 2010)	Drimie, S. and Ruysenaar, S., 2010. The integrated food security strategy of South Africa: an institutional analysis.
EGRef#023	(DuPuis and Gillon 2008)	DuPuis, E.M. and Gillon, S., 2008. Alternative modes of governance: organic as civic engagement. *Agriculture and Human Values*, 26 (1–2), 43–56.
EGRef#028	(Evans 2011)	Evans, A., 2011. Governance for a resilient food system. *Oxfam Policy and Practice: Agriculture, Food and Land*, 11 (2), 63–92.
EGRef#029	(Finan and Nelson 2001)	Finan, T.J. and Nelson, D.R., 2001. Making rain, making roads, making do: public and private adaptations to drought in Ceará, northeast Brazil. *Climate Research*, 19 (2), 97–108.
EGRef#031	(Galiè 2013)	Galiè, A., 2013. Governance of seed and food security through participatory plant breeding: empirical evidence and gender analysis from Syria. *Natural Resources Forum*, 37 (1), 31–42.
EGRef#037	(Hesselberg and Yaro 2006)	Hesselberg, J. and Yaro, J.A., 2006. An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. *GeoJournal*, 67 (1), 41–55.
EGRef#038	(Holden and Lunduka 2010)	Holden, S. and Lunduka, R., 2010. *Too poor to be efficient? Impacts of the targeted fertilizer subsidy programme in Malawi on farm plot level input use, crop choice and land productivity.* Norway: Department of International Environment and Development Studies, Noragric, No. 55.
EGRef#040	(Huntjens et al. 2012)	Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., and Kranz, N., 2012. Institutional design propositions for the governance of adaptation to climate change in the water sector. *Global Environmental Change*, 22 (1), 67–81.
EGRef#042	(Jacobi, Schneider, Bottazzi, et al. 2015)	Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P., and Rist, S., 2015. Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. *Renewable Agriculture and Food Systems*, 30 (02), 170–183.
EGRef#043	(Juhola and Westerhoff 2011)	Juhola, S. and Westerhoff, L., 2011. Challenges of adaptation to climate change across multiple scales: a case study of network governance in two European countries. *Environmental Science & Policy*, 14 (3), 239–247.

Table 6 (continued)

Project ID	Short reference	Full reference
EGRef#044	(Kochar 2005)	Kochar, A., 2005. Can targeted food programs improve nutrition? An empirical analysis of India's public distribution system. *Economic Development and Cultural Change*, 54 (1), 203–235.
EGRef#046	(Korhonen-Kurki et al. 2014)	Korhonen-Kurki, K., Sehring, J., Brockhaus, M., and Gregorio, M.D., 2014. Enabling factors for establishing REDD+ in a context of weak governance. *Climate Policy*, 14 (2), 167–186.
EGRef#047	(Lebel et al. 2006)	Lebel, L., Anderies, J., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T., and Wilson, J., 2006. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, 11 (1), 19.
EGRef#048	(Leith et al. 2012)	Leith, P., Jacobs, B., Brown, P.R., and Nelson, R., 2012. A participatory assessment of NRM capacity to inform policy and practice: cross-scale evaluation of enabling and constraining factors. *Society & Natural Resources*, 25 (8), 775–793.
EGRef#052	(Mandemaker et al. 2011)	Mandemaker, M., Bakker, M., and Stoorvogel, J., 2011. The role of governance in agricultural expansion and intensification: a global study of arable agriculture. *Ecology and Society*, 6 (12), 8.
EGRef#053	(Masiero 2015)	Masiero, S., 2015. Redesigning the Indian food security system through e-governance: the case of Kerala. *World Development*, 67, 126–137.
EGRef#055	(Minde et al. 2008)	Minde, I.J., Jayne, T., Crawford, E., Ariga, J., and Jones, G., 2008. *Promoting fertilizer use in Africa: current issues and empirical evidence from Malawi, Zambia, and Kenya.* East Lansing: Michigan State University, Department of Agricultural, Food, and Resource Economics, No. 54501.
EGRef#057	(Nelson and Finan 2009)	Nelson, D.R. and Finan, T.J., 2009. Praying for drought: persistent vulnerability and the politics of patronage in Ceará, northeast Brazil. *American Anthropologist*, 111 (3), 302–316.
EGRef#059	(Osbahr et al. 2010)	Osbahr, H., Twyman, C., Adger, W.N., and Thomas, D.S.G., 2010. Evaluating successful livelihood adaptation to climate variability and change in southern Africa. *Ecology and Society*, 15 (2), 27.
EGRef#060	(Osbahr et al. 2008)	Osbahr, H., Twyman, C., Neil Adger, W., and Thomas, D.S.G., 2008. Effective livelihood adaptation to climate change disturbance: scale dimensions of practice in Mozambique. *Geoforum*, 39 (6), 1951–1964.
EGRef#062	(Pedersen and Benjaminsen 2007)	Pedersen, J. and Benjaminsen, T.A., 2007. One leg or two? Food security and pastoralism in the northern Sahel. *Human Ecology*, 36 (1), 43–57.
EGRef#065	(Pesqueira and Glasbergen 2013)	Pesqueira, L. and Glasbergen, P., 2013. Playing the politics of scale: Oxfam's intervention in the Roundtable on Sustainable Palm Oil. *Geoforum*, 45, 296–304.
EGRef#070	(Poteete and Ostrom 2004)	Poteete, A.R. and Ostrom, E., 2004. Heterogeneity, group size and collective action: the role of institutions in forest management. *Development and Change*, 35 (3), 435–461.
EGRef#071	(Quinn et al. 2011)	Quinn, C.H., Ziervogel, G., Taylor, A., Takama, T., and Thomalla, F., 2011. Coping with multiple stresses in rural South Africa. *Ecology and Society*, 16 (3), 2.
EGRef#074	(Rocha and Lessa 2009)	Rocha, C. and Lessa, I., 2009. Urban governance for food security: the alternative food system in Belo Horizonte, Brazil. *International Planning Studies*, 14 (4), 389–400.
EGRef#075	(Sahley et al. 2005)	Sahley, C., Groelsema, B., Marchione, T., and Nelson, D., 2005. *The governance dimensions of food security in Malawi*. USAID.
EGRef#076	(Schader et al. 2014)	Schader, C., Grenz, J., Meier, M., and Stolze, M., 2014. Scope and precision of sustainability assessment approaches to food systems. *Ecology and Society*, 19 (3), 42.
EGRef#077	(Schouten et al. 2012)	Schouten, G., Leroy, P., and Glasbergen, P., 2012. On the deliberative capacity of private multi-stakeholder governance: the Roundtables on Responsible Soy and Sustainable Palm Oil. *Ecological Economics*, 83, 42–50.
EGRef#078	(Sonnino et al. 2014)	Sonnino, R., 2013. Local foodscapes: place and power in the agri-food system. *Acta Agriculturae Scandinavica, Section B — Soil & Plant Science*, 63 (sup1), 2–7.
EGRef#079	(Spielman et al. 2008)	Spielman, D.J., Cohen, M.J., and Mogues, T., 2008. *Mobilizing rural institutions for sustainable livelihoods and equitable development: a case study of local governance and smallholder cooperatives in Ethiopia.* Washington, DC: International Food Policy Research Institute.
EGRef#081	(Tompkins and Adger 2004)	Tompkins, E.L. and Adger, W.N., 2004. Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society*, 9 (2), 10.
EGRef#083	(Umali-Deininger and Deininger 2001)	Umali-Deininger, D.L. and Deininger, K.W., 2001. Towards greater food security for India's poor: balancing government intervention and private competition. *Agricultural Economics*, 25 (2–3), 321–335.
EGRef#084	(von Geibler 2013)	von Geibler, J., 2013. Market-based governance for sustainability in value chains: conditions for successful standard setting in the palm oil sector. *Journal of Cleaner Production*, 56, 39–53.

