Social and Ecological Systems Resilience and Identity

Francois Bousquet, Tara Quinn, Clara Therville, Raphaël Mathevet, Olivier Barreteau, Bruno Bonté, Chloé Guerbois

Social and Ecological Systems Resilience and Identity

Francois Bousquet, Tara Quinn, Clara Therville, Raphaël Mathevet, Olivier Barreteau, Bruno Bonté, and Chloé Guerbois

Introduction

For several decades now, researchers have been examining the resilience of social and ecological systems (SES; Folke, 2006) ranging in scale from forests, towns, fisheries, and lakes through to planetwide systems. Given the number of rapidly changing SES and their implications for global health and well-being, there is an impetus to examine how resilient they are in the face of global changes. Here we outline what a SES is, and we give an overview of the history of interdisciplinary encounters that has led to the evolution in definition of SES resilience. Subsequently, we will focus on the process of identification and distribution of vulnerability, and we propose (using the empirical example of the experience of four cities) a new lens through which SES processes can be conceived that helps to identify the potential resilience of a system.

Plants, animals, humans, water, and social, natural, and physical infrastructures interact, and observers, actors, and analysts identify an SES through the definition of its boundaries, the components, and the important interactions. After this first task the observers look at the properties, the functions of the SES (to provide goods, to secure services), and they try to understand whether the SES they have identified is resilient, which means whether the components, the interactions, the properties, and the functions are maintained when the SES faces adversity and shocks. Thus, resilience is a process and not a trait. The resilience process is inextricably shaped by the vulnerabilities embedded in the SES. A forest largely dominated by one species is vulnerable to a disease affecting that species; a town built on a river can be vulnerable to floods if the inhabitants are not prepared; etc. Each SES has

embedded in it both a distribution of vulnerabilities together with the means to cope with these vulnerabilities. Time passes by, components of the SES will disappear, new ones will be included, and interactions will change but the properties and the function is maintained: for the observers, the SES is the same despite the changes. Or, to the contrary, the properties and the functions have changed, and for the observers, this is not the same SES. For instance, after a large forest fire, trees have regrown, but new species are dominating the diversity. Previous inhabitants have left and people with different lifestyles settle in the forest and make use of it. For the observers it is not the same SES as the previous one. It has not the same identity. We will argue in the second part of this chapter that the study of the resilience needs, in parallel to the analysis of modifications of components and their interactions, to look at the identity of an SES and the embedded vulnerabilities.

In one of his recent synthesis papers on SES resilience, Carl Folke (2016), a leading researcher in this field, defines the resilience of SESs as: "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, and feedbacks, and therefore identity, that is, the capacity to change in order to sustain identity" (para. 21). When an SES faces events and adversity (e.g., storms, diseases, invasions, droughts, pollution) resilience is the process that enables an SES to maintain its identity (forest/fishery/town/catchment remains the "same"). But what does the identity of an SES exactly mean? How can an observer say that this forest/town/fishery has been resilient and retained its identity or that, on the contrary, it has lost its identity? From a complexity science perspective an SES is an organization/configuration made up of plants, animals, humans, infrastructures, and entities—parts of the SES or external observers of the SES—internalize this organization through their perceptions, attitudes, and actions and the identity of the SES can consequently be reinforced or transformed. The identification process is the bundle of construction processes that ascribes an identity to a SES, either confirming the previous one or declaring a new identity (e.g., the Amazon forest was formerly identified as the "green hell" and is now identified as "the planet's lung"). At any given time in the identification process, the declared identity of the system reflects the dominant perception of the organization of the SES and reveals its capacity to deal with its vulnerabilities.

In a complex multisystemic organization such as a SES, the modification of one relationship within the system leads to modifications in other parts of the system (Anderies & Janssen, 2011). Due to external shocks, adversity, or internal modification of relationships, the distribution of vulnerabilities within the SES evolves. An entity that was formerly vulnerable is not anymore but has transferred its vulnerability to another entity, maybe at another scale; therefore, a new type of vulnerability has emerged affecting a group of entities. For example, when the Amazon was identified as a green hell, the vulnerable entities were the people settling there (not the Indigenous peoples), while now, as a green lung, the vulnerable entities are the trees, the Indigenous peoples, and the region's biodiversity. The boundaries of the system have also changed, the green lung being a fragile part of a larger planetary body. The transformation, the disruption of the relationship between natural and social entities, leads to transfers of vulnerability and a new distribution of vulnerabilities. The identification process leads to a new distribution of vulnerabilities among the entities of the SES and the means to cope with them.

In summary, in the SES resilience domain, it is assumed that SES continuously reorganize while undergoing change. Resilience is not a question of whether a SES can come back to a former state but rather whether the SES remains the same or has become something else. To address this question, we use the body of research on identity, which tells us that identity results from a continuous identification process that reveals but also contributes to SES change and distribution of vulnerabilities. Consequently, our main thesis is that to study and qualify the resilience of a SES, there is a need to study the intertwined processes of SES change and identification.

An Overview of SES Resilience

A chronological look at research on SES resilience shows that the SES concept has been defined after the process which is at stake—resilience. Having been dominated in the 1970s and 1980s by the studies of researchers in ecology, the focus of the concept evolved in the 1990s with the growing weight of work on social dynamics: the object of resilience gradually moved from ecosystems to SESs. Here, we define the concept briefly and paint the story of the evolution of the (SES) resilience concept.

What Is a Socioecological System?

As indicated by Brondizio, Solecki, and Leemans (2015) in their reflection on the history of SES, decades of study on the relationship between ecology and society preceded the emergence of the SES concept. More recently, Colding and Barthel (2019) published a paper on the SES concept attributing the first definition of a SES to the Russian microbiologist B. L. Cherkasskii (1988) who described it as

> consisting of two interacting subsystems: the biological (epidemiological ecosystem) and the social (social and economic conditions of life of the society) subsystems where the biological subsystem plays the role of the governed object and the social acts as the internal regulator of these interactions. (p. 321)

Almost at the same time in 1989 (referring to a paper written in 1986), the Argentinian ecologist Gilberto Gallopin (Gallopin, Gutman, & Maletta, 1989) framed socioecological systems "in terms of a set of causal circuits and of relevant questions to be asked, rather than as a set of subsystems (other than the obvious—and still somewhat arbitrary—splitting of the whole into social and ecological subsystems)" (p. 385).

In the early 1990s, Berkes and Folke (1994) introduced this concept into their resilience research. Unlike Gallopin, they framed socioecological system as the integration of humans and their actions into ecological systems. Several years later, Ostrom published in *PNAS* (Ostrom, 2007) and *Science* (Ostrom, 2009), two articles proposing a framework of analysis for socioecological systems that put humans at the center of analysis as users of natural resources. Her research focused on the coevolution of ecological dynamics and management rules.

