

# VULNERABILITY AND RESILIENCE: POTENTIALS, CONVERGENCES AND LIMITATIONS IN INTERDISCIPLINARY RESEARCH

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DIEGO PEREIRA LINDOSO<sup>1</sup>

## Introduction

Scientific knowledge on human-environment interface is a pressing and increasingly urgent need in addressing the risk posed by global environmental change. At the core of such a demand are two questions: *How are human-environment coupled systems affected by external disturbances? How do they respond?* The search for answers leads to research in an interdisciplinary territory, of which the topography is explored by the traditions of various social and natural sciences.

Vulnerability and resilience approaches have been at the forefront of the quest. In the former, adaptation is understood as reducing vulnerability, either by moderating sensitivities or by strengthening adaptive capacity. In the latter, adaptation is understood as the construction of resilience (ADGER et al, 2005). What unites them is the effort in providing a compression on the functioning of socio-ecological systems for an informed decision-making process aimed at reducing social and environmental risks. What separates them is how each one of them approaches the problem and the theoretical and methodological fundaments.

The present paper proposes a critical reflection on these approaches, contributing to the debate on their usefulness as arenas for building up an interdisciplinary research field in progress covering the interface between the environment and society, while having global environmental changes as a backdrop. To that end, this paper undertakes a wide review of relevant authors and literature which have contributed to the individual development of each approach and the dialogue between them (JANSSEN et al, 2006).

There is a convergence trend between the theoretical-conceptual frameworks of resilience and vulnerability, which results in a rich scientific lexicon, but also confusion in its diversity of concepts and interpretations for the same set of terms and notions. The divergences and theoretical-methodological inconsistencies between resilience and vulnerability will also be discussed. Research on sustainability and climate change will be used as a background to address the issue.

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1. Ph.D. in Sustainable Development from University of Brasilia. Currently, Diego is a CAPES post-doctoral fellow (e-mail: diegolindoso@gmail.com)

## 1. Environment-Society Interface

There is a growing recognition that in order to understand and anticipate the behaviour of social and ecological systems, it is necessary to take into account the dynamics which emerge in the interactions between both (GALLOPÍN, 2006). In literature, the analytical recognition that human dynamics and the ecosystem are empirically inseparable is synthesized in the terms as socio-ecological systems and human-environment coupled systems, both used synonymously (TUNNER *et al*, 2003).

In the present paper, the term adopted is “socio-ecological system” (SES). Such a choice is justified, given that the term is widely used in scientific production on resilience, vulnerability, and sustainability. However, here is a caveat. In Vulnerability literature, the use of socio-ecological systems does not imply theoretical commitments, it only highlights that the observed conditions and processes are products of the interaction between human and natural subsystems. On the other hand, in the Resilience approach, the use of the term goes beyond - it assumes a series of theoretical premises regarding the behaviour of the analysed system.

If, on the one hand, the paradigm has the virtue of approaching the environmental and human dimensions, the conception of SES will always be a social construct and cannot be confused with reality itself (CANNON; MÜLLER-MAHN, 2010). In other words, the cut is centred on those human-environment relations which are relevant from the human perspective. In this context, there are innumerable ways of conceiving an SES, each differing in the emphasis given to human behaviour, social relations, biophysical/ecological processes, economic processes, etc. (ANDERIES and NORBERG, 2008).

However, the concept of SES is not a consensus in the literature (STAJONOVIC *et al*, 2016). To critics, the systems perspective depoliticizes social relations and naturalizes them, ignoring the influence of the subjectivity of human interactions as agency, simplifying the complexity of social dynamics (WELSH, 2014). Despite criticism, the concept of SES as a heuristic tool can function as a productive space for the interdisciplinary meeting (BINDER *et al*, 2013), and for this reason, is highlighted in the present work. The framing of SES used by the vulnerability and resilience approaches, although distinct, are largely complementary, as will be discussed below.

## 2. Vulnerability Approach

The vulnerability approach has its roots in the risk-hazard school, later deriving the research on Natural Disasters (MARANDOLA; HOGAN, 2004). This, in turn, was influenced by *Political Ecology* and *Political Economy* from the 1970s, resulting in the Vulnerability Approach (ALCANTÁRA-AYLA, 2002). In the 1980s and 1990s, as a consolidating interdisciplinary field, it provided fertile ground for research on Global Environmental Changes (GALLOPÍN, 2006).

