AN INTEGRATIVE APPROACH FOR OVERCOMING DICHOTOMOUS THINKING IN NATURAL HAZARDS AND DISASTERS RESEARCH

UMA ABORDAGEM INTEGRATIVA PARA SUPERAR O PENSAMENTO DICOTÔMICO NA PESQUISA DE RISCOS NATURAIS E DESASTRES

Franciele Maria Vanelli[1]
Masato Kobiyama[2]
Itzayana González Ávila[3]
Emanuel Fusinato[4]
Mariana Madruga de Brito[5]

"The way up and the way down is one and the same."
Heraclitus

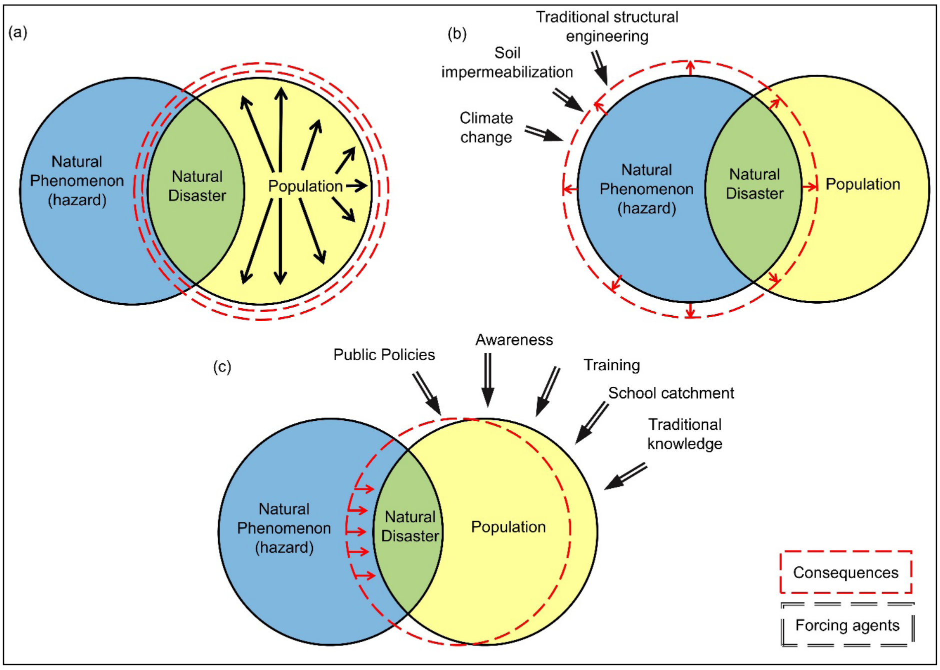
"The more we study the major problems of our time, the more we come to realize that they cannot be understood in isolation. They are systemic problems, which means that they are interconnected and interdependent."
Fritjof Capra

1 PhD student, CNPq scholarship student, Grupo de Pesquisa em Desastres Naturais (GPDEN), Instituto de Pesquisas Hidráulicas (IPH), Universidade Federal do Rio Grande do Sul (UFRGS). ORCID: https://orcid.org/0000-0001-8763-5786. E-mail: francielevanelli@gmail.com.
2 Professor, CNPq scholarship researcher, Grupo de Pesquisa em Desastres Naturais (GPDEN), Instituto de Pesquisas Hidráulicas (IPH), Universidade Federal do Rio Grande do Sul (UFRGS). ORCID: https://orcid.org/0000-0003-0615-9867. E-mail: masato.kobiyama@ufrgs.br.
3 PhD student, CNPq scholarship student, Grupo de Pesquisa em Desastres Naturais (GPDEN), Instituto de Pesquisas Hidráulicas (IPH), Universidade Federal do Rio Grande do Sul (UFRGS). ORCID: https://orcid.org/0000-0003-1684-8885. E-mail: i.goavil@gmail.com.
4 Master's student, CNPq scholarship student, Grupo de Pesquisa em Desastres Naturais (GPDEN), Instituto de Pesquisas Hidráulicas (IPH), Universidade Federal do Rio Grande do Sul (UFRGS). ORCID: https://orcid.org/0000-0002-5602-5085. E-mail: eng.emanuelfusinato@gmail.com.
5 Researcher, Department of Urban and Environmental Sociology, Helmholtz Centre for Environmental Research, Germany. ORCID: https://orcid.org/0000-0003-4191-1647. E-mail: mariana.brito@ufz.de.