Table 6 (continued)

Project ID	Short reference	Full reference
EGRef#085	(Wertz-Kanounnikoff and McNeill 2012)	Wertz-Kanounnikoff, S. and McNeill, D., 2012. Performance indicators and REDD+ implementation. *In*: *A. Angelsen, M. Brockhaus, W.D. Sunderlin, and L. Verchot (eds), Analysing REDD+: Challenges and Choices (pp. 233–246). CIFOR, Bogor, Indonesia.*
EGRef#089	(Acemoglu et al. 2009)	Acemoglu, D., Johnson, S., Robinson, J.A., and Yared, P., 2009. Reevaluating the modernization hypothesis. *Journal of Monetary Economics*, 56 (8), 1043–1058.
EGRef#102	(Jacobi, Schneider, Mariscal, et al. 2015)	Jacobi, J., Schneider, M., Mariscal, M.P., Huber, S., Weidmann, S., Bottazzi, P., and Rist, S., 2015. Farm resilience in organic and nonorganic cocoa farming systems in Alto Beni, Bolivia. *Agroecology and Sustainable Food Systems*, 39 (7), 798–823.
EGRef#104	(Kay 2002)	Kay, C., 2002. Why East Asia overtook Latin America: agrarian reform, industrialisation and development. *Third World Quarterly*, 23 (6), 1073–1102.
EGRef#105	(Khan 2011)	Khan, M., 2011. *Political settlements and the governance of growth-enhancing institutions.* London: School of Oriental and Africa Studies.
EGRef#119	(Füssel 2010)	Füssel, H.-M., 2010. How inequitable is the global distribution of responsibility, capability, and vulnerability to climate change: a comprehensive indicator-based assessment. *Global Environmental Change*, 20 (4), 597–611.
EGREF#123	(Kabubo-Mariara 2007)	Kabubo-Mariara, J., 2007. Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. *Ecological Economics*, 64 (1), 25–35.
EGREF#131	(Purdon 2013)	Purdon, M., 2013. Land acquisitions in Tanzania: strong sustainability, weak sustainability and the importance of comparative methods. *Journal of Agricultural and Environmental Ethics*, 26 (6), 1127–1156.
EGREF#135	(Wambugu et al. 2015)	Wambugu, S.W., Chomba, S.W., and Atela, J., 2015. Institutional arrangements for climate-smart landscapes. *In*: *P. A. Minang, M. van Noordwijk, O. E. Freeman, C. Mbow, J. de Leeuw, and D. Catacutan, editors. Climate-Smart Landscapes: Multifunctionality in Practice.* Nairobi: World Agroforestry Centre (ICRAF).
EGREF#136	(Wilbanks and Kates 2010)	Wilbanks, T.J. and Kates, R.W., 2010. Beyond adapting to climate change: embedding adaptation in responses to multiple threats and stresses. *Annals of the Association of American Geographers*, 100 (4), 719–728.
EGREF#145	(Barungi 2013)	Barungi, J., 2013. *Agri-food system governance and service delivery in Uganda: a case study of Tororo District*. No. 61.
EGREF#152	Bizikova et al. (2014)	Bizikova, L., Nijnik, M., and Nijnik, A., 2014. Exploring institutional changes in agriculture to inform adaptation planning to climate change in transition countries. *Mitigation and Adaptation Strategies for Global Change*, 20 (8), 1385–1406.
EGREF#159	(Brownhill and Hickey 2012)	Brownhill, L. and Hickey, G.M., 2012. Using interview triads to understand the barriers to effective food security policy in Kenya: a case study application. *Food Security*, 4 (3), 369–380.
EGREF#177	(Duncan and Barling 2012)	Duncan, J. and Barling, D., 2012. Renewal through participation in global food security governance: implementing the international food security and nutrition civil society mechanism to the Committee on World Food Security. *International Journal of Sociology of Agriculture and Food*, 19 (2), 143–161.
EGREF#178	(Eakin et al. 2011)	Eakin, H., Eriksen, S., Eikeland, P.-O., and Øyen, C., 2011. Public sector reform and governance for adaptation: implications of new public management for adaptive capacity in Mexico and Norway. *Environmental management*, 47 (3), 338–351.