The research on socio-ecological systems' vulnerability, before composing a cohesive theoretical line, involves a set of perspectives which oscillate between more social approaches and more biophysical approaches. The first, grouped under the scope of social

vulnerability, address vulnerability as a social construct - historical roots - and explained by economic, political, and cultural causes which reduce the ability of systems to prevent or respond satisfactorily to external shocks (KELLY, 1999). It assumes that vulnerability can be studied independently of the environmental driver - that is, it is mainly a product of the socioeconomic and political characteristics internal to the system. Works which adopt the perspective of social vulnerability reflect the predominant influence of political ecology, political economy, and research on entitlement. Analyses of social vulnerability cover the underlying social causes underlying issues such as food insecurity, poverty, famine (DERCON; KHRISNAN, 2000).

On the other extreme, there are the biophysical vulnerability perspectives, for which the natural or biophysical disturbance is central in building up vulnerability, which can be described as a result of interactions between a place/population and a specific exposure driver (eg. Droughts) (BURTON, 1997). Research on biophysical vulnerability is influenced by the risk-hazard tradition, explicit in the lexicon used (risk, natural hazard, natural disaster). Nevertheless, hybrid approaches in which social and biophysical vulnerability are integrated have been proliferating in Global Environmental Change research (IAWAMA *et al.*, 2016; BLAIKIE *et al.*, 1994).

In the literature on climate change, vulnerability is particularly defined as the degree to which a system is susceptible to or incapable of dealing with the adverse effects of climate change, including climatic variability and extremes (SMIT *et al.*, 2001). It is presented as a function of three attributes: exposure, sensitivity, and adaptive capacity (LINDOSO *et al.*, 2011). Exposure refers to the source of disturbance, therefore being an external element to the system under analysis (FÜSSEL; KLEIN, 2006). Exposure is frequently characterized by the nature, duration, magnitude, and frequency of the stimulus (SMITHERS; SMIT, 1997). Sensitivity refers to the system's internal characteristics which make it more or less susceptible to a given stimulus. It can be understood as the system's propensity to be modified/affected, or to suffer impacts, damages, or losses when exposed to a disturbance (ADGER, 2006; GALLOPÍN, 2006; O'BRIEN *et al.*, 2004).

Different interpretations for the relationship between sensitivity, exposure, and vulnerability are found in the literature, reflecting that the dichotomy between social and biophysical vulnerability is still present. Some authors consider exposure to be an integral part of vulnerability and inseparable from sensitivity (O'BRIEN *et al.*, 2004), while others argue that a system is only vulnerable if there is an exposure factor as a reference (BROOKS, 2003; FORD *et al.*, 2006). However, there are those, such as Gallopín (2006), who approach exposure as an independent element of sensitivity and external to vulnerability. The author defends his perspective by arguing that externalizing exposure from vulnerability is a useful artifice for decision-making once the strategy facilitates policy intervention on the general aspects of vulnerability, rather than elaborating policies specific to each exposure context.

Finally, adaptive capacity is a property of socio-ecological systems, determined by internal and external factors (FÜSSEL, 2007). It can be defined as the ability to manage, accommodate, and recover from environmental disturbances (SMIT; WANDEL, 2006). According to Smit *et al.* (2001), adaptive capacity reflects the degree to which

adjustments in processes, structures, and practices can moderate losses or reduce climate change impacts. For Klein *et al* (2003), adaptive capacity is related to the ability to plan and prepare for a threat, as well as to implement technical measures before, during, and after the disturbance. In some works on vulnerability, adaptive capacity is associated with the notion of entitlements, used to refer to the availability of options (resources) and conditions to access these options through institutional arrangements and/or individual capacities (ADGER, 2006; ADGER; KELLY, 1996)

### 2.1. Socio-ecological Systems in the Vulnerability Approach

Among the vulnerability approaches, environment-society relations are emphasized, focusing on the interactions which determine sensitivities or influence adaptive capacity. The social subsystem is usually the reference unit: the one subjected to impacts and both the agent and the target of adaptive actions. It is referred to as *exposure unit* or *adaptive unit*, and is usually comprised of populations, social groups, places, sectors, geographic regions, or political-administrative units (O'Donnell *et al*, 2004). Less frequent are research adopting ecosystems and/or elements of biodiversity as an exposure unit (MARENGO, 2007; JOHNSON *et al*, 2007; KLAUSMEYER *et al*, 2011).