Introduction

Disasters are defined as a severe disruption of the functioning of a community or a society at any scale due to natural or technological hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to human, material, economic, and/or environmental losses and impacts (UNDRR, 2009). In disasters triggered by natural hazards, both societal and physical aspects are interwoven, and their interactions over time and space are key in determining the disaster impacts (MASSAZZA; BREWIN; JOFFE, 2019; VANELLI; KOBIYAMA, 2021; VANELLI; KOBIYAMA; MONTEIRO, 2020; WORLD BANK; UNITED NATIONS, 2010). This is because natural hazards, even if their triggering factors could be of an anthropogenic origin, are controlled by natural processes (VILÍMEK; SPILKOVÁ, 2009). At the same time, natural hazards do not result in disasters in the absence of humans or their activities (KOBIYAMA *et al.*, 2019; UNITED NATIONS FOR DISASTER RISK REDUCTION, 2020). Examples of interactions between natural hazards and populations that influence the disasters' impacts are given in Figure 1. These interactions can occur concurrently under global and local influences.

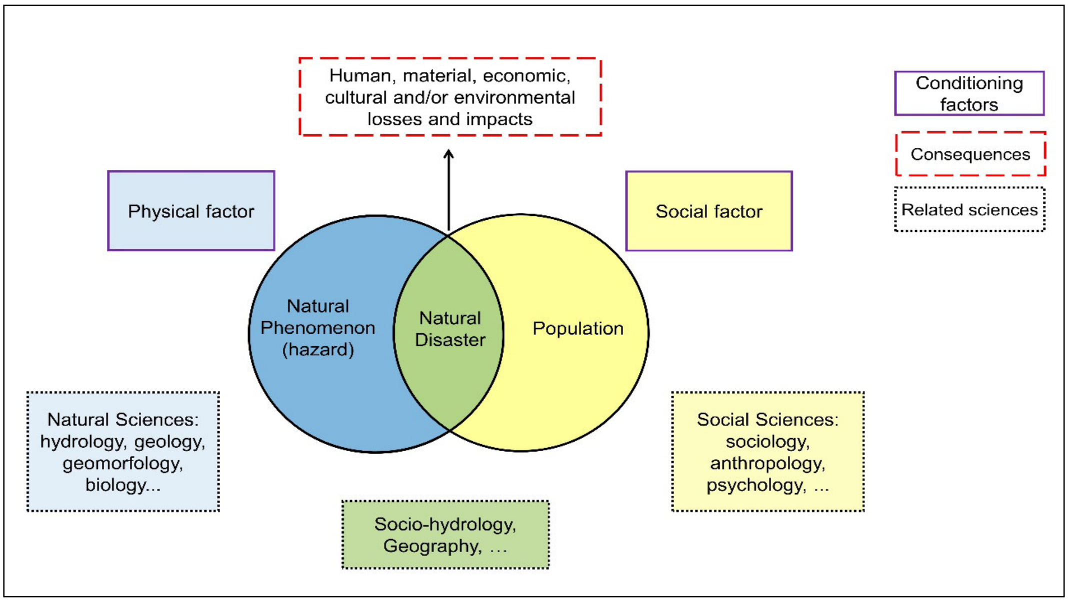
Despite the importance of both societal and physical aspects, current disaster research predominantly studies them as two separated and independent components. The way of thinking categorizing things or ideas into two opposite parts is called dichotomous thinking. The term “dichotomy” derives from the Greek language and it means “dividing in two”. It is used in several disciplines, such as mathematics, philosophy, statistics, psychology, biology, among others. In natural disasters research, dichotomous thinking is still prevalent, for instance: (i) hazard paradigm × vulnerability paradigm; (ii) top-down × bottom-up approaches; (iii) structural × non-structural measures; (iv) natural × social sciences; (v) quantitative × qualitative data and methods; (vi) global × local spatial scales (BLÖSCHL; VIGLIONE; MONTANARI, 2013; DI BALDASSARRE *et al.*, 2018; GAILLARD; MERCER, 2013; GILBERT, 1995; JACKSON; MCNAMARA; WITT, 2017; RUSCA; MESSORI; DI BALDASSARRE, 2021; VANELLI; KOBIYAMA, 2021). Each of these components has its own advantages and limitations and different results are obtained when only a single side is considered for studying natural disasters. Here, it is worth mentioning that several researchers have discussed the “unnaturalness” of natural disasters, and suggest the substitution by the term “socio-natural” disaster, but this is still an emerging concept.