EGREF#197	(Gereffi et al. 2005)	Gereffi, G., Humphrey, J., and Sturgeon, T., 2005. The governance of global value chains. *Review of International Political Economy*, 12 (1), 78–104.
EGREF#225	(Kirwan and Maye 2013)	Kirwan, J. and Maye, D., 2013. Food security framings within the UK and the integration of local food systems. *Journal of Rural Studies*, 29, 91–100.
EGREF#232	(Lesnikowski et al. 2013)	Lesnikowski, A.C., Ford, J.D., Berrang-Ford, L., Barrera, M., Berry, P., Henderson, J., and Heymann, S.J., 2013. National-level factors affecting planned, public adaptation to health impacts of climate change. *Global Environmental Change*, 23 (5), 1153–1163.
EGREF#272	(Schiff 2008)	Schiff, R., 2008. The role of food policy councils in developing sustainable food systems. *Journal of Hunger & Environmental Nutrition*, 3 (2–3), 206–228.
EGREF#276	(Sietz et al. 2011)	Sietz, D., Boschütz, M., and Klein, R.J., 2011. Mainstreaming climate adaptation into development assistance: rationale, institutional barriers and opportunities in Mozambique. *Environmental Science & Policy*, 14 (4), 493–502.
EGREF#283	(Stringer et al. 2009)	Stringer, L.C., Dyer, J.C., Reed, M.S., Dougill, A.J., Twyman, C., and Mkwambisi, D., 2009. Adaptations to climate change, drought and desertification: local insights to enhance policy in southern Africa. *Environmental Science & Policy*, 12 (7), 748–765.

Table 6 (continued)

Project ID	Short reference	Full reference
EGREF#290	(Tirado et al. 2010)	Tirado, M.C., Cohen, M.J., Aberman, N., Meerman, J., and Thompson, B., 2010. Addressing the challenges of climate change and biofuel production for food and nutrition security. *Food Research International*, 43 (7), 1729–1744.
EGREF#302	(Wilder et al. 2010)	Wilder, M., Scott, C.A., Pablos, N.P., Varady, R.G., Garfin, G.M., and McEvoy, J., 2010. Adapting across boundaries: climate change, social learning, and resilience in the US–Mexico border region. *Annals of the Association of American Geographers*, 100 (4), 917–928.
EGREF#307	(Candel et al. 2015)	Candel, J.J.L., Breeman, G.E., and Termeer, C.J.A.M., 2015. The European Commission's ability to deal with wicked problems: an in-depth case study of the governance of food security. *Journal of European Public Policy*, DOI:https://doi.org/10.1080/13501763.2015.1068836.
EGREF#308	(Gupta et al. 2010)	Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., and Bergsma, E., 2010. The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy*, 13 (6), 459–471.
EGREF#309	(Termeer et al. 2013)	Termeer, C.J.A.M., Dewulf, A., Breeman, G., and Stiller, S.J., 2013. Governance capabilities for dealing wisely with wicked problems. *Administration & Society*, 47 (6), 680–710.

References

Acemoglu, D., Johnson, S., Robinson, J. A., & Yared, P. (2009). Reevaluating the modernization hypothesis. *Journal of Monetary Economics, 56*(8), 1043–1058.

Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power*. Prosperity and Poverty: Crown Publishing, New York, USA.

Adger, W. N. (2001). Scales of governance and environmental justice for adaptation and mitigation of climate change. *Journal of International Development, 13*(7), 921–931.

Alrøe, H., Moller, H., Læssøe, J., & Noe, E. (2016). Opportunities and challenges for multicriteria assessment of food system sustainability. *Ecology and Society, 21*(1), 38.

Altieri, M. A., & Toledo, V. M. (2011). The agroecological revolution in Latin America: Rescuing nature, ensuring food sovereignty and empowering peasants. *The Journal of Peasant Studies, 38*(3), 587–612.

Azmat, F., & Coghill, K. (2005). Good governance and market-based reforms: A study of Bangladesh. *International Review of Administrative Sciences, 71*(4), 625–638.

