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Published in:
A Research Agenda for Social Networks and Social Resilience

DOI:
10.4337/9781803925783.00005

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> Hence, it is safe to argue that resilience does not currently engage the core of social sciences. (Olsson et al., 2015)

How resilient is society? It is the recent confluence of several developments that has pushed this question to the very top of societal and academic debate. The manifold consequences of climate change – ranging from violent conflict over scarce resources to disaster-induced migration – have become more visible than ever, as has our susceptibility to pandemics or other global crises. In combination with demographic trends such as population ageing and socio-economic developments including increasing inequalities, polarisation and civil strife, but also unsustainable consumption patterns, current governments face a particularly frightening cocktail of challenges. What kind of interventions and policies would be needed to prevent these threats undermining social welfare, further exacerbating societal rifts or irreversibly destroying our ecosystems? What does it take to prevent the deterioration of crucial ecological and social infrastructures? How to identify and interrupt the self-reinforcing processes that feed this deterioration? How to restore our economies and social structures after systemwide shocks like pandemics and financial crises?

Uncharted Terrain

Despite the problem of social resilience and its urgency being widely recognised, the social and behavioural sciences as well as the humanities seem to feel increasingly uneasy with resilience as an object of inquiry. Resilience is considered to be a contested if not "Janus-faced" concept (Brand & Jax, 2007). Many observers perceive it as a theoretical construct that may have added value for

the study of ecological systems but that is far too ambivalent to be meaningfully applied to social systems. And, in fact, as the opening quote shows, taken from a recent review essay on the topic, resilience does not play a key role in the research agenda of contemporary social and behavioural sciences. This of course does not mean that social scientists have completely neglected the topic. A recent meta-analysis (Downes et al., 2013) drawing on the entire Web of Science counts 3,759 social science entries and 2,789 ecological empirical studies that explicitly address resilience problems. However, a review focusing only on the ten highest-ranked journals in different disciplines concludes that in the period from 2001 to 2013 the concept is virtually absent in the top journals in economics, political science, sociology and anthropology (Olsson et al., 2015).

The issue of social resilience is a political issue of collective survival. In a book called *Who Shall Survive?*, Moreno (1934) develops a sociometry that measures affective, family and social ties, based on which he develops a theory of roles. He visualises and discusses, on the same graphs, attractions, repulsions/rejections and indifference between, for example, pupils in a school/detention facility or members of a rural community. He looks, for example, at patterns of social ties among the residents of the school/detention facility, focusing on specific weakly linked chains of mutual friendships. The list of substructures he uses to decompose a network make it understandable and position actors in it. It has evolved ever since with new models, but dyads, triads, path-chains, stars and isolates are already there. These configurations are shown to be important in the graphs that he studies, for example because they show the importance of some intermediaries or of "dominating individuals" who attract others who ignore/repulse each other. Mutual attractions and repulsions can take forms that reject and isolate individuals or groups outside of their group. The shape of the network has consequences for the circulation of information, such as a rumour. This link between survival and the social organisation of relationships and interactions is brought to light again in many fields, some of them covered by the contributors to this book. It takes us a long way, as Moreno showed, because it leads to questions about the future of societies as a whole.

Networks and Resilience

What about more recent developments, and the role of social network analysis? A quick scan of the Web of Science from 1945 to June 2021 shows 225 entries for the combined search term ("resilie* and networ*") in the titles of journal articles in the social and behavioural sciences and humanities. The

first entry ("The Resilience of Social Networks to Changes in Mobility and Propinquity") dates back to 1980 and appeared in the second issue of the journal *Social Networks* (Lee, 1980). It took 22 years for the second entry, a paper on "Resilience within the Family Networks of Lesbians and Gay Men: Intentionality and Redefinition", to appear in the *Journal of Marriage and the Family* (Oswald, 2002), and yet another decade for the topic to become more common, with the period 2015–2020 showing an average of 27 articles containing both search terms, and 42 papers being produced in the year 2020 alone.

If anything, this coarse-grained evidence provides us with two noteworthy insights. First, the year 2015 marks the beginning of a clear and steady surge in interest in studying networks and resilience, with 73% of all studies containing both keywords in the title having appeared during the past five years. Second, whereas social science network scholars – and in particular sociologists – were among the first, three decades ago, to actively engage with the resilience concept, their interest did not really develop into a sustained research stream. After a period of 40 years, the count for sociological articles on networks and resilience is currently at n=8, and the respective figure for economics is n=30.

Conceptualisation

There is certainly no lack of attempts to define and dimensionalise the concept of resilience (Brand & Jax, 2007). These definitions often differ considerably, defying efforts to find common ground among them (Downes et al., 2013) and triggering warnings with regard to the risks inherent to the unbridled dilution of the original concept (Brand & Jax, 2007). Nevertheless, some consensus has emerged concerning two crucial analytical key dimensions in the varying definitions of resilience (Olsson et al., 2015). The first captures whether the meaning of resilience is exclusively defined in terms of the "bouncing back" of a system into the *status quo ante*, or whether it also involves the system's transformation. The second dimension captures whether one takes a descriptive or prescriptive approach to resilience; that is, whether resilience is conceptualised as a neutral attribute or as something desirable, positive or inherently "good". These two dimensions summarise a large part of the debates concerning the concept, and the resulting four-field typology helps position individual studies with regard to their underlying assumptions (Olsson et al., 2015).