On the other hand, the ecological subsystem is usually taken as a backdrop. Normally, environmental factors are taken as the a priori cause or condition in the analysis, so that the ecological processes in which they are inserted or on which they depend are ignored or exploited superficially (TURNER, 2010). The most common way of considering the ecological (or environmental) subsystem in vulnerability analysis is as an exposure vector: a source of disturbance and stress for the human subsystem. In the literature, the main exposure drivers are natural ones, such as climatic. However, exposure drivers can also be biological (epidemics), technological (nuclear and industrial accidents), social (wars), economic (globalization), or even complex drivers (desertification, hunger waves) (WHITE *et al*, 2001; O'BRIEN; LEICHENKO, 2000).

The ecological subsystem also enters into the vulnerability analysis as sensitivity factors. It is the case of soil and topography, environmental aspects which interact in a particular way with each vector of exposure, producing different sensitivities (O'HARA and RIVAS, 2005). Sensitivities also result from interactions between the exposure unit's socioeconomic characteristics and the exposure vector, such as (HUYNEN *et al*, 2001) and income profile (LINDOSO *et al*, 2011).

However, the approach to vulnerability is not limited to characterizing disturbances and propensities for impacts. It also seeks to understand the conditions and relationships of adaptive capacity. Here, elements of the ecological subsystem are often analysed as a source of adaptive options - for example, water stocks in the baobab tree in years of extreme drought (IBNOUF, 2011). The social subsystem is both seen as a source of adaptive options (income, technologies and behaviours) and analysed as a means (financial resources and institutions), which enables access to adaptive options (O'BRIEN *et al*, 2004).

### 3. Socio-Ecological Resilience

The term “resilience” was originally used in 19<sup>th</sup> century Physics to describe the property of certain materials to return to equilibrium after suffering a disturbance (FOLKE, 2006). In Ecology, the term appeared in the 1970s as a counterpoint to the ecological stability paradigm (HOLLING, 1973), then developed during the following decades into a robust theoretical framework, establishing itself as a central paradigm of Ecosystems Ecology (O’NEILL, 2001). In the following years, the notion of resilience broke the borders of ecology and was appropriated by works in Anthropology (VAYDA; MCCAY, 1975), Environmental Psychology (LAMSON 1986), Human Geography (ZIMMERER, 1994), Political Sciences (DIETZ *et al*, 2003), and Sociology (ADGER, 2000). From the dialogue between human and natural sciences, the concept of socio-ecological resilience is built up, becoming central to the adaptive complex systems theory (NORBERG; CUMMING, 2008) and a key paradigm into the emerging “science of sustainability” (TURNER, 2010).

Socio-ecological resilience is more than just a concept - it is a scientific theory on the functioning of complex systems. As a hypothesis, it is based on a set of assumptions about the behaviour of systems. First, the premise of the multi-stable states: the system - be it natural, human, or socio-ecological - may exist in different configurations (stability domains or alternative states of stability), each characterized by specific structures and feedback relationships between the components of the system (FOLKE, 2006). Second, the position of the system in the stability domain can be measured by means of state variables: parameters which oscillate in response to disturbances. Third, if external perturbations push the state variables to specific thresholds (tipping points), it undergoes a catastrophic shift process, also called a regime shift, moving to a new domain or state of stability (SCHEFFER *et al*, 2001). In the new domain, the system’s components may remain the same, but a new structure, relations, and feedback are established (GALLOPÍN, 2006). Fourth, in order for the system to return to the previous stability domain, it is not enough to reestablish conditions immediately before the regime shift - it is necessary to return the state variables to more extreme values than previous ones, reaching new thresholds, resulting in a new regime change and the reestablishment of the previous stability domain. The pattern in which the transition from stability domain A to B occurs under conditions other than that from B to A is called hysteresis (SCHEFFER *et al*, 2001).