Biermann, F., Abbott, K., Andresen, S., Bäckstrand, K., Bernstein, S., Betsill, M. M., et al. (2012). Transforming governance and institutions for global sustainability: Key insights from the earth system governance project. *Current Opinion in Environmental Sustainability, 4*(1), 51–60.

Bizikova, L., Echeverría, D., & Hammill, A. (2014). *Systematic review approach to identifying key trends in adaptation governance at the supranational level.* (no. 93). Copenhagen, Denmark: CGIAR research Programme on climate change agriculture and food security (CCAFS). www.ccafs.cgiar.org

Bizikova, L., Nijnik, M., & Nijnik, A. (2015). Exploring institutional changes in agriculture to inform adaptation planning to climate change in transition countries. *Mitigation and Adaptation Strategies for Global Change, 20*(8), 1385–1406.

Blunt, P. (1995). Cultural relativism, "good" governance and sustainable human development. *Public Administration and Development, 15*(1), 1–9.

Boons, F., & Mendoza, A. (2010). Constructing sustainable palm oil: How actors define sustainability. *Journal of Cleaner Production, 18*(16–17), 1686–1695.

Brownhill, L., & Hickey, G. M. (2012). Using interview triads to understand the barriers to effective food security policy in Kenya: A case study application. *Food Security, 4*(3), 369–380.

Candel, J. J. L. (2014). Food security governance: A systematic literature review. *Food Security, 6*(4), 585–601.

Candel, J. J. L., Breeman, G. E., & Termeer, C. J. A. M. (2015). The European Commission's ability to deal with wicked problems: An in-depth case study of the governance of food security. *Journal of European Public Policy*, 1–25.

Clapp, J. (2017). The trade-ification of the food sustainability agenda. *The Journal of Peasant Studies, 44*(2), 335–353.

Colonna, P., Fournier, S., & Touzard, J. (2013). Food Systems. In C. Esnouf, M. Russel, & N. Bricas (Eds.), *Food system sustainability: Insights from duALIne*. UK: Cambridge University Press.

Cooper, S. J., & Wheeler, T. (2015). Adaptive governance: Livelihood innovation for climate resilience in Uganda. *Geoforum, 65*, 96–107.

Cornwall, A., & Coelho, V. S. (2007). *Spaces for change?: The politics of citizen participation in new democratic arenas*. London: Zed Books.

Crane, T. A., Delaney, A., Tamás, P. A., Chesterman, S., & Ericksen, P. (2017). A systematic review of local vulnerability to climate change in developing country agriculture: In search of transparency, coherence and comparability. *WIREs Climate Change, 8*(4), e464.

De Schutter, O. (2014). Final report: The transformative potential of the right to food (no. a/HRC/25/57). New York, USA: UN general assembly, human rights council. http://www.ohchr.org/EN/HRBodies/HRC/RegularSessions/Session25/Pages/ListReports.aspx

Delaney, A., & Tamás, P. A. (2016). *Strengthening the food systems governance evidence base: Supporting commensurability of research through a systematic review of methods - technical report supporting working paper 167, Copenhagen, Denmark: CGIAR research program on climate change, agriculture and food security (CCAFS)*. Denmark: Copenhagen http://hdl.handle.net/10568/72721.

Delaney, A., Evans, T., John, M., Blekking, J., Schlachter, T., Korhonen-Kurki, K., et al. (2016a). Strengthening the food systems governance evidence base: Supporting commensurability of research through a systematic review of methods (no. 167). Copenhagen, Denmark: CGIAR research program on climate change, agriculture and food security (CCAFS). http://hdl.handle.net/10568/72720

Delaney, A., Tamás, P. A., Crane, T. A., & Chesterman, S. (2016b). Systematic review of methods in low-consensus fields: Supporting commensuration through 'construct-centered methods aggregation'

in the case of climate change vulnerability research. *PLoS One, 11*(2), e0149071. https://doi.org/10.1371/journal.pone.0149071.

Donovan, R. Z., Clarke, G., & Sloth, C. (2010). *Verification of progress related to enabling activities for the Guyana-Norway REDD+ agreement*. USA: Rainforest Alliance.

Dupuis, J., & Biesbroek, R. (2013). Comparing apples and oranges: The dependent variable problem in comparing and evaluating climate change adaptation policies. *Global Environmental Change, 23*(6), 1476–1487.

Dubbeling, M., Santini, G., Renting, H., Taguchi, M., Lançon, L., Zuluaga, J., et al. (2017). Assessing and planning Sustainable City region food systems: Insights from two Latin American cities. *Sustainability, 9*, 1455.

Eakin, H., Connors, J. P., Wharton, C., Bertmann, F., Xiong, A., & Stoltzfus, J. (2017). Identifying attributes of food system sustainability: Emerging themes and consensus. *Agriculture and Human Values, 34*, 757–773.

Eakin, H., Eriksen, S., Eikeland, P.-O., & Øyen, C. (2011). Public sector reform and governance for adaptation: Implications of new public management for adaptive capacity in Mexico and Norway. *Environmental Management, 47*(3), 338–351.

Eakin, H., Winkels, A., & Sendzimir, J. (2009). Nested vulnerability: Exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems. *Environmental Science & Policy, 12*(4), 398–412.

Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change, 18*(1), 234–245.

Ericksen, P. J., Ingram, J. S., & Liverman, D. M. (2009). Food security and global environmental change: Emerging challenges. *Environmental Science & Policy, 12*(4), 373–377.