Souce: Modified from Vanelli and Kobiyama (2021).

Figure 1. Examples of interactions between societal (yellow) and physical (blue) factors, which can result in natural disasters (green): (a) increasing impacts from disaster due to population growth (more people are exposed to the potential harms of natural hazards) and/or (b) intensification of extreme events due to disharmonious anthropogenic activities; (c) decreasing impacts from disasters by disaster risk management contributing to harmonious coexistence between the population and natural hazards and/or population moving away from disaster risk areas.

In our view, dichotomous thinking has immediate implications both for disaster research and for how it can feed into policy-making processes. It does not only result in a partial and narrow view of disasters as socio-hydrological phenomena. It also hampers the holistic understanding of how to manage disasters and risks aiming to reduce negative consequences. Hence, to support the development of evidence on the interplay between natural hazards and society, we consider that overcoming the dichotomous thinking is extremely relevant. To this end, is considered that disciplinary-focused studies are needed to get deep insight into physical or social processes. However, we argue that the investigation of both in an interdisciplinary and integrative research design is needed to provide targeted information on "How society and natural hazards shape each other?". For instance, while hydrologists and social scientists focus on understanding water and society, respectively, socio-hydrologists must focus on the interface between both of them (VANELLI; KOBIYAMA, 2019). In this regard, Figure 2 illustrates natural sciences studying natural phenomena (hazards), social sciences studying population dynamics, and socio-hydrology focusing on disasters. In this example, mutual interactions between physical and social factors result in negative impacts.



Source: Modified from Vanelli and Kobiyama (2021).

Figure 2. Disciplinary-focused studies are needed to get deep insight into physical and social processes whereas an interdisciplinary and integrative research design is needed to provide targeted information on the mutual interactions between both physical and social factors that result in natural disasters.

Disasters scientists often specialize in narrow fields, with little emphasis on the interactions between different areas. Even though this siloed way of thinking has brought major advances in disaster risk management, it is not appropriate for responding to compound and cascading disasters that are rapidly evolving, with high-impact events (DE BRITO, 2021) and that bring together researchers, responders, and citizens who do not routinely interact. Given different assumptions, epistemologies, and practices, each of which may be generally accepted within a particular field, working together in disaster situations can become challenging. Hence, it is important to acknowledge the contribution each "part" brings and go beyond artificial barriers between disciplines (BEDFORD *et al.*, 2019). Instead, we must integrate tools and practices from a diverse range of fields.