In this context, resilience is described as the ability of the system to tolerate disturbances, and yet remain in the same stability domain (NORBERG; CUMMING, 2008). It is also related to the capacity for self-organization, learning, and adaptation during and after the disturbance (CARPENTER *et al*, 2001; ENGLE; LEMOS, 2010).

In the research on socio-ecological systems, Walker *et al* (2006) define resilience as the system’s ability to absorb disturbance and organize itself as it undergoes change in order to essentially maintain the same functions, structure, identity, and feedback. The ability of the system to transit between domains of stability when desirable is referred to as transformability (WALKER *et al*, 2006). Adaptive capacity is used in socio-ecological resilience as the ability of systems to move within a domain of stability (ANDERIES; NORBERG, 2008) - in other words, the ability to manage resilience. Walker *et al*. (2004)

employ the term adaptability in a similar way, defining it as the ability of a system's stakeholders to influence resilience. Norberg and Cumming (2008) present socio-ecological systems' adaptive capacity as a function of: (i) the set of adaptive options available and (ii) the ability of the system to move between options when necessary. In literature, adaptive capacity has been related to diversity, learning, innovation, reorganization, and development (CARPENTER *et al.*, 2001).

### 3.1. Socio-Ecological Systems in the Resilience Approach

In the resilience approach, the human-environment interface is seen from the perspective of feedback relations. It is also analysed from the point of view of structural rearrangement processes and of self-organization which the socio-ecological system goes through in response to disturbances. Ecological, social, and economic processes are autonomous in their functioning rules, but interdependent in time and space. There is no clear tradition of the hierarchy of importance between the social and ecological subsystems, as opposed to the vulnerability approach, which tends to prioritize the social. The level of detail that each subsystem receives depends on the nature, interests, technical capacity, and objectives of the researcher group. Given its roots in biology, much of the scientific production on resilience presents ecosystems as the object under analysis (SCHEFFER *et al.*, 2001).

In general, the resilience's analytical framework understands an adaptive unit facing an environment under continuous change, resulting in a constant source of disturbance, leading the system to a likewise constant response and adjustment. A key perspective underlining the resilience approach is that no ecosystem is eternal given enough time - the succession of ecological configurations is inexorable to nature's dynamics (O'NEIL, 2001). The preference between two possible domains of stability is a subjective human decision. The choice between desirable and undesirable states, according to human criteria, is a clear delineation in the transition from the neutral and amoral approach of ecological resilience to the normative and political approach present in socio-ecological resilience. Thus, the "normativization" of the resilience approach was an important step for it to become relevant in social research. It is in this context that the approach of socio-ecological resilience unfolded (without detaching) from the ecological view and approached - from an analytical point of view - the vulnerability approach.

## 4. Conceptual Convergences

In exploring nuances of the human-environment interface, attempts to integrate vulnerability and socio-ecological resilience approaches were inevitable (CANNON; MÜLLER-MAHN, 2010). Initiatives came from both social scientists, who saw in the notion of resilience a powerful metaphor (BENÉ *et al.*, 2016), and ecologists, who incorporated the concept of vulnerability into their theoretical framework and began to consider social systems as case studies (LUERS, 2005).

A pioneer, the geographer Peter Timmerman was one of the first to reflect on potential connections between the concept of resilience and that of human vulnerability