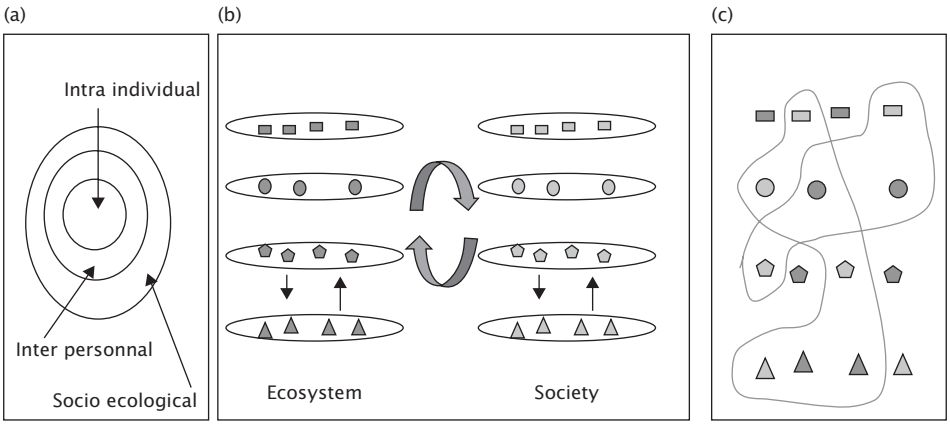

FIGURE 36.1 Different conceptualizations of an SES.

Schoon and Van der Leeuw (2015) brought new epistemological dimensions to the SES concept. For them, SES proposes a new ontological approach that includes (a) an integration of the social and ecological into a fully coupled SESs perspective; (b) a holistic view of scientific phenomena requiring a transdisciplinary approach to its study; and (c) the refutation of a purely equilibrium-based understanding of systems.

Figure 36.1 illustrates different conceptualizations of SES. Figure 36.1A presents the idea of nested systems, the individual being embedded in a group, which itself is embedded in a socioecological set of processes (Liu, Reed, & Girard, 2017). Figure 36.1B presents the SES as composed of two interacting systems, an ecological and a social one. Each system is viewed as a hierarchy of dynamic subsystems (i.e., individuals, households, institutions, and organizations on the social side; individuals, populations, and ecosystems on the ecological side). This is the model that prevails in the ecosystem services literature. Figure 36.1C present the view of complex systems where human, nonhuman entities, institutions, and organizations interact in many ways across scales and categories. A tree can interact with a state; an individual, with a fish population; and so forth.

The Development of the SES Resilience Concept

Inspired by Folke's 2006 paper we outline here a story of the emergence and trajectory of this concept.

From Equilibrium to Multiple Stable States

In the late 1960s and early 1970s, ecologist Crawford S. Holling worked on population interactions, such as predator–prey relationships, using a combination of mathematical models and experiments. Researchers in ecology were interested in the notion of equilibrium. The work of Holling and his colleagues showed that there is not just one but in fact several states of equilibrium between these populations. This discovery transformed how the concept of

resilience was applied in research (Holling, 1973). Resilience had previously been defined by the return time to a unique equilibrium for which Holling spoke of "engineering resilience"; here the world is perceived as predictable and the aim is to understand the system's return to an initial state after a disturbance. With the conception of a world of multiple equilibria, Holling introduced the "ecological resilience" concept, defined as the amount of disturbance a system is able to receive before moving to another state. He then used the metaphor of the ball and the landscape (see Figure 36.2 for an illustration by Mathevet and Bousquet, 2014) to illustrate what he calls the different "myths" of nature, each image representing different ways of seeing the world.

The ball represents the system and is placed on a line that represents the landscape, the context in which the system evolves. If the landscape is flat, a small disturbance will make it evolve erratically; the myth of a "flat nature." If the ball is placed in a hole (Figure 36.2a), small disturbances will not make it change because it will fall back into the depression; it is in a stable state; the myth of an "equilibrium nature" and reflecting the concept of resilience in engineering. If the ball is placed on a hump (Figure 36.2b), a tiny disturbance will have great effects; it is the myth of an "anarchic nature." The last situation corresponds to a landscape with multiple equilibria; there are several holes and several humps corresponding to different equilibria. This is the myth of "resilient nature" in the sense of ecological resilience. The landscape changes and hollows and bumps are transformed (as illustrated by (Figure 36.2c–e). Research efforts switched to a focus on understanding change instead of stability. How and under what conditions does the system pass from one state to another, cross thresholds, and tipping points? What are the slow and fast processes that modify the landscape? In the 1970s

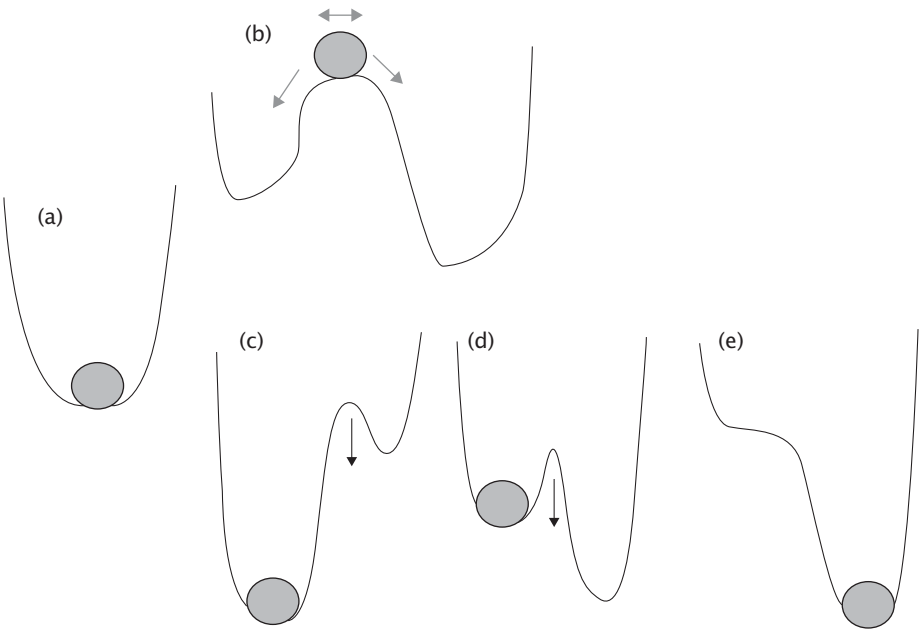

FIGURE 36.2 Metaphor of the transitions between states (Mathevet & Bousquet, 2014).

and 1980s, Holling and the researchers working with him studied these shifts, always combining field data analysis and mathematical modeling.

The Transition From a Focus on States to a Focus on Trajectories and Cycles

After laying the foundations of this new perspective in the 1970s, researchers expanded the number and types of cases they studied. Then, rather than simply focusing on transitions from one state to another, they proposed a general model of transitions between states (Holling, 1986). Figure 36.3 shows the model of adaptive cycles that provides a framework for thinking about the trajectories of ecosystems.

Building on this previous model, in the early 2000s researchers proposed the concept of panarchy, which incorporates the idea of different levels of organization within a SES (Gunderson & Holling, 2002; see Figure 36.4).