Esnouf, C., Russel, M., & Bricas, N. (2013). *Food system sustainability: Insights from duALIne*. UK: Cambridge University Press http://www.cambridge.org/us/academic/subjects/life-sciences/natural-resource-management-agriculture-horticulture-and/food-system-sustainability-insights-dualine.

FAO. (1996). World Food Summit: Rome Declaration and Plan of Action. http://www.fao.org/docrep/003/w3613e/w3613e00.HTM. Accessed 25 November 2015.

FAO. (2011). Good food security governance: The crucial premise to the twin-track approach - background paper. FAO, Rome, Italy. http://www.fao.org/fileadmin/templates/righttofood/documents/other_documents/2011_good_food_security_gov/FoodSecurityGovernanceWorkshop_backgroundpaper.pdf. Accessed 25 Nov 2015.

FAO. (2012). FAO - News Article: FAO calls for strengthened food security governance. http://www.fao.org/news/story/en/item/162391/icode/. Accessed 25 Nov 2015.

FAO. (2014). *SAFA: Sustainability assessment of food and agriculture systems - guidelines version 3.0*. Rome: FAO.

FAO, IFAD and WFP. (2013) The state of food insecurity in the world 2013: The multiple dimensions of food security. Rome: FAO.

Fukuyama, F. (2013). What is governance? *Governance, 26*, 347–368.

Fung, A. (2004). *Empowered participation*. New Jersey: Princeton University Press.

Galiè, A. (2013). Governance of seed and food security through participatory plant breeding: Empirical evidence and gender analysis from Syria. *Natural Resources Forum, 37*(1), 31–42.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy, 12*(1), 78–104.

Gibson, C. C., Ostrom, E., & Ahn, T. K. (2000). The concept of scale and the human dimensions of global change: A survey. *Ecological Economics, 32*(2), 217–239.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., et al. (2010). Food security: The challenge of feeding 9 billion people. *Science, 327*(5967), 812–818.

Grindle, M. S. (2004). Good enough governance: Poverty reduction and reform in developing countries. *Governance, 17*(4), 525–548.

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., et al. (2010). The adaptive capacity wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy, 13*(6), 459–471.

Hermes, N., & Lensink, R. (2001). Changing the conditions for development aid: A new paradigm? *Journal of Development Studies, 37*(6), 1.

Hirsch, P. D., Adams, W. M., Brosius, J. P., Zia, A., Bariola, N., & Dammert, J. L. (2011). Acknowledging conservation trade-offs and embracing complexity. *Conservation Biology: The Journal of the Society for Conservation Biology, 25*(2), 259–264.

Hooghe, L., & Marks, G. (2003). Unraveling the central state, but how? Types of multi-level governance. *American Political Science Review, 97*(2), 233–243.

Horton, P., Banwart, S. A., Brockington, D., Brown, G. W., Bruce, R., Cameron, D., et al. (2017). An agenda for integrated system-wide interdisciplinary agri-food research. *Food Security, 9*(2), 195–210.

Hospes, O., & Brons, A. (2016). Food system governance: A systematic literature review. In A. Kennedy & J. Liljeblad (Eds.), *Food systems governance: Challenges for justice, equality, and human rights*. New York: Routledge.

Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., & Kranz, N. (2012). Institutional design propositions for the governance of adaptation to climate change in the water sector. *Global Environmental Change, 22*(1), 67–81.

Ingram, J. (2011). A food systems approach to researching food security and its interactions with global environmental change. *Food Security, 3*(4), 417–431.

Jacobi, J., Schneider, M., Mariscal, M. P., Huber, S., Weidmann, S., Bottazzi, P., & Rist, S. (2015a). Farm resilience in organic and non-organic cocoa farming systems in alto Beni, Bolivia. *Agroecology and Sustainable Food Systems, 39*(7), 798–823.

Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P., & Rist, S. (2015b). Agroecosystem resilience and farmers' perceptions of climate change impacts on cocoa farms in alto Beni, Bolivia. *Renewable Agriculture and Food Systems, 30*(2), 170–183.

Jawtusch, J., Schader, C., Stolze, M., Baumgart, L., & Niggli, U. (2013). Sustainability Monitoring and Assessment Routine: Results from pilot applications of the FAO SAFA Guidelines. In *Symposium International sur L'Agriculture Biologique Méditerranénne et Les Signes Distinctifs de Qualité liée à l'Origine, 2–4 Décembre 2013, Agadir, Morocco*. http://orgprints.org/29547/. Accessed 22 Jan 2016.

Juhola, S., & Westerhoff, L. (2011). Challenges of adaptation to climate change across multiple scales: A case study of network governance in two European countries. *Environmental Science & Policy, 14*(3), 239–247.

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L., & Schösler, H. (2016). Transition towards circular economy in the food system. *Sustainability, 8*, 69.

Kabubo-Mariara, J. (2007). Land conservation and tenure security in Kenya: Boserup's hypothesis revisited. *Ecological Economics, 64*(1), 25–35.

Kay, C. (2009). Development strategies and rural development: Exploring synergies, eradicating poverty. *The Journal of Peasant Studies, 36*(1), 103–137.

Koohafkan, P., Altieri, M. A., & Gimenez, E. H. (2012). Green agriculture: Foundations for biodiverse, resilient and productive agricultural systems. *International Journal of Agricultural Sustainability, 10*(1), 61–75.