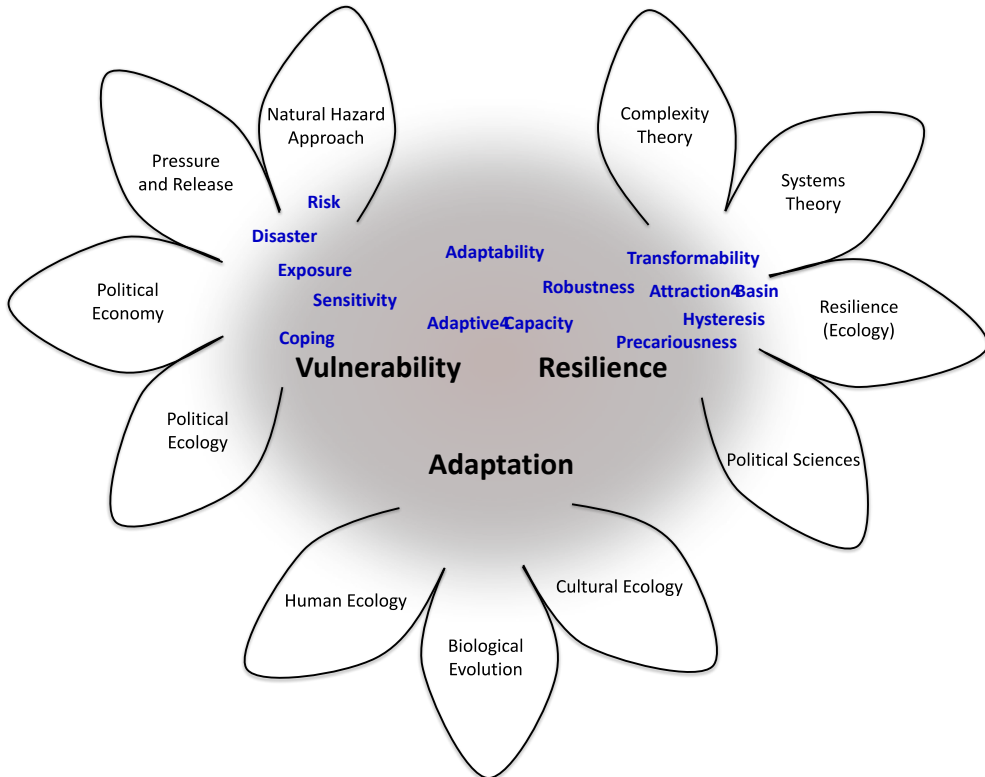
(TIMMERMAN, 1981). Since then, the bridge between approaches has been strengthened and often presented as convergent, despite the roots in different domains of knowledge (ADGER, 2006; SMIT; WANDEL, 2006). Some authors present the concept of resilience as the inverse of vulnerability (FOLKE *et al*, 2002), while others disagree. Gallopín (2006), for example, presents resilience as a more restricted concept, an internal property of socio-ecological systems, referring to the system's ability to remain within a domain of stability. Vulnerability is a broad concept, determined by external factors (exposure) and internal properties of the socio-ecological system (sensitivity and adaptive capacity). The vulnerability space encompasses a landscape of stability (composed of several domains of stability), which precludes any perspective that places the two concepts in degrees of equivalence. As an alternative, the author suggests the concept of robustness<sup>i</sup> as the inverse of vulnerability.

Adaptive capacity has played the role of bridging-concept between the two approaches (JANSSEN; OSTROM, 2006), commonly interchanged with the term "resilience" in the framework of vulnerability (DOW, 1992; KASPERSON *et al*, 2005; TURNER *et al*, 2003). However, some authors defend a hierarchical relationship between resilience and adaptive capacity. For example, Klein *et al* (2003) present resilience as a property of adaptive capacity. Such an interpretation goes against the one adopted by socio-ecological resilience theorists, for whom there is an opposite hierarchical relationship: adaptive capacity as a property of resilience (FOLKE *et al*, 2002; CARPENTER *et al*, 2001). In turn, the notion of vulnerability was incorporated by some natural scientists during their research on ecological resilience (LUERS, 2005).

The lexicon involved in resilience and vulnerability research is broader and richer in interpretations and reinterpretations than the one presented here, adding more complexity to communication between scientists, as well as between scientists and users of scientific information. The lack of conceptual consensus and multi-ways of how to relate terms and definitions in analytical frameworks bears the risk of misunderstandings and misappropriation of scientific information.