When putting together this edited volume, we deliberately refrained from picking a specific definition or conceptualisation of resilience from the vast

pool of available descriptions (for useful collections of definitions and conceptualisations, see, e.g., Brand & Jax, 2007 or Downes et al., 2013). Nor did we ask the authors of this volume to do so. Instead, each chapter explicates how it understands resilience, thereby allowing authors to closely relate to the state of the art in their respective subfields.

Critique

There are of course both advocates and fervent critics of the use of the concept of resilience for the analysis of social phenomena, and in particular of incorporating a normative dimension. Among the most outspoken critics are Olsson et al. (2015). In their reflection on the differences between the use of the concept in the natural sciences, on the one hand, and the social and behavioural sciences, on the other, they identify five important incommensurabilities, leading them to issue a warning: rather than reflecting an innocent theoretical construct that refers to an abstract property of social as well as ecological systems, the notion of resilience may actually be the carrier of an attempt to colonise the field with what they perceive to be a misguided attempt towards theoretical unification (Sjöstedt, 2015), led by the close-knit coalition of scientists of the Resilience Alliance and its flagship journal *Ecology and Society*, which has published a large proportion of resilience research. Among their more substantive concerns, they mention problems related to the ontology and boundary of systems, the conceptualisation of self-organisation and feedback processes and the notion of function and functionalism. These "incommensurabilities" are noteworthy because a social network perspective may actually contain the key to resolving them. In the context of the present volume, two of them stand out because they relate to core mechanisms that are often invoked by social network scholars.

Equilibria, Thresholds and Feedback Mechanisms versus Social Processes

First, according to Olsson et al. (2015), "equilibria, thresholds, and feedback mechanisms" – key to mapping ecological resilience – should be considered highly problematic when applied to the study of society. The reason is that these concepts would provide an overly simple representation of norm-based processes and "because feedback mechanisms in social systems are primarily determined by agency, or structured agency, rather than by structural forces". But on closer scrutiny, this criticism does not hold. Self-reinforcing feedback processes and the vicious and virtuous cycles they bring about have been amply

and fruitfully described in the social sciences, and this applies in particular to the structural forces behind them. In fact, some of sociology's classics revolve around the analysis of such feedback processes (Masuch, 1985). In the field of social network analysis, it is the opportunities provided by novel techniques for the study of the co-evolution of networks and behaviour (Steglich et al., 2010) that have provided a major boost for a more fine-grained analysis of social processes. Social network data and analyses have helped develop sociological knowledge on the most generic social processes in social life, including solidarity and exclusion, social control and conflict resolution, learning and socialisation, and regulation and institutionalisation – in particular to understand the extent to which individuals and organisations try to navigate these core social processes by building impersonal interactional or personalised relational infrastructures. The study of these processes and how actors navigate them collectively and politically is no longer a matter of just "equilibria, thresholds, and feedback mechanisms".

Self-Organisation versus Conflictual Joint Regulation

Second, "self-organisation" is considered as a core element of the analysis of resilience of ecological systems, but is problematic when applied to social systems. Here, Olsson et al. (2015) refer to the frequently invoked but ill-conceived notion of markets as self-organising systems through which the interaction of selfish individuals results in societally beneficial outcomes. Pointing to the vast literature demonstrating the social and institutional embeddedness of markets as part of broader social power structures, and the allegedly misguided assumptions underlying methodological individualism and rational choice theory, they argue that social scientists (should) conceive self-organisation mainly "as a retain to power asymmetries and structural inequality such as in the formation of social movements" (5).

From a social network perspective, this conceptualisation of self-organisation appears far too narrow. In our view, pitching principles of self-organisation against the importance of structures of power and inequality runs the risk of creating false dichotomies. In organisational societies (Perrow, 1991), which are class societies in which the meso level and its own generic logics are over-developed, whether through violent impositions or less violent negotiations driven by political, social and economic rationalities, actors positioned in stratified power structures become involved in struggles for social change. The term meso-social refers to all the organisational forms of collective self-assertion that are built by individuals and organisations that construct the macro level of society, from public administrations and business corporations to citizen and professional associations and the other collective interests

(including kinship) constitutive of the real social world (Lazega, 2020; Wittek et al., 2007).