Korhonen-Kurki, K., Sehring, J., Brockhaus, M., & Gregorio, M. D. (2014). Enabling factors for establishing REDD+ in a context of weak governance. *Climate Policy, 14*(2), 167–186.

Landert, J., Schader, C., Moschitz, H., Stolze, M., (2017). A holistic sustainability assessment method for urban food system governance. *Sustainability, 9*, 490.

Lang, T., & Barling, D. (2012). Food security and food sustainability: Reformulating the debate. *The Geographical Journal, 178*(4), 313–326.

Larson, A. M., & Petkova, E. (2011). An introduction to forest governance, people and REDD+ in Latin America: Obstacles and opportunities. *Forests, 2*(1), 86–111.

Lamine, C., Renting, H., Rossi, A., Wiskerke, J. S. C., & Brunori, G. (2012). Agri-food systems and territorial development: Innovations, new dynamics and changing governance mechanisms. Farming systems research into the 21st century: The new dynamic. I. Darnhofer, D. Gibbon and B. Dedieu. Dordrecht, springer Netherlands: 229-256.

Lebel, L., Anderies, J., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T., & Wilson, J. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society* http://digitalcommons.library.umaine.edu/sms_facpub/52.

Leith, P., Jacobs, B., Brown, P. R., & Nelson, R. (2012). A participatory assessment of NRM capacity to inform policy and practice: Cross-scale evaluation of enabling and constraining factors. *Society & Natural Resources, 25*(8), 775–793.

Lesnikowski, A. C., Ford, J. D., Berrang-Ford, L., Barrera, M., Berry, P., Henderson, J., & Heymann, S. J. (2013). National-level factors affecting planned, public adaptation to health impacts of climate change. *Global Environmental Change, 23*(5), 1153–1163.

Linstone, H. A., & Turoff, M. (Eds.). (1975). *The Delphi method: Techniques and applications*. Massachusetts: Addison-Wesley.

Liverman, D., & Kapadia, K. (2012). Chapter 1 food systems and the global environment: An overview. In J. Ingram, P. J. Ericksen, & D. Liverman (Eds.), *Food Security and Global Environmental Change*. 3-24: New York: Routledge.

MacRae, R. (1999). Not just what, but how: Creating agricultural sustainability and food security by changing Canada's agricultural policy making process. *Agriculture and Human Values, 16*(2), 187–201.

Makhura, M. T. (1998). The development of food security policy for South Africa (SAFSP): A consultative process. *Food Policy, 23*(6), 571–585.

Mandemaker, M., Bakker, M., & Stoorvogel, J. (2011). The role of governance in agricultural expansion and intensification: A global study of arable agriculture. *Ecology and Society, 6*(12), 8.

Maye, D., & Kirwan, J. (2013). Food security: A fractured consensus. *Journal of Rural Studies, 29*, 1–6.

Miller, C., & Erickson, P. (2006). The politics of bridging scales and epistemologies: Science and democracy in global environmental governance. In W. V. Reid, T. J. Wilbanks, D. Capistrano, & F. Berkes (Eds.), *Bridging scales and knowledge systems: Concepts and applications in ecosystem assessment*. Washington, DC: Island Press.

Miller, T., Baird, T., Littlefield, C., Kofinas, G. F., Chapin, I. I. I., & Redman, C. (2008). Epistemological pluralism: Reorganizing interdisciplinary research. *Ecology and Society, 13*(2), 46.

Minde, I. J., Jayne, T., Crawford, E., Ariga, J., & Jones, G. (2008). *Promoting fertilizer use in Africa: current issues and empirical evidence from Malawi, Zambia, and Kenya.* (no. 54501). Michigan: Michigan State University, Department of Agricultural, food, and resource economics.

Moragues-Faus, A., Sonnino, R., & Marsden, T. (2017). Exploring European food system vulnerabilities: Towards integrated food security governance. *Environmental Science & Policy, 75*, 184–215.

Newell, B., Crumley, C. L., Hassan, N., Lambin, E. F., Pahl-Wostl, C., Underdal, A., & Wasson, R. (2005). A conceptual template for integrative human–environment research. *Global Environmental Change, 15*(4), 299–307.

Osbahr, H., Twyman, C., Neil Adger, W., & Thomas, D. S. G. (2008). Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique. *Geoforum, 39*(6), 1951–1964.

Osbahr, H., Twyman, C., Adger, W. N., & Thomas, D. S. G. (2010). Evaluating successful livelihood adaptation to climate variability and change in southern Africa. *Ecology and Society, 15*(2), 27.

Paillard, S., Treyer, S., & Dorin, B. (2011). Agrimonde – Scenarios and challenges for feeding the world. Editions Quae. http://www.springer.com/us/book/9789401787444. Accessed 10 Oct 2015.

Pesqueira, L., & Glasbergen, P. (2013). Playing the politics of scale: Oxfam's intervention in the roundtable on sustainable palm oil. *Geoforum, 45*, 296–304.

Poteete, A. R., & Ostrom, E. (2004). Heterogeneity, group size and collective action: The role of institutions in forest management. *Development and Change, 35*(3), 435–461.

Purdon, M. (2014). *The Comparative Turn in Climate Change Adaptation and Food Security Governance Research* (no. 92). Copenhagen, Denmark: CGIAR research Programme on climate change agriculture and food security (CCAFS). https://ccafs.cgiar.org/publications/comparative-turn-climate-change-adaptation-and-food-security-governance-research#.Via1BivsQxI. Accessed 20 Oct 2015.