The perspective of semantic incommensurability between rival paradigms, developed by Kuhn (1975), is a way of interpreting the resulting cacophony and the impossibility of comparing or obtaining a common theoretical-conceptual framework linking socio-ecological vulnerability and resilience approaches. While there are terms which can be used in both without loss of meaning, there are others, such as resilience, whose "translation" becomes impossible without losses, either because of the difficulty of a scientific "translator" with profound understanding of both lexicons, or because there are fundamental differences in scientific languages that do not allow equivalent translations of concepts (SILVA, 2013). One caveat should be highlighted: Kuhn's incommensurability was applied in analysing rival paradigms during scientific revolutions within the same epistemic line. In the case of the comparison between socio-ecological resilience and vulnerability, there is a factor adding more complexity: each approach is compounded by several competing paradigms with their internal incommensurabilities, which sum up to a broader semantic and methodological incommensurabilities between the approaches originating in their roots as distinct, respectively, as natural and social sciences can be.

Figure 1. Diagram representing some elements of the interdisciplinary theoretical-conceptual terrain in the research on adaptation to climate change. Vulnerability and resilience are the main approaches (gray area). Source: prepared by the author based on literature review.



Research on adaptation to global environmental change, particularly climate change, is a privileged scientific space in which dialogue between the vulnerability and resilience approaches has been occurring more intensively, with interesting integrative experiences which can lay out a sufficiently common groundwork for interdisciplinary scientific communication (LINDOSO; RODRIGUES-FILHO, 2016). Figure 1 synthesizes, in a simplified way, the confluence of terms, concepts, and notions which gravitate around three main conceptual nuclei: adaptation, vulnerability, and resilience.

The petals represent disciplinary or interdisciplinary approaches, and the red space not delimited in the centre represents the interdisciplinary territory in which the research on climatic change is being developed. Although it is possible to trace the terms' and concepts' origins in disciplinary traditions, their location in the diagram represents their relevance in interdisciplinary research. The more centralized the term, the greater its transit between the resilience and vulnerability approaches. The position is merely illustrative, and its distance from the petals or from the centre should not be taken as perfect equivalents to its "degree of interdisciplinarity."



## 5. Methodological and Theoretical divergences

On the one hand, the Vulnerability and Resilience approaches are tangible in their conceptual frameworks. On the other hand, there are particularities and incompatible aspects between the two which distinguish them and inhibit the total dissolution of epistemic boundaries aiming towards a single approach.

The first barrier refers to the methodological approach and specific research objectives. In common, both seek to understand how socio-ecological systems are affected and respond to disturbances. However, the resilience approach's focus is on understanding response processes (innovation, learning, organization), identifying threshold/status indicators, and characterizing stability domains. To that end, the resilience approach places a great emphasis on the use of hypothetical mathematical models to describe and simulate the observed socio-ecological phenomena. The vulnerability approach, in turn, focuses on assessing impacts, damages, and losses, as well as understanding contexts which make socio-ecological systems susceptible to disturbances and undermine the response. Methodologically, it uses case studies and analogies to observe the behaviour of socio-ecological systems (FORD *et al*, 2010). Some authors argue that the emphasis placed by the resilience approach to the self-organization principle obscures the principles of agency, conflict, and power, central to social research, reducing its capillarity and usefulness in social perspectives (OLSSON *et al*, 2015).

From the normative point of view, there are also important divergences. In the resilience approach, the term "resilience" is amoral - this implies that being resilient is, at first, neither good nor bad, but that the moral definition is secondary and case-specific, depending on what is or is not desired by the stakeholders involved. Thus, the political objective in some cases will be to build resilience, while in others, to erode resilience when the permanence of the system in a given domain of stability is considered undesirable. In the vulnerability approach, the political objective is clear: vulnerability reduction, invariably the result of any adaptive intervention.

Another difference is found in the analytical unit. In the theory of resilience, reference units are hypothetical - stability domains - while in vulnerability, the reference is a palpable entity - populations, sectors, places, individuals. In addition, the resilience approach has, as fundamental theoretical premises, the notions of adaptive cycles, *panarchy*, tipping point, basin of attraction, and stability landscapes, which are still strange in research on vulnerability.

## 6. Vulnerability or Resilience?

From the above discussion, the choice between the approaches of vulnerability and resilience is more than just an epistemic preference for concepts, theories, and methodologies. It is also a political choice, which involves interests that go beyond scientific arena (KNORR-CETINA, 1983). This is especially relevant in highly politicized scientific fields which produce knowledge for supporting decision-making, such as research on climate change.