The trajectory at a given scale influences interactions at other scales. The lower scales, whose dynamics are faster, invent and test new ways of life or new practices; the higher scales, whose dynamics are slower, gradually integrate tests where results have been conclusive (such as technological innovations or know-how).

In 1995, Frances Westley introduced the notion of institutions in the field of resilience. It was also at that time, in 1996, that Holling and Lance Gunderson began an active collaboration with the Beijer Institute of Ecological Economics in Sweden where Folke was developing his research. The network, called the Resilience Network and later the Resilience Alliance, promoted meetings and collaborations of researchers. At that time, Elinor Ostrom who won Nobel prize for economics in 2009 was collaborating with other scientists that were

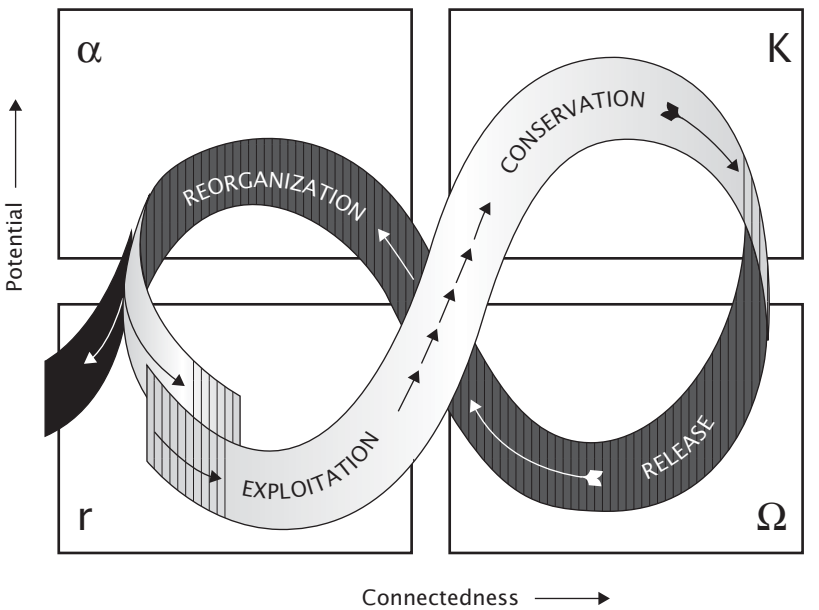

FIGURE 36.3 The adaptive cycle model illustrating the connection between different states within a system.

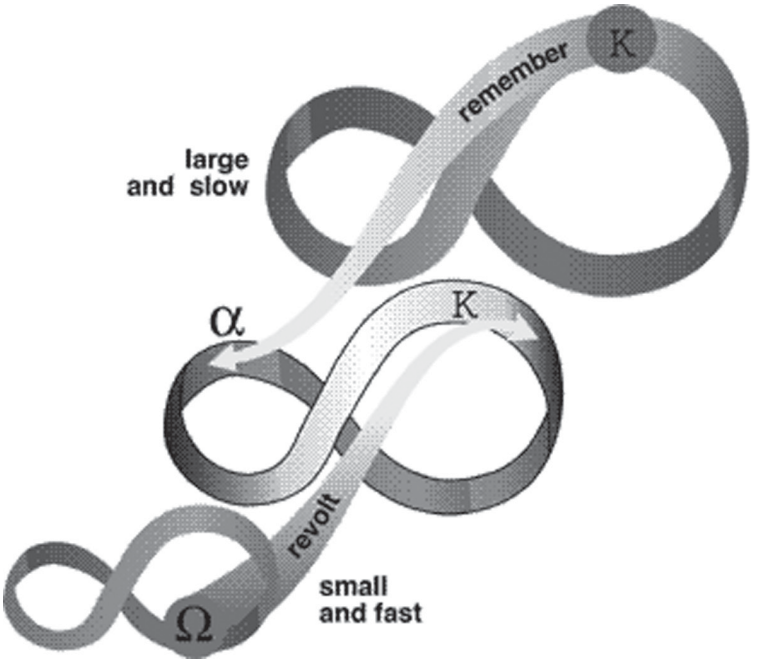

FIGURE 36.4 The panarchy model showing the multiple scales at which SES resilience can be measured, and the connections between these.

studying management of the commons. Her work in political science provided a scientific basis for a pragmatic collective action approach during adaptive management workshops, transforming a practice into a subject for scientific research. Fikret Berkes, an ecologist, also played an important role in the evolution of thinking about resilience, both for his work on institutions, but also because he has greatly contributed to the recognition of the importance of local knowledge for land management. An environmental social scientist, Neil Adger, also posed the question of how resilient institutions are in environmental management by introducing the concept of social resilience that defines the ability of a social group to cope with a disruption or external stress resulting from social, political, or environmental change (Adger, 2000). This period of interactions with social scientists took resilience thinking a step further by integrating the idea that actors and social groups adapt and transform themselves in interaction with ecosystem changes.

From Resilience to Transformability

In the late 1990s and early 2000s, encounters between researchers active in the field of complexity science also contributed to the changing thinking on frameworks of resilience. The systemic vision, the bedrock of resilience research in the 1970s, consisted of identifying stocks (of matter, energy, information) and flows between these stocks, or by measuring the positive and negative influences that variables exert on each other. One simplified example of such an approach would be to analyze a fishery by modeling the interactions between fish stocks (the variable being the number of fish) and the capital of the fishermen (the variable

being the quantity of boats). Complexity science proposes that the object of study is made up of entities with different behaviors, that interact through networks and form organizations that co-evolve. Their components are endowed with unique characteristics and bear singular histories (representing the behavior of each fisherman and his interactions with other fishermen). Christopher Langton (1992) showed that states are not predictable a priori. A change in behavior or in interactions leads to a new arrangement, a new organization that cannot be predicted. This new organization imposes constraints on the entities that make up the system, and so on. Langton's work focused on organizational changes, rather than the flows between stocks.

It is during the same period that the Resilience Alliance integrated new members with a constructivist research approach. For constructivism, knowledge is not a mere copy of reality, but a reconstruction of it. Constantly renewed, these constructions are elaborated from older representations of past events. Each actor of a social system has their own point of view of the reality of the system, which they have constructed in time, in physical, and social space, with their own goals. These constructions are at once derived and constitutive of the system of representations reflective of the culture to which the actor belongs. The visions of these actors evolve according to the state of this world—they learn—and, conversely, the world evolves according to their representations.

Later, researchers distinguished two types of capacities for change: adaptability and transformability. Adaptability is the ability to react to stress or disturbance without modifying the structure and functioning of the system. A transformation stems from the observation that the functioning of a system is not desirable and must be changed. The transformability is the ability to create untried beginnings from which to evolve a new way of living when existing ecological, economic, or social structures become untenable (Walker, Holling, Carpenter, & Kinzig, 2004).