Purdon, M. (2015). Advancing comparative climate change politics: Theory and method. *Global Environmental Politics, 15*(3), 1–26.

Quinn, C. H., Ziervogel, G., Taylor, A., Takama, T., & Thomalla, F. (2011). Coping with multiple stresses in rural South Africa. *Ecology and Society, 16*(3), 2.

Rastoin, J.-L., & Ghersi, G. (2010). *Le système alimentaire mondial: Concepts et méthodes, analyses et dynamiques*. Paris: Quae.

Rhodes, R. A. W. (1997). *Understanding governance. Policy networks, governance, reflexibility and accountability*. Buckingham: Open University Press.

Roberts, S. M., Jones, J. P., & Frohling, O. (2005). NGOs and the globalization of managerialism: A research framework. *World Development, 33*(11), 1845–1864.

Schouten, G., Leroy, P., & Glasbergen, P. (2012). On the deliberative capacity of private multi-stakeholder governance: The roundtables on responsible soy and sustainable palm oil. *Ecological Economics, 83*, 42–50.

Sietz, D., Boschütz, M., & Klein, R. J. (2011). Mainstreaming climate adaptation into development assistance: Rationale, institutional barriers and opportunities in Mozambique. *Environmental Science & Policy, 14*(4), 493–502.

Spielman, D. J., Cohen, M. J., & Mogues, T. (2008). *Mobilizing rural institutions for sustainable livelihoods and equitable development: A case study of local governance and smallholder cooperatives in Ethiopia*. Washington DC: International Food Policy Research Institute.

Steinberg, P. F. (2015). Can we generalize from case studies? *Global Environmental Politics, 15*(3), 152–175.

Stiglitz, J., Lin, J., Monga, C., & Patel, E. (2013). Industrial policy in the African context (no. WPS6633). The World Bank, Washington DC.

Termeer, C. J. A. M., Dewulf, A., Breeman, G., & Stiller, S. J. (2013). Governance capabilities for dealing wisely with wicked problems. *Administration & Society, 47*(6), 680–710.

Termeer, C. J. A. M., Dewulf, A., & van Lieshout, M. (2010). Disentangling scale approaches in governance research: Comparing monocentric, multilevel, and adaptive governance. *Ecology and Society, 15*(4), 29.

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. I. (2012). Climate change and food systems. *Annual Review of Environment and Resources, 37*(1), 195–222.

van Bers, C., Pahl-Wostl, C., Ericksen, P.J., Lenaerts, L., Förch, W., Korhonen-Kurki, K., Methner, N., Jones, L., Vasileiou, I., & Ericksen, S. (2016*). Transformations in governance towards resilient food systems*, CCAFS working paper (no. 190). Copenhagen, Denmark.

von Braun, J. (2009). Addressing the food crisis: Governance, market functioning, and investment in public goods. *Food Security, 1*(1), 9–15.

von Geibler, J. (2013). Market-based governance for sustainability in value chains: Conditions for successful standard setting in the palm oil sector. *Journal of Cleaner Production, 56*, 39–53.

Wahlqvist, M. L., McKay, J., Chang, Y.-C., & Chiu, Y.-W. (2012). Rethinking the food security debate in Asia: Some missing ecological and health dimensions and solutions. *Food Security, 4*(4), 657–670.

Wambugu, S. W., Chomba, S. W., & Atela, J. (2015). Institutional arrangements for climate-smart landscapes. In P. A. Minang, M. Van Noordwijk, O. E. Freeman, C. Mbow, J. De Leeuw, and D. Catacutan, editors. *Climate-Smart Landscapes: Multifunctionality in Practice.* Nairobi: World agroforestry Centre (ICRAF).

Wilder, M., Scott, C. A., Pablos, N. P., Varady, R. G., Garfin, G. M., & McEvoy, J. (2010). Adapting across boundaries: Climate change, social learning, and resilience in the US–Mexico border region. *Annals of the Association of American Geographers, 100*(4), 917–928.

Zanella, M. A., Rahmanian, M., Perch, L. N., Callenius, C., Rubio, J. L., Vuningoma, F., et al. (2015). Discussion: Food security and sustainable food systems: The role of soil. *International Soil and Water Conservation Research, 3*(2), 154–159.

Aogán Delaney is a Luxembourg-based consultant researcher who specializes in systematic reviews, particularly systematic reviews of methods. His recent work includes a systematic review of methods to research local-level vulnerability to climate change. Aogán's research interests include climate vulnerability and adaptive capacity, socio-ecological systems, governance, violent conflict and peacebuilding, and urban studies. He is also interested in development of methods for conducting systematic reviews and research synthesis methodologies. He holds a Masters in International Development Studies from Wageningen University in the Netherlands and a Bachelor degree in Mathematics and Sociology. His research profile is characterized by interdisciplinarity and the use of novel combinations of disciplinary methods and approaches.

Tom Evans is a professor in the Department of Geography and Senior Research Fellow with the Ostrom Workshop at Indiana University, USA. His current research focuses on food security, water governance and adaptation to climate change in Sub-Saharan Africa. Methodologically his research involves the integration of social and environmental data through application of spatial modeling, institutional analysis and decision science.