As a descriptive theory of reality, resilience is more robust. The search for patterns and causal processes - frequently simulated in predictive theoretical models - provides an explanatory body for observed behaviours stronger than those adopted by vulnerability. From the adaptive management point of view, the resilience approach becomes interesting for the possibility of identifying ecosystems and social thresholds, state variables, and key processes, among other information which can indicate points and parameters for monitoring and adaptive intervention.

However, the robust explanatory capacity implies a high scientific cost, which often limits research and political use of the resilience approach routinely. First, the strong mathematical bias presented in theoretical models seems hermetic to laypeople and scientists unfamiliar with the language. This restricts research to a relatively small part of the scientific community, mostly linked to or derived from ecological traditions, as well as reducing its capillarity among decision makers.

Secondly, due to the emphasis on processes, empirical work on resilience runs into experimental limitations. The research effort is great - many socio-ecological patterns and processes can only be identified after a long period of observation (years or decades). Delimiting stability domains and identifying ecological thresholds are often only possible in ex-post analyses, after regime shifts are observed (WALKER; MEYERS, 2004). Additionally, values, preferences, and beliefs interact in space and time when defining what is acceptable and desirable, adding a subjective aspect in analysing social thresholds as well as great complexity to research (CHRISTENSEN, KROGMAN, 2004). Thus, the scientific practice in resilience research demands resources which are not easy to find or frequently available.

Another point raised is the neutral (amoral) character underlying the resilience theory, which is understood by many authors as a disadvantage given that social choices are political. In addition, the resilience theory accepts, in principle, losses and damages at lower scales for sustainability in higher scales. This might represent risks for groups and stakeholders less powerful in governance networks to be marginalized in the political struggle under the justification of strengthening the resilience of the system.

In contrast, the vulnerability approach is much easier to operationalize and communicate scientifically, especially from an older policy-driven scientific tradition. This is only possible due to the simplification of the socio-ecological system into a human-centred system - less representative of reality in deed, but more functional in many respects. The results are generally presented in the form of costs, losses, and damages or through indices, indicators, and maps of vulnerability and didactic language, and with great capillarity between public managers and non-governmental decision-makers. The use of scenarios to communicate risks and potential outcomes of policy interventions also contributes to making the approach attractive. The methodologies of data collection and treatment are simpler and more accessible to the general public, allowing more transparent and replicable research by less technically specialized practitioners. In addition, the demands for political intervention are clear: vulnerability reduction through intervention in socioeconomic, environmental, and politico-institutional aspects.

Aside from the particularities, both approaches have much with which to comple-

ment each other, since they address the same questions and socio-ecological phenomena. For example, socio-ecological processes - privileged by the resilience approach - are results of pre-existing conditions - an analytical focus of the vulnerability approach. In this sense, dissecting the dynamics of socio-ecological processes in resilience research could point out which contexts or conditions are favorable to adaptation in vulnerability research. Another possible complementarity point is the assessment of damages and losses - common in the vulnerability approach - which could provide important clues in the identification of desirable and undesirable thresholds, state variables, and stability domains in the resilience research. It would be incorrect to elect or advocate a definitive theoretical and analytical framework or approach. On the contrary, it is recognized that both approaches have virtues and limitations which must be considered in light of the research questions and objectives. Research which adopts hybrid approaches, mixing theoretical-methodological elements from both, are highly recommended as interdisciplinary experimentation.

## Final Considerations

The dissolution of disciplinary barriers is moving forward thanks to initiatives of both natural and human sciences. If, on the theoretical-methodological framework, there are key divergences that separate the vulnerability and resilience approaches, they converge on problems and questions as well as in cross-cutting concepts and analysis, having in notions like adaptive capacity a bridge-concept.