Such struggles require what Reynaud (1989) called "joint regulation" taking place in what Selznick (1949: 6) calls organised "dynamic configuring fields". Joint regulation is the conflictual meeting producing compromises between top-down "control regulation" and bottom-up "autonomous regulation", both struggling to define the rules of the game. Since the beginning of its development, social network analysis has been used, for example by the so-called Manchester School, to get a better grip on emergent new socio-structural arrangements designed by actors against established power structures. This became apparent when more and more individuals moved from their rural areas to the nascent urban conglomerates, in which neighbourhood and other community relational infrastructures gradually and conflictingly complemented if not dismantled and replaced the traditional kinship-based structures. By now, social network analyses are used by social scientists, management, police forces and insurance companies to study or track these conflictual joint regulations in hybrid forms of governance of corporations and businesses, as well as in inter-organisational collaborations in the public sector, but also in the huge variety of grassroots platforms, marketplaces and social movements that meanwhile populate the World Wide Web. This is why, in this book, the core issues of social inequalities, discriminations and justice are often addressed with the question of "resilience for whom", away from a conception of resilience as mechanical self-organisation.

Contributions in This Volume

All chapters in this volume try to follow the evolution of contemporary societies, where the stakes of transitions are so high, by showing how social network analyses – including dynamic and/or multilevel network analyses – help us better understand resilience as a network issue. They account for research identifying patterns of relationships and modelling social processes at various levels, and their consequences for survival of collectives.

Knowledge presented in this collective book is meant to provide keys for better understanding of how social networks are used, or could be used, for action. The number of themes that are included is limited by space constraints: social network analyses could shed light on many more issues and fields that would have deserved to be included. Each of the contributors has more to provide in their own work, and the literature reviews offer guidance for interdisciplinary

extensions into other urgent topics. In addition, reading these chapters will provide the reader with a specific mindset that can then be activated to think in social network terms about important issues of resilience, social change and survival in different situations of vulnerability. This can strengthen our capacity to project ourselves into the future. All chapters therefore outline pathways to urgent and much-needed research.

A growing body of research and expertise uses network analytical tools to map human-made climate change as it threatens the living world in its very existence. Research on perturbations of the biosphere shows how the degradation of this living world can be expressed in terms of destructive interdependencies between humans, their organised collective agency, overexploitation of resources and the dumping of costs of destruction and inhabitability on the weaker part of humanity, while the stronger part carries on with lifestyles that use unsustainable levels of energy expenses, threatening planetary equilibria. Wallerstein's (1974) "world system" of interdependencies created by industrial revolutions, capitalisms and colonial exploitations beyond national territories has led to global environmental and political crises inextricably intertwined with economic and social injustice.

Social Resilience and Inequalities

In this context of growing inequalities, thinking about resilience of societies starts with the resilience of its weaker, marginalised communities. In her chapter, Miranda J. Lubbers shows how social networks shape the resilience of disadvantaged groups in society. Based on the literature on social support, social capital, sustainable livelihoods and structural violence, she discusses how social networks can strengthen people's reactive, adaptive and transformative capacities to cope with adversities and sustain wellbeing, but how they also perpetuate and exacerbate inequalities, subordination and exclusion, as in the case of the "burden of reciprocity" (Offer, 2012). For future directions, the chapter calls for greater attention to power differentials in unequal relationships, intersectionality in social network analysis, the contextual embeddedness of social network effects, and how networks can transform the social arrangements that produce marginalisation.

In a similar perspective, G. Robin Gauthier and Kelly L. Markowski look at gender inequality, social networks and resilience. Using observations during the COVID-19 pandemic, they explore the latter's major disruptions within social networks, with consequences that are only beginning to be understood. These disruptions exacerbated previous gendered inequalities in access to network resources, which are important sources of resilience during crises.

Crises strain resources (network and otherwise). During the pandemic, widespread efforts to contain the virus reinforced traditional gender roles, increasing the already disproportionate demands on women's time and resources. Crises also restrict access to support, and even shrink social networks. Men, who generally have smaller, less robust social networks, likely found this deficit increased. The chapter reviews previous literature on pre-existing differences in personal network characteristics by gender, including social isolation and network size, tie composition, network composition and the network structural feature, density. It describes how these features of social networks are sources of resilience during crises for both men and women, and how they have been strained in gendered ways.

Social Resilience and Work Practices

It is through work that the world of tomorrow is built. It is therefore important to look at the role played by social networks in the social organisation of work, whether regulated by management, workers or conflictingly both. One entry point in this broad issue is provided by Birgit Pauksztat's chapter on social networks and resilience in work teams. She explores social networks and resilience in an organisational context, focusing on work teams and their strategies for preparing, managing and learning from adversities. To date, only a few studies have considered social networks in relation to the resilience of individuals and teams in organisations (see, e.g., Teekens et al., 2021). This chapter shows how a social network perspective contributes to our understanding of team resilience. Specifically, it proposes that for research on team resilience, social networks can be relevant in three ways: they provide resources, they offer a way of analysing responses to adversity and they are important outcomes. Organisational design and interventions play a key role in resilience by influencing team members' networks, as well as the resources and strategies available to them. This approach is a foothold for continuous attention to this field of social action, Pauksztat argues: future studies should take a holistic approach to explore team processes in response to adversities over time, taking into account the multilevel context in which teams are embedded.