John McGreevy has been studying the relationship between food security and tree loss in rural Haiti since 2010. In 2013, he received his MA in Anthropology with a specialization in Human-Environmental Interaction from Colorado State University in the USA, where he studied as a Center for Collaborative Conservation Fellow. He is currently working on a PhD in Integrative Conservation and Anthropology at the University of Georgia. McGreevy has contributed to collaborative projects studying disaster recovery in the bayous of Louisiana, interdisciplinary research trends in costal Georgia, and the influence of non-governmental organization on livelihoods in Haiti.

Jordan Blekking is a graduate student in the Department of Geography at Indiana University, USA, conducting research on seed certification, hybrid maize adoption and the role of agricultural cooperatives in Sub-Saharan Africa.

Tyler Schlachter is a graduate student in the Department of Geography at Indiana University conducting research on the food, energy and water nexus in Sub-Saharan Africa.

Kaisa Korhonen-Kurki is an environmental policy scientist working as a research coordinator in Helsinki University Centre for Environment, Finland, as well as a Research Associate in the Center for International Forestry Research, CIFOR. She holds an Adjunct professorship in environmental and climate policy in the University of Helsinki. Her research has focussed on social sustainability of biodiversity conservation, social aspects of ecosystem services, corporate social responsibility, REDD+ and multi-level climate governance. She is a board member of the interdisciplinary doctoral program and currently planning for a new sustainability science centre in the University of Helsinki. Her current research interests are in sustainability transformations and transformative science.

Peter A. Tamás is a lecturer and researcher in research methodology at Wageningen University, the Netherlands. He obtained his doctorate from the University of Massachusetts, Amherst, USA in 2006. His areas of expertise are systematic review in immature disciplines, measurement validity in qualitative inquiry, operationalization of complex social constructs, research methods in (post-) conflict areas and validity within collaborative research.

Todd A. Crane is a senior scientist at the International Livestock Research Institute, Kenya, focusing on the social dimensions of climate change adaptation and mitigation. In particular, he is interested in interdisciplinary approaches to analysing and engaging in socio-technical change in agropastoral systems. Todd has degrees in anthropology from Indiana University (BA) and University of Georgia (PhD), USA.

Hallie Eakin is an Associate Professor in Sustainability Science with the School of Sustainability, Arizona State University, USA. She has a PhD in geography (University of Arizona). Her research focuses on the adaptability, resilience and sustainability of households that face global environmental and socioeconomic change.

Wiebke Förch joined GIZ as advisor for the SADC Adaptation to Climate Change in Rural Areas in Southern Africa (ACCRA) programme. Previously she has worked as science officer for the CGIAR Research Programme on Climate Change, Agriculture and Food Security, based at the International Livestock Research Institute (ILRI) in Nairobi, Kenya. Wiebke holds a PhD from the Arid Lands Resource Sciences Program at the University of Arizona, focusing on community resilience in drylands of Tigray, Ethiopia. She holds a Bachelor's Degree in Agriculture from the University of Reading, UK. Her research interests include climate vulnerability and resilience, global environmental change, agricultural research for development, livelihoods, governance and learning.

Lindsey Jones is a Research Fellow at the Overseas Development Institute (ODI), UK, working on issues of climate change, adaptation and development. His background lies in international development and global environmental governance. Lindsey has previously worked with the United Nations Development Programme in Nepal (supporting the country's National Adaptation Plan of Action) and the World Food Programme. Lindsey has an MSc in Environmental Policy from the University of Oxford, UK, and has experience working in Southern and Eastern Africa (including Tanzania, Ethiopia, Mozambique, Uganda, and South Africa), and Southern and South-Eastern Asia (India, Nepal, and Cambodia).

Christoph Oberlack is a senior researcher at the Centre for Development and Environment (CDE), University of Bern, and a post-doctoral researcher at the Institute for Geography, University of Bern, Switzerland. He obtained his PhD in Economics from the University of Freiburg, Germany, working on climate change adaptation in polycentric governance systems. More recently, he has advanced his studies by investigating livelihood vulnerability and potentials, resource conflicts and environmental justice in the face of large-scale land acquisitions. Methodologically, he is contributing to advances in diagnostic methods and in the analysis of archetypical patterns based on case studies.

Donald R. Nelson is an ecological anthropologist who teaches in the Department of Anthropology at the University of Georgia, USA. During the last 15 years his interdisciplinary work has focused on the human dimensions of climate variability and change, exploring public and private adaptations and how social and political relations shape decision-making and policy outcomes. In particular, he works with rural populations on topics related to climate variability, poverty, food security, participatory planning, and natural resource governance.

Mark Purdon is an expert on climate change policy and political economy, working at the intersection of public policy, comparative politics and international relations. He is currently a visiting researcher at the Department of Political Science at the University of Montreal in Canada, after earning a doctorate in political science at the University of Toronto in 2013 and a SSHRC postdoctoral fellowship at the London School of Economics in 2014.

Stephan Rist is Associate professor for human geography at the Institute of Geography of the University of Bern, Switzerland. He is holder of the UNESCO Chair 'Natural and Cultural Heritage of Sustainable Mountain Development', and also works at the Centre for Development and Environment (CDE) of the University of Bern, where he heads the Cluster on Sustainability Governance of Land and Natural Resources. Stephan's geographic focus is on Latin America and Africa being involved in several international research projects dealing with critical sustainability assessments of large scale land investments, food sustainability, local knowledge, social movements and transdisciplinary approaches of research aiming at the enhancement of societal transformation for environmental justice.