However, in the wake of this effort, a cacophony of terms and their interpretations - sometimes congruent, sometimes divergent - are manifested in the lack of consensus on a common conceptual framework. This is aggravated by the fragmented nature of the scientific community moving through both approaches and the very local incommensurability of terms between paradigms and approaches. Distributed in numerous research centres and groups, scientists cover a wide range of disciplinary traditions, each with a particular interest and often not aware of parallel initiatives (KATES, 2011). The result is a scientific "Tower of Babel," in which the same terms and notions are given definitions ranging from slightly distinct to opposing, depending on the interpretation received. Perhaps such plurality and epistemic incongruity is an inevitable symptom of an interdisciplinary field under construction. Furthermore, since it is still early in its history, we lack the necessary historical perspective for scientific practitioners to have the real dimension of the process and its trends. On the other hand, there is a risk that such plurality and incongruity will unfold into an irreversible cacophony and unproductive epistemic frictions, rendering scientific communication unfeasible, and consequently, hampering comparisons between the approaches that deal with the environment-society interface. The just measure lies somewhere between breaking the disciplinary barriers where bridges are possible and maintaining the particularities and disciplinary virtues in the face of inevitable incommensurabilities. For this, there is no formula beyond the predisposition for the challenging exercise of interdisciplinarity.

## Note

i Robustness: ability of a system to maintain its structure in the face of a disturbance

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# VULNERABILITY AND RESILIENCE: POTENTIALS, CONVERGENCES AND LIMITATIONS IN INTERDISCIPLINARY RESEARCH

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DIEGO PEREIRA LINDOSO

**Abstract:** The demand for scientific knowledge in human-environment interface is a pressing need and an increasingly urgent one given the risk posed by global environmental changes. The Vulnerability and the Resilience approaches stand out in such context. Even though each one comes from different epistemic traditions, currently they are in a fertile interdisciplinary field. This paper presents a critical discussion on the similarities, differences and limitations for the dialogue between both, given the effort to solve problems emerging from the interactions between society and environment, particularly on climate change research. Although a conceptual convergence is on course, there are still theoretical and methodological perspectives that halt the merger into a single approach. However, since both look at the same issues and are based on similar research questions, there is great potential for beneficial complementarity in advancing interdisciplinary research on socio-ecological systems.

**Key words:** vulnerability, resilience, socio-ecological systems, climate change, interdisciplinarity.

**Resumo:** A demanda por conhecimento científico na interface homem-natureza é uma necessidade premente e cada vez mais urgente frente ao risco representado pelas mudanças ambientais globais. Duas abordagens de pesquisa que se destacam nesse contexto são a da Vulnerabilidade e a da Resiliência, cada qual vinda de tradições epistêmicas distintas, mas que agora se encontram em um campo interdisciplinar fértil. A partir da literatura, o presente trabalho faz uma reflexão crítica das convergências, divergências e limitações para o diálogo entre ambas frente ao esforço de encontrar soluções aos problemas que emergem da interação sociedade e ambiente, em especial a mudança climática. Apesar de uma convergência conceitual, ainda há perspectivas teóricas e metodológicas que dificultam a fusão de ambas em uma abordagem única. Entretanto, ao se debruçarem sobre as mesmas problemáticas e partindo de perguntas semelhantes, há grande potencial de complementaridade benéfico à pesquisa interdisciplinar sobre a dinâmica dos sistemas socioecológicos.

**Palavras-chave:** vulnerabilidade, resiliência, sistemas socioecológicos, mudanças climáticas, interdisciplinaridade.

**Resumen:** dos enfoques que se destacan en la investigación en el interfaz hombre-naturaleza son la Vulnerabilidad y la Resiliencia. Cada uno procedente de diferentes tradiciones epistémicas, pero ahora están en un campo interdisciplinario fértil. Este trabajo es una reflexión crítica de las similitudes, diferencias y limitaciones para el diálogo entre ambos, frente a los esfuerzos para encontrar soluciones a los problemas que surgen de la sociedad de la interacción y el medio ambiente, en particular el cambio climático. Aunque hay una convergencia conceptual, todavía hay perspectivas teóricas y metodológicas que dificultan la fusión de los dos en un solo enfoque. Sin embargo, una vez que estudian minuciosamente los mismos problemas y en base a preguntas similares, existe un gran potencial para la complementariedad beneficiosa para la investigación interdisciplinaria sobre la dinámica de los sistemas socio-ecológicos.

**Palabras-clave:** vulnerabilidad, resiliencia, sistemas socio-ecológicos, cambio climático, interdisciplinarietà.

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