However, as shown by Paola Tubaro's chapter on social networks and resilience in emerging labour markets, the recent emergence of digital platforms as labour market intermediaries also disrupts such collective work practices, fostering fragmentation and individualised sub-contracting. She shows that in these environments, where isolation dominates, social networks operate very minimally, barely supporting social resilience. This chapter reviews insights from socio-economic studies of networks, discusses their applicability to digital platforms and compares and contrasts them with existing evidence

on platform work. The analysis confirms that, overall, technology-enabled platform intermediation restrains sociability and limits interactions, but specific cases where networking has been possible highlight some of the possible advantages this may have for workers. She suggests directions for future research and policy action.

Social Resilience and Massive Migrations

Massive contemporary, and especially future, environmental, climate-related and economic migrations, both internal to countries and transnational, lead to often violent uprootings, social re-compositions of populations, further ethnic diversification of societies and changing interethnic relationships.

In their chapter, Tobias H. Stark and Verena Seibel look at interethnic relationships in social networks and their effect on the resilience of ethnically diverse societies. The increasing ethnic, religious and cultural diversity of many European countries is accompanied by tensions and negative attitudes between groups. Research looks at efforts to counter such developments that require resilience in ethnic relations. This includes both the majority's willingness to accommodate newcomers and minorities' willingness to socially integrate in the new society. Their chapter reviews research showing how insights from social network analysis can be used to promote resilience by reducing ethnic segregation and creating positive interethnic relationships. This work shows the crucial effects of local and larger social network structures in which interethnic contact takes place on the improvement of intergroup relations, thereby contributing to societal resilience. Social network analysis also provides new perspectives on social support exchanges between migrants and natives that facilitate the accommodation of newcomers. They also argue that these insights can be put to the test in network interventions that promote resilience through creating new interethnic ties or spreading positive attitudes through existing networks.

In this context, institutions such as schools are core places where social resilience policies are designed, tested, implemented and evaluated. Knowledge of the role of social networks in the social resilience of more or less ethnically diverse schools is a key example for understanding the capacity of such institutions to help with such massive problems. In his chapter, Clemens Kroneberg shows that by promoting shared feelings of belonging and positive intergroup relations, schools can strengthen the social resilience of ethnically diverse societies. He discusses how social networks can both enable and constrain schools in serving this function. Research has shown that residential segregation and segregated parental networks contribute to ethnic segregation across schools,

which tends to widen educational inequality and erects barriers to intergroup contact. In ethnically mixed schools, however, studies have repeatedly found evidence for ethnic segregation and ethnic homophily in the social networks of students. This has been argued to potentially undermine social resilience by hindering the reduction of interethnic prejudice, triggering feelings of threat or superiority, or increasing the likelihood of victimisation by outgroup members. The chapter critically evaluates these claims, points out promising interventions and identifies open questions for future research.

Social Resilience from Legal Levers

Law is a fundamental lever for the coming transitions. In all domains of law, including civil, criminal, commercial, administrative, constitutional, environmental and international, law – although too often formulated by powerful actors exclusively – is a crucial lever for policies that have to be multilevel, applied locally as much as globally to boundaryless problems. As illustrated by obstacles met by international Conference of the Parties (COP) meetings, the greening of international law (as coined by Sands, 1993), international institutions and policies still operates at the level of improvisation.

In situations of increased vulnerability, crime increases and societies are further threatened by what it considers criminal networks (Silitonga et al., 2016). In his chapter, Paolo Campana looks at the relationship between criminal networks and social resilience. He first discusses the dualism between substantive and instrumental approaches to study criminal networks, favouring the latter. Next, he suggests four lines of inquiry: (1) groups' internal structure and organisation; (2) wider market structures; (3) recruitment into criminal groups, criminal careers and desistance; and (4) neighbourhoods and places. Finally, he discusses some cross-cutting issues in criminal network research, namely: (a) terminology; (b) data sources; (c) multiplexity; (d) network modelling; and (e) integration between network and non-network approaches.

Social Resilience, Power and Politics

Rethinking our societies requires, among many other things, new laws respecting planetary limits. Such changes are in fact colossal, since the creation of new institutions that are perceived and respected as legitimate and capable of maintaining rapport between actors at all levels has involved heterogeneous forces of "governance" –including efficient lobbying by large multinational corporate hegemons – that dovetail or compete with governmental or state powers. Such processes will not be able to avoid conflicts to constrain powerful actors. This raises the issue of transformation of democratic regimes that

need to incorporate long-term stakes to face global changes. Climate policies require, however, apart from states, the mobilisation and creation of different infra- and supra-national political institutions. But is, for example, climate federalism able to govern and save such commons as biodiversity? Are current political institutions able to establish equity in access to resources across countries and territories?