Critiques of a Systems Approach

There are a number of critiques of the SES resilience concept. We propose here a brief synthesis and look at how these critiques have been taken into account in recent research.

Some researchers emphasize that a systems approach erases the diversity of perspectives, the complexity of processes, the balance between different positions. Stedman (2016) suggests that the "SES perspective may relatively neglect the subjective human agent as an active perceiver and interpreter of social-ecological change and stability" (p. 892). In addition, an extension of the systemic approach to the social system, generally carried out by ecologists, supposes an analogy between nature and society, which meets fierce disputes (Cote & Nightingale, 2012; Foster & Clark, 2008).

Another critique of a systemic approach is the need to define the limits to the system. What is part of the system and what is not? How to define them, and who defines them? Olsson, Jerneck, Thoren, Persson, and O'Byrne (2015) published a social science critique and analyzed core concepts and principles in resilience theory that cause disciplinary tensions between the social and natural sciences (system ontology, system boundary, equilibria and thresholds, feedback mechanisms, self-organization, and function).

A third objection emphasizes that the systemic approach tends to neglect relationships between individuals, the role of power and structural arrangements (Hatt, 2012) for the benefit of a more functional design based on consensus. A theory of resilience would propose a simplistic analysis of the institutions or arrangements between actors that does not adequately integrate the issue of power (Nadasdy, 2007).

And, finally, there is a concern about the strategic use of the resilience concept in policies and governance (Bousquet et al., 2016; Brown, 2015). For Leach, Raworth, and Rockström (2013), resilience narratives represent a powerful storyline that assigns responsibility and blame and underpins, justifies, and legitimates action. For instance, the application of a resilience perspective at the global level favors the recognition of the "Earth system" and "safe operating space" as legal entities that could legitimize supranational resilience governance and threaten to become "a pervasive idiom of global governance" (Walker & Cooper, 2011). For Joseph (2014), the resilience project is part of a broader strategy that seeks to govern from a distance and regulate the conduct of states.

A New Stage in SES Resilience Research

After this period of criticism, which mainly related to the charge of the imperialism of natural sciences and market forces over social sciences, it seems that new perspectives are emerging. Evidence-based investigations into the differences between approaches have been experimented with leading to nuanced conclusions and a plea for pluralism in approaches and methods (Bousquet, Robbins, Peloquin, & Bonato, 2015). Stone-Jovicich, Goldstein, Brown, Plummer, and Olsson (2018) present new social science perspectives that stress the complex, dynamic, and multiscalar interconnections between biophysical and social realms in explaining social-environmental change and that place both the social and ecology center stage in their analyses. They identify integrative and hybrid approaches that share with social-ecological resilience thinking a focus on the interdependent and dynamic ways in which biophysical and social processes shape our world. Olsson and Jerneck (2018) suggest that combining field theory and systems thinking can assist resilience scientists and others in integrating the best available knowledge from the natural sciences with that from the social sciences. Endress (2015) discusses the sociohistorical construction of resilience from a sociological point of view guided by four central analytical dimensions: normative neutrality, temporality, perceptivity, and power. Rampp (2019) proposes the use of Norbert Elias's concept of figuration to understand the resilience of SES (Elias, van Krieken, & Dunning, 1997).

Social and Ecological System Identification

The story of the SES resilience concept is a story of trajectories between persistence and change. In this section we use a hybrid approach to look at the dynamics of SES identity.

From Identity to Identification

In 2005, Cumming and Collier (2005) wrote the first piece of work on identity we know of by an SES researcher. It deals with the question of identity in complex systems with a focus

on SESs, paying particular attention to the ecosystem element. Recently Rampp (2019) posed the question of sociological identity in research on the resilience of SESs.

With regard to systems research, it is common to distinguish between an essentialist vision and a constructivist vision. Cumming and Collier (2005) propose a rather essentialist vision arguing that "the challenge of determining the identity of the system is to establish the natural properties of the system that constitutes identity conditions over time and space" (para. 6). They make an equivalence between identity and unity:

> System identity resides in the continued presence, in both space and time, of key components and key relationships . . . the following should be included: (1) the system components, which may be defined in varying degrees; (2) the relationships between system components; (3) the location and spatial dimension, where the definition is applicable and the importance, or lack thereof, of spatial constancy; and (4) the temporal scale, which is applicable to the author's perspective on identity through time. (para. 11)

In this instance identity is defined by the perspective of the author (the observer, the analyst). A decade later Cumming and Peterson (2017) proposed an updated definition of identity that reflects a constructivist epistemology:

> Identity is defined by key components and relationships that must be maintained through time and space for the system to be considered the same system. Identity is subjectively defined according to the properties in which an observer, who may also be part of the system, is interested. Although subjective, it is not arbitrary; it requires establishment of (and agreement on) key criteria. (p. 699)

The position of most of the social sciences is resolutely constructivist. Identity is a matter of perception and ascription at the intrapsychic, interpersonal, and intergroup levels. At the internal psychological level, for Erikson (1972), the identity of the individual is the subjective and tonic feeling of personal unity and temporal continuity. At the external sociological level, identity comes from everything that makes it possible to identify the subject from the outside and refers to the status that the subject shares with the range of groups they belong to. For Tajfel (1974) identity is the emotionally significant self-image of an individual, which is derived from their membership in social groups (called in-groups). Researchers are more interested in the identification process than in the concept of identity. Identification is therefore made up of a number of processes:

> Identity has to be understood in this context (never final, but always contingent and continuously contested) result of various, interrelated processes of construction. Processes of construction—and thus empirical realizations of identity—are deeply rooted in the respective social, spatial, and temporal context and they are related to manifest issues of power. (Rampp, 2019, p. 63)

The identification process is therefore a dance between interiorization and exteriorization: as long as it is not internalized and recognized externally, an identity has not emerged yet, although an identification process can be ongoing.

Identification as a Processual, Relational, and Strategic Approach to Resilience

If the approaches to identity vary, they converge on certain issues: The relationship between continuity and change and the importance of a relational understanding.

- *Continuity and change*. To tackle the question of identity requires attention to the relationship between continuity and change. As previously discussed, in the field of SESs resilience research, the prevailing model of change is the tryptic of coping, adaptation, and transformation. Only the model of transformation would correspond to a change of identity, as the entities of the system consider the ecological, economic, or social structures untenable. But how do we know if we are in a situation of transformation? For Cumming and Collier (2005), a loss of identity occurs when there is spatial or temporal separation of a system from its predecessor, where one exists. In social sciences, the question of an identity shift passes by the question of the process of identification: at a given moment of the process how does a new crystallized order emerge, how do individuals internalize it and reproduce it? Generated over time, what makes a new continuity tangible, conceivable, or even legitimate?
- *Relationships*. Identity is defined through relationships, relations between social and ecological elements within the system and external relations with other entities. For Cumming and Collier, it is about identifying the relationships that make the system. Which relations are relevant to the system is an empirical question that varies for each type of dynamic system. Following Barth (1969) and other social scientists, the question of identity lies in the definition of "we" and "them" at the border between these two groups. It is the examination of the interactions that characterize the differences between two groups rather than the attempt to define what is the essence of a group. And these boundaries are continually readjusted. The identification process is always contingent, contested, and negotiated between several construction processes. The construction processes are rooted in contextual, temporal, relational contexts.