We suggest that the dichotomous way of thinking in natural hazard and disaster research can be overcome through an integrative approach based on the "Yin-Yang" from the Chinese philosophy and "unity of opposites" from Heraclitus of Ephesus (CAPRA, 1975). The archetypal pair "Yin-Yang" represents how opposite aspects may be complementary, interconnected, and interdependent, and how they may give rise to each other as they interrelate to one another. This idea was also explored by the Greek philosopher Heraclitus of Ephesus through the "unity of opposites" theory when he argued that everything is constantly changing and opposite things are connected and they are part of the same thing. Assuming this perspective, an integrative approach means the process of combining the two ‘opposites’ parts, remaining the integrity of the individual components interacting with each other in a dynamic system and constituting a “whole” that is stronger than the single parts.

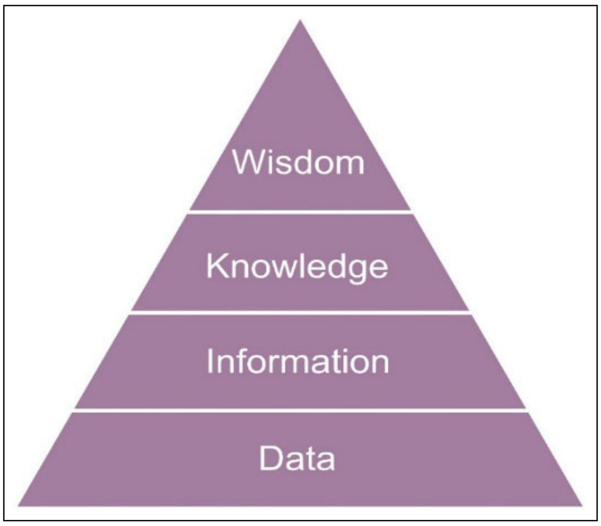
In disaster research, the use of integrative approaches can yield new insights not easily achievable through considering single parts. The Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR, 2015) advocates for a more integrative disaster risk reduction (DRR) than the current dichotomous way of thinking. One of the priorities of this Framework is related to understanding disaster risk in all its dimensions of societal and physical aspects by considering different data-related aspects:

- Gather and process relevant and reliable data, ensuring information dissemination, taking into account the needs of different users;
- Use traditional, indigenous, and local knowledge and practices to complement scientific knowledge;
- Use technology innovations to enhance measurement tools and the collection, analysis, and dissemination of data;
- Enhance the development and dissemination of science-based methodologies and tools to gather, process, and share disaster data.

Against this background, we propose an integrative approach based on the complementarity of the two opposite parts for studying disasters triggered by natural hazards. We suggested that the first step for an integrative approach refers to expanding the range of data sources and analysis techniques used. To do this, in this study, we discussed different types of data, followed by the methods that can be used for combining them. At the end of the chapter, we advanced the discussion by presenting other dichotomies related to natural hazards and disaster studies and explored how the integration of the parts can depict plurality.

Data: the first step for an integrative approach

In classical physics, an event can be depicted by a set of coordinates: (x, y, z, t), where x, y, z are the three-dimensional (3D) spatial axes and t is the one-dimensional (1D) temporal axis. Thus, following this perspective, the data used to describe events can be expressed on spatio-temporal dimensions. Furthermore, data are symbols that represent properties of objects, events, and their environments, i.e., products of observation (ACKOFF, 1989). In this context, data is the basis for understanding the world inside the “data–information–knowledge–wisdom (DIKW) hierarchy” (Figure 3; ROWLEY, 2007). This hierarchy is often implicitly used in methodologies where information results from data analysis when added to a context; knowledge is defined in terms of information containing meanings; whereas wisdom adds value and insights to knowledge through methodical judgments. Hence, the science development first depends on the data.