In his chapter, James Hollway offers to international relations (IR), which is often concerned with but has rarely employed the concept of "resilience", a vocabulary and framework extracted from across the interdisciplinary resilience literature and complemented with network ideas. He points out how IR scholars might be interested in the resilience of an international network as a whole – he uses the trade network as an example throughout – or of particular nodes or even ties within that network. He argues that, depending on the level of analysis, scholars may be interested in the resilience of the unit's function or identity. He also proposes a typology of crises based on the exogeneity and time horizon of its causes to highlight how shocks are but one type of crisis of political interest. In his framework, he distinguishes resilience from the related terms robustness, responsiveness and fragility on the basis of a processual mapping, before relating examples of resource-, redundancy- and diversity-related network configurations back to the junctures between these processes. He then reviews two developments in social networks, towards more multimodal and dynamic modelling (Knoke et al., 2021), that offer ways of exploring these concepts in IR in more detail. The chapter concludes with some general reflections on what the concept of resilience does and for whom, ultimately arguing that more research is necessary to understand when and which units ought to be resilient rather than robust, responsive or even fragile.

In their chapter, Karin Ingold, Dimitris Christopoulos and Manuel Fischer deal with the issue of resilience in political networks. Indeed, if resilience is defined as the capacity of a system to recover quickly after shocks, such an ability for continuity is also relevant for political systems. Important shocks to political systems can be triggered by natural disasters, political regime changes or other major events. The chapter conceptualises political systems as political networks consisting of several interconnected political actors tackling problems on the political agenda. It investigates political networks' ability to recover from shocks. To do so, the authors first identify different types of shocks that have the ability to impact political networks. Second, they review the literature on resilience and discuss concepts related to political resilience. Third, they outline network measures and models able to grasp the reaction of a political network to shocks, in order to operationalise the level of resilience of such a system. Throughout the text, they illustrate theoretical ideas with

selected case studies and empirical examples. In particular, their network analyses lead to the conclusion that political networks need to allow for change and flexibility during the "after-shock" situation: a resilient political network is not one that adopts the exact same shape, but one that has reinforced elements of its structure as a response to a shock.

Grassroots also matter in politics and their links with social networks have been studied systematically, online and offline. Isabelle Langrock and Sandra González-Bailón show that social network analysis is well primed to answer questions around how movements gain traction, create or change story frames, enact policy change and mobilise supporters, both online and offline. Focusing on the Black Lives Matter movement, they show how it has spurred massive international protests since it first emerged around the eponymous Twitter hashtag in 2013, and how research about this movement uses network approaches to understand its emergence, growth and resilience, especially as it enters its second decade and contends with counter-movements. More generally, the chapter offers a discussion of the opportunities and challenges associated with incorporating social media data in the analysis of resilience as it manifests in the growth of networked social movements.

Social Networks and Collective Intelligence

Mobilising collective intelligence around complex problems requires the capacity to bring together actors with different, local, incomplete perspectives to help hammer out risky decisions. Information and communication technologies play a significant role in these appropriate and collective knowledge-building and co-orientation efforts. Camille Roth provides a striking in-depth view of how the resilience of online socio-semantic bubbles creates and/or reinforces polarisations that both stimulate and undermine efforts at mobilising collective intelligence. He shows that the polarisation observed in digital spaces makes them a prototypical playground for the study of sets of actors cohesively connected to alters holding similar opinions. Such socio-semantic bubbles raise the issue of resilience at two levels, in which macro-level resilience may conflict with meso-level resilience: put differently, the deliberative capacity of a social system may be disrupted by the stability of groups whose members hardly encounter diverging narratives and are susceptible to "groupthink" or vulnerable to so-called fake news. This chapter reviews our current knowledge on the empirical socio-semantic cohesiveness of bubbles and on the normative models explaining their plausible emergence. It also challenges the common correspondence between low-level homophily and high-level fragmentation, which neither holds nor suffices to explain the wide spectrum of socio-semantic configurations observed across a myriad of

online systems. It proposes further research directions in this regard, while reviewing the ongoing efforts towards understanding the potential role of algorithms in the emergence of online socio-semantic bubbles. Further developments and sharing of knowledge about social networks in the mobilisation of collective intelligence is needed to frame democratic debates about the use of high and/or low tech in exercising power and sharing sustainably managed resources.

Social Resilience of Food Systems

One way in which the planet threatens to become unliveable already for many people is related to access to food, healthcare, mobility and satisfactory shelter. But in addition to measurements of quantitative planetary limits (Raworth, 2017), there are also qualitative issues that require the understanding and mobilisation of social networks to deal with such momentous problems. In a globalised context where systemic risks abound (Centeno et al., 2015), economic inequalities increase within and between countries, reducing the satisfaction of basic needs of an increasing share of humanity. Access to water and food matter first, but the capacity to manage change in lifestyles is also of increasing importance for transitions. Public policies but also social networks therefore have the capacity to make a difference.