A constructivist approach leads to the question of why identities are constructed and described. Identification is linked to a question of power and normativity. A positive identity is the product of confidence in the continuity of self and in-groups and a sense of self-efficacy, distinctiveness, and self-esteem (Breakwell, 2015). It is a key factor in people's behavior as they seek to maintain a positive self-image by behaving in ways that are consistent with the norms of their in-groups. Identity can be purposively used to create action, to assign rights, to empathize, or to exercise control. Bousquet and Mathevet (2019) outline an example on the dynamics of these negotiated identities through the study of a Spanish festival in southern France as an example of festivals that mobilize the representation of nature.

The processes of identification and distinction are inseparable. Identity is a relative notion that can be built on a balance of power, which means that the resilience of one unit implies the vulnerability of another (Endreß & Rampp, 2015; Sondershaus & Moss, 2014). "Human systems, environmental systems, and the built environment interact to produce antecedent conditions which contain both inherent vulnerabilities as well as inherent resilience" (Cutter, 2014, p. 66). Thus, there is a need to identify the probable winners and losers (Keck & Sakdapolrak, 2013) of resilience in the process of analyzing the figurations in which identities are being socially constructed.

Out of a diversity of perceptions, meanings, ideologies, practices, attitudes, and power tensions, new patterns of SES emerge and become "common sense" for the individuals and the collective. These new patterns integrate visible and invisible vulnerabilities. Bourdieu notes that every established order tends to produce the "naturalization" of its own arbitrariness (Stedman, 2016). In this sense, the identification process contributes to the crystallization of a new distribution of vulnerabilities among the entities of the SES.

Understanding the Resilience of SES Through an Analysis of Identification Processes: The Tale of Four Towns

In this section we consider two case studies, one of two German cities facing climate change taken from the literature and our own research in two French cities facing similar flood risks. We first outline how these SESs cope with change, and we describe the associated identification process. We then take our analysis a step further with our French site and unpack how the identification processes reshaped the distribution of vulnerabilities within the SES and consider what this ultimately means for a system's resilience.

The Changing Identity of Towns in Response to Climate and Global Change

Rostock and Lübek, Germany. Christman, Balgar, and Mahlkow (2014) have analyzed using discourse analysis of local publications the constructions of vulnerability and resilience in the context of climate change relying on two German cities, Rostock and Lubeck, and their reactions to climate change. With a distance of 100 kilometers between them, the cities are similar with regard to their geographic position on the coast: they have comparable natural conditions, and according to predictions by natural scientists, they will have experience similar climate-related developments, including sea level rise. They are port cities and, more specifically, Hanseatic cities (an historical alliance of ports in the Northern and Baltic sea). However, each of the cities have distinct histories.

Central to Lübek's history is the reputation of being a culturally important city. This is a vital part of Lübeck's urban identity and also frames its approach to climate change. What is essential for the local population is the preservation of the old buildings, the cultural heritage of the city, and the inner city itself. At the same time, however, Lübeck is portrayed in

the publications as a city that has always defied the biggest challenges in its long Hanseatic history and has traditionally been well-equipped to cope with the threats to come. Local media points to centuries-old traditions and extensive experience of dealing with the dangers of the sea. Lübeck's actors trust in their own competence; they believe that they are up to the climate change–induced challenges of the future. The old town is viewed as being threatened and worthy of being preserved, whereas the sea together with storm surges as well as heavy rain are seen as threatening elements. Although possible vulnerabilities emanating from climate change point to devastation in the (distant) future, the debate on climate change stands under the wider umbrella of the city's history: it is the narrative of the Hanseatic tradition and of the centuries-old experience with hazards that is dominant. This narrative implies that over a long period of history, the city has had a high coping capacity on which one can rely on in the future (Christmann et al., 2014).

In Rostock, by contrast, vulnerability perceptions are primarily focused on the urban economy, high unemployment, and increasing emigration. With regards to vulnerabilities due to climate change, it is the sea that is seen as being vulnerable because fish stocks are changing. Urban actors anticipate that, as a consequence, former fishing methods will not be suitable anymore, which will also call the economic utilization of the sea into question and will further weaken the economic situation of the city. The central narrative, thus, is the problematic economic situation (Christmann et al., 2014). The coastal area is constructed as being vulnerable because various fish stocks will probably disappear. This unit of analysis, however—which is a material factor—is not the only salient element of the system's identity. Other units of the relational network are the structurally weak economy and rising temperatures, as well as an anticipated growth in the tourism sector. The structurally weak economy is seen as threatening and the whole city as being threatened (unemployment, emigration). According to the Rostock rationale, global warming can help to build resilience. Warm and long summer periods promote tourism, which will improve the economic situation. As already mentioned, in Rostock we can find very few historical references in the context of climate change issues. The past is largely eclipsed, be it the Hanseatic tradition, which remains weak, or the recent history of the former German Democratic Republic from which residents distance themselves. Rather, attention is given to the future and to the hope of becoming a "climate winner" (Christmann et al., 2014, p. 154).

Sommières and Lattes, France. Another study compares the response to global change of two towns in the south of France interrogating their relationship with water (Quinn, Bousquet, Guerbois, Heider, & Brown, 2019). The study comprised surveys in both towns (n = 400) and a number of interviews with public authorities and risk management organizations. Half a century ago, the two towns of Lattes and Sommières, approximately 30 kilometers apart, were similar in the way they managed autumnal river floods (the hydrological regimes are similar). The different perceptions of the acceptability of floods by public authorities, informed by prevailing urban planning, though, has led to different flood adaptation trajectories in the two towns.

Sommières, a town built partly on the riverbed since the Roman era, has a long history of flooding, and residents and authorities have developed adaptive strategies to deal

with autumnal floods, such as monitoring the upper watershed, warning systems, and rapid transfer of their belongings to the upper floors of their homes. The river Vidourle, often personified by residents, floods the city every year, and the river's rhythm has been considered by the city's population as a natural event for centuries and is generally accepted as part of Sommières life. For survey respondents in Sommières, the river meanings are often positive, either for the relationships it enhances or the services it provides. However, it is important to note that of the responses given, approximately 15% of those surveyed in Sommières associated the river with a danger meaning. In the recent past Sommières has developed an identity of a town that "lives with floods." Policymakers and residents in Sommières continue to claim to have a "living with risk" culture as they have for centuries. Risk can be responded to quickly through warnings and solidarity.