Source: Rowley (2007)

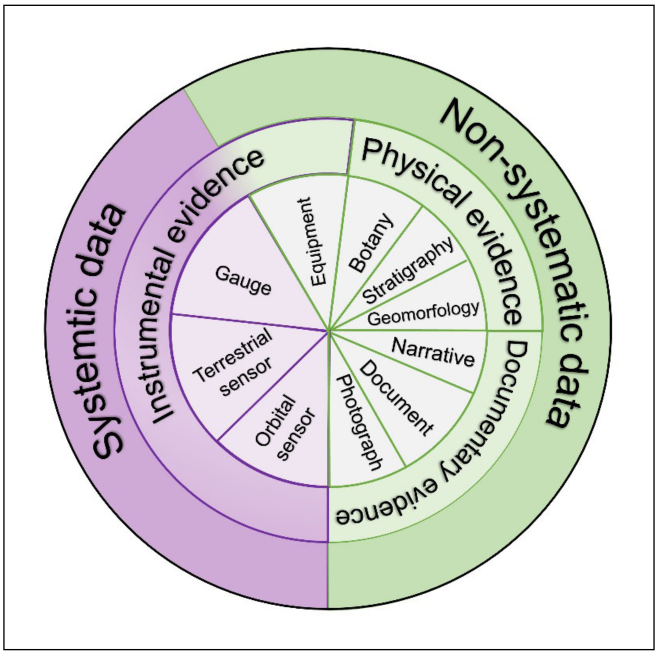
Figure 3. Data-Information-Knowledge-Wisdom (DIKW) Hierarchy.

Data can be classified following different criteria: type (qualitative or quantitative), who gathered (primary or secondary), recording mode (systematic or non-systematic), source (instrumental, physical, or documentary evidence), among others. In this study, we adopted the data classification according to the record mode and the source (Table 1; Figure 4). Dealing with systematic and non-systematic data from different sources requires understanding quantitative and qualitative data gathering and processing techniques.

Table 1. Characteristics of systematic and non-systematic data

Systematic data	Non-systematic data
• Recording with a predefined temporal interval (Δt), resulting in a time-series • Δt = constant	• Recording with irregular and discontinuous temporal interval • $\Delta t \neq$ constant
• Recording in the same position ($\vec{x}$) over time • $\vec{x}$ = (x, y, z)	• Recording in different positions over time • $\vec{x} \neq$ constant
• Quantitative data continuously recording (time-series)	• Qualitative data • Quantitative inferences from qualitative data • Quantitative data from a single recording

Source: Vanelli; Fan; Kobiyama (2020).



Source: Vanelli; Fan; Kobiyama (2020).

Figure 4. Combined use of systematic and non-systematic data from instrumental, physical, and documentary sources for a more integrative perspective of the disasters.

Each data type has advantages and limitations. For instance, systematic data enables the investigation of causal relations over time (longitudinal analysis); whereas non-systematic data can provide important details about the past phenomena. Hence, the combined use of systematic and non-systematic data from instrumental, physical, and documentary sources has high potential to provide a more holistic perspective needed to understand disasters' complex problems. More details about systematic and non-systematic data can be found in Vanelli, Fan, and Kobiyama (2020).

Disaster research needs to move forward to ensure more relevant and reliable descriptions of the social and physical dimensions. To this end, data from different sources must be treated as complementary and equally valuable. With this in mind, local knowledge and practices (e.g. traditional knowledge, indigenous people, stakeholders) can actively contribute to scientific knowledge development. Traditional knowledge is based on personal and collective experiences from local communities developed over time and passed through generations, whose attributes are related to the long-time experiences of religious, folklore, and mythical beliefs, and tightly connected to the characteristics of the local environment. While modern scientific knowledge is based on strict methodologies and rational explanations, local knowledge is based on long-time experience and can provide vast empirical data of natural phenomena and how the population dealt with them (RAI; KHAWAS, 2019). Therefore, relevant non-systematic data can be gathered from local knowledge using techniques, mainly from social sciences (e.g. ethnography, focus groups, among others) and used together with systematic data from modern scientific knowledge.