Today, the food system is responsible for a "triple crisis" combining increasing obesity, hunger and climate change. While there is a widespread consensus that our food system must change, the extent and direction of this change is contested. The contrast between a dominant corporate food regime and an increasing variety of hyper-local, alternative food networks makes it difficult to build a shared understanding of what a sustainable food system will be. Laura Prota's chapter offers a new methodological lens based on social network analysis to explore food system resilience and change. Taking a socio-technical framework as theoretical background, resilience is conceptualised as the capacity of the food system to absorb innovations and adapt to new conditions without changing its structural configuration. Pre-specified blockmodelling is used to capture the organisational structure of an observed food system and compare it to a stylised model of governance (i.e. hierarchy, core–periphery). This structural analysis of food systems is particularly useful to compare alternative food systems across space and monitor the evolution of food systems over time. The structural analysis proposed can be used as an effective policy tool to accelerate the transition towards more sustainable, inclusive and resilient food systems.

Food insecurity also concerns wealthy countries. In her chapter on social networks to support food and nutrition security, Kayla de la Haye documents the interconnection between food systems, food and nutrition security, and social systems, with a focus on a country such as the United States: despite having an adequate food supply, it has high rates of food insecurity and diet-related disease as the leading cause of death. This chapter describes the important role of multilevel social networks – including personal social networks, networks of community leaders and stakeholders, and networks of policymakers – in building resilient food systems, including gaps and opportunities in this research. It points to the need to increase our understanding of how to foster multilevel networks that are empowered to create more resilient, equitable and sustainable food systems to improve food and nutrition security for all.

With the agricultural sector being first in line to deal with global environmental changes, Mathieu Thomas, Christian Leclerc, Isabelle Goldringer, Baptiste Rouger, Vanesse Labeyrie and Sélim Louafi follow a multilevel relational approach, including production relations of food crops, where big international companies are dominant actors. They reveal the importance of resilient seed circulation networks in a context where seed systems are increasingly controlled and structured by the huge agrifood businesses upstream of production. Seed systems in agriculture play an essential role in food autonomy and therefore in the resilience of human societies. Their chapter focuses on the resilience of seed systems based on the study of seed networks involving farmers and other stakeholders. As seeds are living entities, they evolve over time according to the growing environment and production practices. This specificity leads us to consider the resilience of seed networks from two perspectives: through the structural properties of these networks and through the study of genetic evolution of circulating seeds. The authors share their experience of undertaking a collaborative research approach with farmers and other stakeholders such as breeders and gene-bank managers. They show how the co-design of decision support tools based on the network formalism with the actors favours reflexivity, which leads to the evolution of their own operating rules in order to improve the resilience of their system.

Still on food security, Petr Matous puts a particular spin on the issue by shedding light on a specific dimension of technocratic interventions that try to build community resilience in rural development projects. His chapter looks at how millions of farmers struggle to sustain their livelihoods while they are expected to feed growing global populations and simultaneously change their practices to help mitigate climate change. It discusses how social network approaches risk triggering intended as well as unintended effects when they promote technology and rural development projects that aim to address this

challenging situation. Social network research can help us better understand the ways in which technocratic interventions interact with the social capacity of smallholder farming communities for collaboration, adaptation and learning to improve food security and farmers' lives in the face of environmental threats; in short, what they mean for community resilience. Further research needs to critically question likely unrealistic expectations on central individuals in smallholder farmers' networks and the impacts of technocratic interventions on community-wide collective-level processes, as well as the consequences of community-orientated projects and programmes across the nominal boundaries of the systems in focus.

Social Resilience of Healthcare and Shelter

Health, both individual and public, is also at vital risk today, as shown by the current pandemic that has not only killed millions but has also paralysed entire countries, challenging the capacity of governments to manage existent national healthcare systems in order not only to reduce the cost in terms of lives and economic activity but also to maintain healthcare institutions. The vulnerability of populations is thus not just an issue of medical care. It is a more general issue of access to all sorts of social and economic resources that determine population health. For example, population ageing coincides with a dramatic increase in the prevalence of age-related diseases. In her chapter on the social safety net and its implications for resilience in old age, Lea Ellwardt shows that, against this background, calls are getting louder for research into the markers of a prolonged healthy and independent life. One of these markers is resilience: the adaptive ability to bounce back from adversity, trauma and stress. Key predictors are integration into and support from social networks. Yet social gerontological frameworks have acknowledged, but abstained from incorporating, classical network theory and analysis. Ellwardt summarises theories and findings on social networks in old age, followed by a brief overview of existing research designs and a discussion of challenges remaining in the field. Her vision extends to other domains, for example also domains where resilience of individuals is the main focus (Ellwardt et al., 2020).

Access to housing considered decent is also an issue of both economic inequalities and lifestyle as incorporated into habitat and urban forms. Combining architectural stakes with healthcare issues, Kerstin Sailer and Xiaoming Li look at how spatial opportunity structures and resilient social networks are shaped by architectural and urban forms, and their empirical example is also in the domain of the elderly: their integration in neighbourhood commons at the very local scale requires attention to conviviality as integrated in the shape of buildings. They bring together research from the domains of social networks,

resilience and spatial morphology to argue that the built environment is an often overlooked but increasingly recognised vector influencing the formation of ties in social networks. Space is defined on different scales – the urban and interior – as opportunity structures supporting or undermining network resilience; that is, the way in which access to resources is enabled (see also about this topic Arana & Wittek, 2016). Based on a literature review, they identify five different spatial mechanisms with the power to inhibit resilience in social networks: proximity, correspondence, severance, access inequality and uniformity. They also present empirical work that conceptualises urban and architectural opportunity structures for the elderly in care homes.