Lattes, a former agricultural town whose population used to accept the risk of living with floods, became part of the greater urban area of Montpellier city in line with an urban planning strategy in the 1960s, and national and local governments (department and regional) targeted this area for the expansion and location of large infrastructure. Decision makers in Lattes reoriented their management approach toward that of "protection from risk," which started in the late 1980s with investments in costly hard infrastructures (e.g., dykes, canals) to protect the population from flood risk. As evident in local flood management documents where the focus of planning moved from coping to flood prevention, floods are no longer an acceptable risk in Lattes. This shift was highlighted by an elected official, who described how the development of infrastructure is changing knowledge in risk management: "Now in Lattes we have lost this culture of risk. If something happens, no-one is prepared." Work by Durand (2014) analyzed how the river Lez in the town of Lattes has been represented in a local newspaper over 30 years. The personalized relationship with the river typified in the earlier period of this study contrasts with the apparent paring back of the relationship to the river in recent times. The representations of the river in the local paper have become more homogenized, and the river Lez has become an object of leisure (see Table 36.1).

Through the example of Lübeck and Rostock on one side and Lattes and Sommières on the other, we have illustrated the framing of a local construction of continuity and change, transformation and identity. It emerges that the differences are rooted in very specific local cultures with their own narratives, rationales, and temporal structures and the relationship with nature and its dynamics. In Lübeck and Sommières, it is the strong historical relationship between the population and water that frames the change issue, whereas in Rostock and Lattes it is problems and a transformation in society which shapes how change is framed.

In terms of SES identity, as previously discussed we can examine the two stories according to the two dimensions, continuity and change on the one hand and the relational aspect on the other. As observers, we can say that in Lubeck and Sommières the core relationship between society and water dynamics has been conserved. The floods and the risks associated with it and the coping and adaptations that were adopted are claimed as part of the local culture. In addition, the inhabitants themselves claim these relationships as part of their identity, and they position this identity in long-term local traditions. The actual identification process which is composed of many potential identities is dominated by an historical identity (respectively, Hanseatic and Roman).

TABLE 36.1 Dimensions of Identification Process in the Four Towns

	Lattes	Sommières	Rostok	Lubek
Continuity or Disruption	Disruption	Continuity	Disruption	Continuity
Relationships	Leisure relationship with the river, new composition of inhabitants, new relationship with neighboring towns	Personalized relation with the river, spatial separation of risk (different areas), local solidarity in case of disaster	Value of the sea to attract tourists and reinforce economy, political shift from former system	Hanseatic traditional relationship with the sea, value of history and culture
Purpose of the identification process	Attract entrepreneurs and wealthy people	Maintain a lifestyle, an aesthetics and a culture	Shift to a new economic model	Maintain a lifestyle, an aesthetics and a culture
Distribution and transfers of vulnerabilities	Risk of flood transferred downstream, indebtment, poor people have to leave, dependence on infrastructure providers, loss of sense of place, agricultural and ecological processes depend on frequency of floods	Neighborhoods at risk of floods, tensions between poor and rich, isolation from the global growth model	Fisheries and fishers activity disappear, unemployment, loss of sense of place	Neighborhoods at risk, self confidence in capacity to cope

As observers, we can say that in Rostock and Lattes the core relationship between society and water dynamics has changed. An active and voluntary transformation process (large-scale building of dykes) has separated the inhabitants of Lattes from the river in terms of landscape, practices, and representations. Agriculture does not exist anymore and the size of the temporary wetland ecosystem has been reduced. With climate change the relationship of Rostock inhabitants to the sea, which was based on fish exploitation, is moving to a leisure relationship. Therefore, fisheries and fish population dynamics are changing. The infrastructures in Lattes and the climate in Rostock are considered as opportunities for transformation attracting new people who will have new relationships with water. Therefore, we claim here that there is an ongoing identification process at stake, composed of many interacting forces, which is leading to a novel SES identity.

As discussed by Rampp (2019), the identification process is strategically used to strengthen the power and the resilience of a SES. For instance, if we compare the two towns of Lattes and Sommières we observe that their claim for a given identity corresponds to positions taken within the watershed and power relations with other SES. Lattes uses its identity of a "town that controls the risk" to attract entrepreneurs, wealthy residents, and hard public infrastructures for transportation or leisure. Sommières officials uses its identity as a "town that lives with the risk" to become "a model of thousands of years adaptation" and attract tourists and residents for the culture and natural dimension of the city. It also uses this identity to reject hard infrastructures upstream and their associated side effects, which would not

be compatible with this identity. Both attitudes imply transfer of vulnerability to other SES or to other components of the SES, leading to new distributions of vulnerabilities.

Resilience, SES Identification Process, and Distributions of Vulnerabilities

Adopting a complex system perspective on a SES means that an SES is composed of many interacting entities (Figure 36.1C) and that its resilience should be studied through hybrid approaches. Any SES is subject to adversity and changes, and there are permanent modifications of the entities composing the SES and modifications of the relationships among these entities. SES resilience research studies and conceptualizes these changes and the persistence of regime shifts (Rocha, Peterson, & Biggs, 2015). The contribution of this chapter is to complement this body of research with an analysis of the identification process. The analysis of resilience of a SES questions whether the SES remains the same (it keeps its identity) or it becomes something else (its identity has changed). The identity is ascribed by people within or from outside the SES, crystallizing for a moment the organization between humans, nonhumans, and infrastructures. Therefore, there are two intertwined processes: the process of change and the process of identification. The examples of Rostock, Lubeck, Sommières, and Lattes demonstrate that these towns are facing challenging events and adversities. For two of them (Rostock and Lattes), we see that there is a change in the relationship between the ecological component and the social one. This leads to a reorganization within the system, new dependences, and new identities that will be declared (Lattes, a former garden agriculture village became a rich suburb; Rostock, a former fishing center, has become an attractive tourist city and a "climate change winner"). In contrast, for the two towns where the relationship between the ecological and social components were not changed, their identity was kept constant (the Roman town for Sommières and the Hanseatic city for Lubeck). The previously described examples also show that the changes to the SES and the crystallization of an identity are associated with a distribution of vulnerabilities, which is key for the resilience of the SES. The identity, as it is ascribed by people, reveals and defines vulnerabilities. For instance, the town's living with the previously described risk identity assigns the responsibility of risk coping to the individuals and causes an internal segregation while the town's living against the risk identity assigns the responsibility of risk coping to the infrastructure providers and creates vulnerabilities outside the SES.