Empirical work, which involves interaction between citizens and researchers requires following guidelines for safeguarding good research practice. In this regard, attention must be paid to data management, power dynamics, researcher positionality in fieldwork with participants, anonymity and confidentiality issues, ethical principles to minimize the risks to participants, mainly disadvantaged groups and marginalized minority populations (FLINT; JONES; HORSBURGH, 2017; RANGECROFT *et al.*, 2021; VANELLI; KOBIYAMA; BRITO, 2022). In Brazil, there an ethical directive is in place (Resolution n.466/2012) for research involving human beings, but it is focused on health sciences research (GUERRIERO; MINAYO, 2013). Given that biomedical studies and empirical social studies have different characteristics, ethical directives focused on social questions in the Brazilian context need to be developed (GUERRIERO; MINAYO, 2013). Despite this gap, prioritizing ethical and equitable relationships between scientists and the population - stakeholders, and mainly, traditional people - is fundamental for understanding existing problems and co-developing solutions through integrating local heterogeneous characteristics and global scientific knowledge. With this in mind, local knowledge can provide more than relevant non-systematic data, the combination of knowledge and skills from both specialists and affected communities can produce effective DRR strategies.

Therefore, we suggest that rethinking what data is, how it is gathered and processed corresponds to the first step for an integrative approach in disaster research. Understanding that both quantitative and qualitative data and social and physical data are complementary and equally valuable, systematic and non-systematic data from different sources can be used for better understanding the interwoven social and environmental processes. To do this, qualitative and quantitative data gathering and processing techniques must be recognized and used in combination.

Mixed method: the combination of qualitative and quantitative strengths

The basic assumption of mixed method approaches is that the use of quantitative and qualitative methods in combination provides a better understanding of the research problem and question than either method by itself (CRESWELL, 2012). This assumption arises due to the need to holistically understand complex research problems (SAMPIERI; COLLADO; BAPTISTA LUCIO, 2010). Mixed methods are also referred to as, integrative research, mixed research, multiple research, triangulation, multi-strategy, among others (BRYMAN, 2007; CRESWELL, 2012; DI BALDASSARRE *et al.*, 2021; JOHNSON; ONWUEGBUZIE, 2004).