Resilience of Socio-Ecological Networks

Last but not least, it is important to note that social network analyses are combined with other formalisms into "integrative network approaches" (this is also done in the chapter by Mathieu Thomas et al.), for example for understanding resilience to environmental change proper. In her chapter, Michele L. Barnes provides an overview of such an extension by looking at the role of social networks and social-ecological networks (networks composed of both people and nature) in supporting resilience to environmental change, and describes the analytical and methodological approaches used to study these relationships. Social networks underpin the resilience of human communities to environmental change because of their role in building adaptive capacity. Social networks can also determine responses to environmental change through social reinforcement and social influence. Novel research in this area has developed theory and provided empirical evidence regarding how and why relationships not only between people (social networks) but also between people and nature (social-ecological networks) can be critically important for understanding resilience to environmental change. She concludes by providing critical research frontiers in this area that can inform the building of more resilient societies and ecosystems to meet the rising tide of dramatic environmental change.

Discussion

The contributions to this volume cover a vast area of substantive problems, theoretical approaches and methodological tools, painting a multifaceted picture of the interplay between social networks and resilience. They also sketch the contours of potential future agendas for research and welfare-enhancing policies and interventions. Where does all this leave us? Which overall take-home

messages, if any, can be distilled from this variety? We see several themes that seem particularly fruitful contributions for both scientific inquiry and evidence-based policy making.

Resilience as a Point of View

As outlined at the start of this chapter, up until now resilience has been a phenomenon that has remained at the fringe of the social sciences and a highly contested concept. The contributions to the present volume show that a serious engagement with resilience in all its complexity has added value, in particular when analysed from a social network perspective. A first contribution that can be made by considering the concept of resilience is to add, to many social network investigations, some explicit attention to the notion of coping with external shocks. This is natural as for many theories basic to social network research, such as the theory of social capital (Flap, 2002), a basic issue is the idea of delayed reciprocity and the value of investing in relations in view of unforeseen future events. Making the value of resilience to expected and unexpected shocks explicit, as a contrast to the value of efficiency in situations of "business as usual", can highlight the contributions that can be made by a social network approach.

Resilience as a Boundary Concept

The added value of paying attention to the concept of resilience is especially high with an eye on potential policy implications. The latter inevitably requires explicating the normative assumptions underlying its conceptualisation: resilience for whom? Whereas adding a normative component to the study of resilience of course comes with its own downsides, in particular that of eventually diluting its original meaning as used in the study of ecological system dynamics, even those critical to its use in the social sciences acknowledge that broadening the theoretical construct may also come with considerable benefits. More specifically, the resulting increase in ambivalence may make it a "boundary concept" that facilitates inter- and transdisciplinary progress (Brand & Jax, 2007). The contributions to this volume show that the resilience concept can indeed fulfil such a boundary-spanning role. The different chapters emphasise different aspects of the multidimensional concept: some stress the need to disentangle different trajectories that processes of adaptation can take; others suggest that viewing it as bouncing back from adversity can be a fruitful conceptualisation; still others shift the attention to group-level strategies for preparing, managing and learning from adversities. A common thread shared by all contributions is that resilience goes far beyond an entity's ability to deal with external shocks. One of the values of network analyses for

the study of resilience is that they look at the interaction patterns between actors when trying to cope with external shocks, differentiating between several types of actors and several structural levels, noting that their efforts can be self-defeating, but that they can also be self-improving.

Multilevel Relational Infrastructures and Their Dynamics

Top-down, centralised and general solutions will not suffice as responses to external shocks. Local and personalised ones will mobilise relational life, and in crises or other cases of serious shocks it will not be possible to ignore social networks. In addition, social actors will need to address actors at other levels – for example, individuals will need to consider relations with and between corporate actors; institutions and firms will need to consider relations with and between individuals. Furthermore, external shocks will often lead to the emergence of the relevance of other actor sets, entirely new ones or actor sets of which the operations were earlier taken for granted. Relations in such configurations can be supportive or conflictual, often both at the same time, and are essentially dynamic. How to observe, model and analyse phenomena that are not only characterised by networks of interdependencies between conflicting actors at one level but that are also simultaneously dynamic and multilevel raises key issues for the social sciences. Multilevel relational infrastructures will be important in the coming transitions, for example because citizens will have to navigate issues of relative status, social comparisons, collective responsibilities, social discipline and solidarities in "coopetitive" social processes established to manage vital resources, both locally and under the control of global institutions.