Figure 36.5 presents an illustration of this complex set of processes. Resilience of an SES is a process and not a trait. The resilience process has to be studied through the modification of systems as well as the identification process, which both create the capacity to deal with change. In Figure 36.5, a given SES exists with a given identity. It is composed of human and nonhuman entities (green and red, respectively) at different scales that interact. If the ecological and social connection are disrupted (slowly or rapidly) a reorganization can result of the interactions among entities, and vulnerabilities are transferred. A new distribution of vulnerabilities is then defined; the SES includes some entities and excludes some other (the boundaries are not the same) at a given time. The new identity reflects the

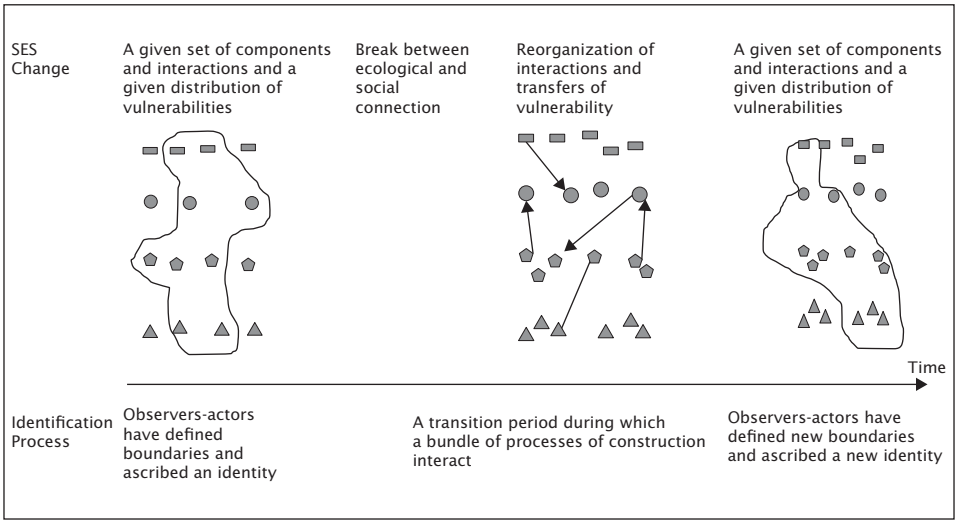

FIGURE 36.5 Interrelated processes of change and identification after a disruption between ecological and social components of an SES.

dominant perception of the organization of the SES and reveals its capacity to deal with its vulnerabilities.

This study of resilience through the identification process is consistent with the transition between the conservation, the release, and reorganization phase of the adaptive cycle model (Figure 36.3). Our contribution here is to orient the research on the identification process, which leads either to the conservation of the previous identity or to a new identity because the SES has been transformed and is not the same as it was before.

Conclusion

In this chapter we have introduced the notion of SES resilience. We have traced the history of the two concepts (SES and resilience), which are interdependent, narrating the interactions between groups of researchers who study the interactions between social and ecological processes. Different concepts, approaches, tools, principles to analyze and manage social, and ecological interactions emerged. From the diverging stances new perspectives also emerged or were reinforced. The core of the conflict was (and still is partly) the criticism of the systems approach that was used by natural sciences to integrate social processes into a pre-existing ecological scientific perspective. Hybrid perspectives are emerging for the description of interactions between ecology and society and the analysis of their response to adversity and shocks.

In the second part of the chapter, we used an approach that combines a complexity lens and a social science analysis of continuity and change. We looked at the specific question of the identity of a SES and how it persists or changes. We examined the meaning of this concept through a literature review, which led us to look at the identification process rather than identity as a trait. We used empirical examples and proposed two narratives to illustrate

how identities ascribed to an SES are related to how vulnerabilities are distributed within its components.

The identification process complements the study of SES change for a better understanding of the SES resilience process. Going forward, this approach will be helpful for analysis and for governance of SES as it reveals the interactions among a bundle of forces which lead, for a given period of time, to a dominant identity that can be purposively used to create action, to assign rights, to empathize with people experiencing change, or to exercise control.

Key Messages

1. SES resilience concept has emerged from the encounters of different research groups over the last 50 years. Hybrid perspectives emerged for the description of interactions between ecology and society and the analysis of their response to adversity and shocks.
2. SES continuously reorganize while undergoing change. Resilience is not a question of whether an SES can come back to a former state but rather whether the SES remains the same or has become something else. Identity results from a continuous identification process that not only reveals but also contributes to SES change.
3. The identity of an SES and the resilience process are inextricably shaped by the vulnerabilities embedded in the SES.
4. The disruption of the relationship between natural and social entities that compose a SES leads to a new distribution of vulnerabilities among the entities and a new identity.
5. Identification is as a processual, relational, and strategic approach to change and resilience.

References

Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, *24*(3), 347–364. doi:10.1191%2F030913200701540465

Anderies, J. M., & Janssen, M. A. (2011). The fragility of robust social-ecological systems. *Global Environmental Change*, *21*(4), 1153–1156. doi:10.1016/j.gloenvcha.2011.07.004

Barth, F. (1969). *Ethnic groups and boundaries: The social organization of culture difference*. Oslo, Norway: Universitetsforlaget.

Berkes, F., & Folke, C. (1994). *Linking social and ecological systems for resilience and sustainability*. Beijer Discussion Paper Series No. 52, Stockholm, Sweden.

Bousquet, F., & Mathevet, R. (2019). Cultural resilience as the resilience of a distinctness. Distinctness from what? For what? In B. Rampp, M. Endreß, & M. Naumann (Eds.), *Resilience in social, cultural and political spheres* (pp. 305–321). Wiesbaden, Germany: Springer Fachmedien Wiesbaden.

Bousquet, F., A. Botta, L. Alinovi, O. Barreteau, D. Bossio, K. Brown, . . . Staver, C. (2016). Resilience and development: Mobilizing for transformation. *Ecology and Society*, *21*(3), 40. doi:10.5751/ES-08754-210340

Bousquet, F., Robbins, P., Peloquin, C., & Bonato, O. (2015). The PISA grammar decodes diverse human–environment approaches. *Global Environmental Change*, *34*, 159–171. doi:10.1016/j.gloenvcha.2015.06.013

Breakwell, G. M. (2015). *Coping with threatened identities*. London, UK: Psychology Press.

Brondizio, E. S., Solecki, W., & Leemans, R. (2015). *Climate change: A virtual special issue with commentary for COP21: Current Opinions in Environmental Sustainability*. Amsterdam, The Netherlands: Elsevier. Retrieved from https://www.elsevier.com/connect/climate-change-a-virtual-special-issue-with-commentary-for-cop21

Brown, K. (2015). *Resilience, development and global change*. Abingdon, UK: Routledge Press.
Cherkasskii, B. L. (1988). The system of the epidemic process. *Journal of Hygiene Epidemiology Microbiology and Immunology*, *32*(3), 321–328.
Christmann, G. B., Balgar, K., & Mahlkow, N. (2014). Local constructions of vulnerability and resilience in the context of climate change. A comparison of Lübeck and Rostock. *Social Sciences*, *3*(1), 142–159. doi:10.3390/socsci3010142
Colding, J., & Barthel, S. (2019). Exploring the social-ecological systems discourse 20 years later. *Ecology and Society*, *24*(1), 2. doi:10.5751/es-10598-240102
Cote, M., & Nightingale, A. (2012). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography*, *36*(4), 475–489. doi:10.1177/0309132511425708
Cumming, G. S., & Collier, J. (2005). Change and identity in complex systems. *Ecology and Society*, *10*(1), 29. Retrieved from https://www.jstor.org/stable/26267756
Cumming, G. S., & Peterson, G. D. (2017). Unifying research on social-ecological resilience and collapse. *Trends in Ecology & Evolution*, *32*(9), 695–713. doi:10.1016/j.tree.2017.06.014
Cutter, S. L. (2014). What makes events extreme? *Journal of Extreme Events*, *1*(1), 1402001. doi:10.1142/s2345737614020011
Durand, S. (2014). *Vivre avec la possibilité d'une inondation? Ethnographie de l'habiter en milieu exposé . . . et prisé* (Doctoral dissertation). Aix-Marseille Université. Retrieved from https://hal.archives-ouvertes.fr/tel-01470592/document
Elias, N., van Krieken, R., & Dunning, E. (1997). Towards a theory of social processes: A translation. *The British Journal of Sociology*, *48*(3), 355–383. doi:10.2307/591136
Endress, M. (2015). The social constructedness of resilience. *Social Sciences*, *4*(3), 533–545. doi:10.3390/socsci4030533
Endreß, M., & Rampp, B. (2015). Resilienz als perspektive auf gesellschaftliche prozesse. In M. Endreß & A. Maurer (Eds.), *Resilienz im Sozialen* (pp. 33–55). Wiesbaden, Germany: Springer.
Erikson, E. (1972). *Adolescence et crise: La quête de l'identité*. Paris, France: Champs essais.
Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. doi:10.1016/j.gloenvcha.2006.04.002
Folke, C. (2016). Resilience (republished). *Ecology and Society*, *21*(4), 44. doi:10.5751/ES-09088-210444
Foster, J. B., & Clark, B. (2008). The sociology of ecology: Ecological organicism versus ecosystem ecology in the social construction of ecological science, 1926–1935. *Organization & Environment*, *21*(3), 311–352. doi:10.1177/1086026608321632
Gallopin, G. C., Gutman, P., & Maletta, H. (1989). Global impoverishment, sustainable development and the environment: A conceptual approach. *International Social Science Journal*, *121*, 375–397.
Gunderson, L., & Holling, C. S. (2002). *Panarchy: Understanding transformations in systems of humans and nature*. Washington, DC: Island Press.
Hatt, K. (2012). Social attractors: A proposal to enhance "resilience thinking" about the social. *Society & Natural Resources*, *26*(1), 30–43. doi:10.1080/08941920.2012.695859
Holling, C. (1973). Resilience and stability of ecological systems. *Annual Review of Ecological Systems*, *4*, 1–23. doi:10.1146/annurev.es.04.110173.000245
Holling, C. (1986). Resilience of ecosystems: Local surprise and global change. In W. Clark & R. Munn (Eds.), *Sustainable development of the biosphere* (pp. 292–317). Cambridge, UK: Cambridge University Press.
Joseph, J. (2014). The EU in the horn of Africa: Building resilience as a distant form of governance. *Journal of Common Market Studies*, *52*, 285–301. doi:10.1111/jcms.12085
Keck, M., & Sakdapolrak, P. (2013). What is social resilience? Lessons learned and ways forward. *Erdkunde*, *67*(1), 5–18. doi:10.3112/erdkunde.2013.01.02
Langton, C. G. (1992). Life at the edge of chaos. In C. G. Langton, C. Taylor, J. D. Farmer, & S. Rasmussen (Eds.), *Artificial life II* (pp. 41–91). Boston, MA: Addison-Wesley.
Leach, M., Raworth, K., & Rockström, J. (2013). Between social and planetary boundaries: Navigating pathways in the safe and just space for humanity. In ISSC & UNESCO (Eds.), *World social science report 2013, changing global environments* (pp. 84–89). Paris, France: OECD Publishing and UNESCO Publishing.

Liu, J. J. W., Reed, M., & Girard, T. A. (2017). Advancing resilience: An integrative, multi-system model of resilience. *Personality and Individual Differences*, *111*, 111–118. doi:10.1016/j.paid.2017.02.007

Mathevet, R., & Bousquet, F. (2014). *Résilience et environnement: Penser les changements socio-écologiques*. Paris, France: Buchet.

Nadasdy, P. (2007). Adaptive co-management and the gospel of resilience. In D. Armitage, F. Berkes, & N. Doudleday (Eds.), *Adaptive co-management: Collaboration, learning and multilevel governance* (pp. 208–227). Vancouver: University of British Columbia Press.

Olsson, L., & Jerneck, A. (2018). Social fields and natural systems: Integrating knowledge about society and nature. *Ecology and Society*, *23*(3), 26. doi:10.5751/es-10333-230326

Olsson, L., Jerneck, A., Thoren, H., Persson, J., & O'Byrne, D. (2015). Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience. *Science Advances*, *1*(4), e1400217. doi:10.1126/sciadv.1400217

Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *PNAS*, *104*(39), 15181–15187. doi:10.1073/pnas.0702288104

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422. doi:10.1126/science.1172133

Quinn, T., Bousquet, F., Guerbois, C., Heider, L., & Brown, K. (2019). How local water and waterbody meanings shape flood risk perception and risk management preferences. *Sustainability Science*, *14*(3), 565–578. doi:10.1007/s11625-019-00665-0

Rampp, B. (2019). The question of "identity" in resilience research: Considerations from a sociological point of view. In B. Rampp, M. Endreß, & M. Naumann (Eds.), *Resilience in social, cultural and political spheres* (pp. 59–76). Wiesbaden, Germany: Springer.

Rocha, J. C., Peterson, G. D., & Biggs, R. (2015). Regime shifts in the anthropocene: Drivers, risks, and resilience. *PLoS One*, *10*(8), e0134639. doi:10.1371/journal.pone.0134639

Schoon, M., & Van der Leeuw, S. (2015). The shift toward social-ecological systems perspectives: Insights into the human-nature relationship. *Natures Sciences Sociétés*, *23*(2), 166–174. doi:10.1051/nss/2015034

Sondershaus, F., & Moss, T. (2014). Your resilience is my vulnerability: "Rules in use" in a local water conflict. *Social Sciences*, *3*(1), 172–192.

Stedman, R. C. (2016). Subjectivity and social-ecological systems: A rigidity trap (and sense of place as a way out). *Sustainability Science*, *11*(6), 891–901. doi:10.1007/s11625-016-0388-y

Stone-Jovicich, S., Goldstein, B. E., Brown, K., Plummer, R., & Olsson, P. (2018). Expanding the contribution of the social sciences to social-ecological resilience research. *Ecology and Society*, *23*(1), 41. doi:10.5751/es-10008-230141

Tajfel, H. (1974). Social identity and intergroup behaviour. *Social Science Information*, *13*(2), 65–93. doi:10.1177/053901847401300204

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, *9*(2), 5. Retrieved from http://www.ecologyandsociety.org/vol9/iss2/art5/

Walker, J., & Cooper, M. (2011). Genealogies of resilience: From systems ecology to the political economy of crisis adaptation. *Security Dialogue*, *42*(2), 143–160. doi:10.1177/0967010611399616