A better understanding of the dynamics of multilevel social, organisational and higher-order networks requires both theoretical and methodological advances. Theorising requires a much more fine-grained approach to cross-level effects, expressing how relations and behaviours at the individual level not only depend on the context defined by relations with and between units at higher levels but also influence them in their turn. Research about these cross-level effects needs to be grounded in behavioural micro-foundations that allow explication of the mechanisms linking processes at the macro level of societies and the meso levels of collectivities such as organisations, communities and families to the level of individual decision making and actions. Indeed, bottom-up and top-down struggles in politics suggest that when a social fact must be observed at analytically different levels of collective action, the analysis of individual agency, relations and skills becomes inseparable from that of organisational agency, structure and culture. Social resilience as a matter of joint regulation requires understanding the combination of relational capital

of individuals (based on analyses of ego networks) and social capital of collectives (more socio-centred network analyses).

To take into account this vertical complexity of a social world in the cohabitation and co-constitution of several levels, it is necessary to further link these levels and their dynamics analytically (Snijders, 2001). Social network analysis not only has the conceptual and methodological tools to analyse and map processes of autonomous regulation and joint regulation, but by its very nature it also incorporates in its analyses power asymmetries and structural inequalities in the navigation of social processes in multilevel, nested social contexts. In this multilevel framework, each level is a part of the context for the other, which implies that contexts may be seen as dynamic multilevel realities, involving processes that interact and retroact on each other in ways that are difficult to anticipate and manage, while at the same time these processes produce damages and costs that create further inequalities. Multilevel networks are defined as multiple networks connecting several different actor sets, where each network has a distinct meaning pertaining to the same social reality (Wang et al., 2013). Their analysis constitutes a frontier for social network analysis (Lazega & Snijders, 2016; Lomi, Robins & Tranmer, 2016). An important methodological challenge is thus to express the combined and interrelated agency of actors in several actor sets in a multilevel network (Snijders, 2016; Koskinen & Snijders, 2022).

Policy Implications

The normative aspects, and associated policy implications, are the – explicit or implicit – core of many of this book's chapters. Resilience is also about choices, as policy recommendations depend on welfare functions. This goes back to the social welfare dimensions discussed earlier. Normative considerations often lead, in studies about resilience, to recommendations for transforming relations and institutions, rather than letting them bounce back to a state that might be considered dysfunctional in the light of the possibility or even certainty of external shocks.

Conclusion

In contemporary societies, positions in the social structure are defined in terms of social stratification (class, professional and occupational categories) but also in meso-level, organisational terms. Contemporary societies are organisational societies dominated by giant, powerful public authorities and highly

profitable and entrenched private firms. They can be characterised by complex meso-level status hierarchies and conflicts but also by sophisticated forms of division of work and complex interdependencies (functional, economic, epistemic, normative, emotional, etc.) among their members. This complexity of positions makes cooperation at each level of agency in terms of social processes (such as solidarity, control, collective learning and regulation) contingent on what happens at the other levels of collective agency, not only at the micro or macro levels. Often actors are aware of the consequences of this, especially when they see that inequalities among players prevent their own investments from being productive: coordination and synchronisation costs incurred by actors are lost for some, productive for others; stabilised and predictable for some, unstable and unpredictable for others.

Thus, producing social resilience raises monumental multilevel collective agency problems and cooperation or coopetition issues. As such, an organisational perspective is useful since it helps members of collectives understand and manage the dilemmas of their collective forms of agency. The formalisms of social and organisational network analyses combining position and behaviour in this complex context have evolved to characterise the dynamics of multilevel networks in organisational societies and to measure them along with their induced effects. Analyses based on these formalisms will play an important role in societies that, on the one hand, increasingly concentrate power and, on the other, are faced with challenges such as the disappearance of levels of intermediation, the apparent democratisation of new technologies that decentralise services (e.g., internet-mediated markets, blockchains), the development of private and parameterised digital platforms for management of local communities that compete with the public architecture of these communities, and other drivers of social change. These developments offer some members of society the capacity to understand their place and position in the organisation of these processes while others remain in the dark, adding to social inequalities and feelings of disorientation. As always in social scientific work, new models help to explore and generate ideas and intuitions when the complexity of phenomena is high and their observability is low.

Social network methods thus help build a view of how society works that will be useful in the short and hopefully long futures. Nationwide policies of management of vital resources will need to synchronise with changes in lifestyles created locally by communities managing their common pool resource institutions (Ostrom, 1990). Each chapter in this book covers a welfare dimension, or even multiple welfare dimensions, in which the field or area of application of network analyses is interested. The book does not pin down this definition to a particular group of welfare functions. As shown by the contributors to

this volume, many policy domains already benefit from applications of social network analyses paying attention to social resilience issues, employing different definitions of resilience. Many chapters provide programmatic statements that point to the potential usefulness, and limitations, of bringing a resilience perspective and social network analysis as an eventual paradigm shift for policy makers. In all these domains, much research is being carried out from this perspective, and much remains to be done.

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