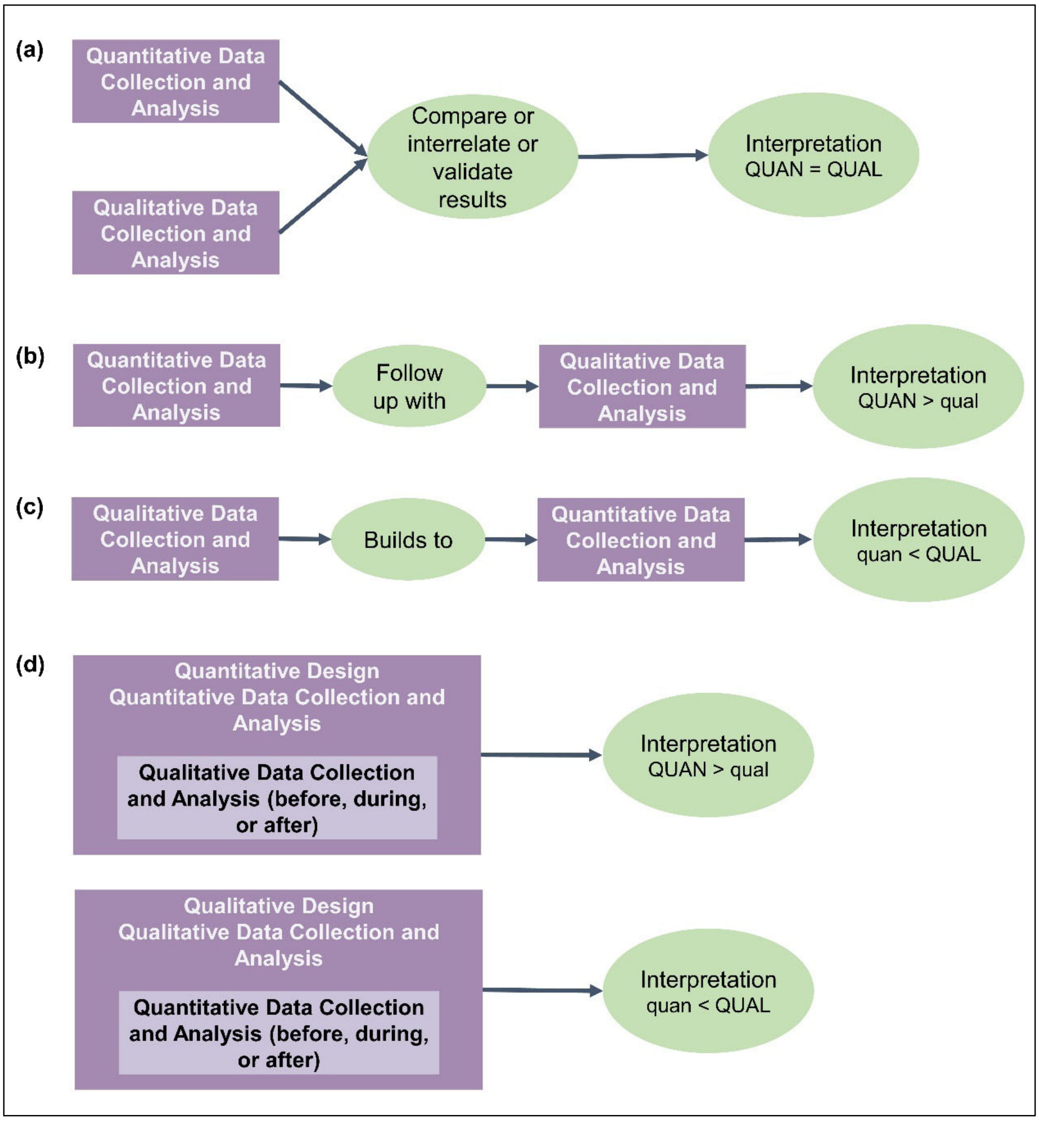
In other words, mixed methods are an integrative approach that overcomes the dichotomized categories: qualitative × quantitative. Their application can be justified by the fact that the world is a combination of objective reality and subjective one. If both objective and subjective realities coexist in the real world, why can not quantitative (objective) and qualitative (subjective) methods coexist in research investigation? In disasters research, the use of integrative approach designs makes it possible to better understand the diverse social, economic, environmental, and political parts that make up natural hazards and disasters (ERIKSEN; GILL; BRADSTOCK, 2011). Hence, researchers have more confidence in the findings because when different methods produce the same or similar results they are less likely to be artifacts (MUNAFÒ; DAVEY SMITH, 2018).

The refusal of some scientists to engage in mixed methods research design is grounded in a series of issues. Gray (2014) indicated that there are differences between ontology and epistemology paradigms of quantitative and qualitative methods. Quantitative methods often assume objectivist and positivist lenses, assuming that researchers are uninvolved with the objects of study. On the other hand, qualitative methods tend to follow constructivist and interpretivist point of view, assuming that the phenomena are constructed/interpreted through researchers' interactions with reality. Therefore, while in quantitative research, the object of study is static to the researcher's presence, in qualitative research, two researchers can have different constructions of the phenomenon (GRAY, 2014). It is worth mentioning that these quantitative methods are not exclusively used by natural sciences. In social sciences, there are quantitative purists researchers, that believe that social observations should be treated as entities in much the same way that physical scientists treat physical phenomena (JOHNSON; ONWUEGBUZIE, 2004).

Given that purists claim that quantitative and qualitative methods are mutually exclusive regarding the research, the pragmatists accept the plurality and refuse the dichotomy quantitative × qualitative. The pragmatism translated by the mixed methods allows the researchers to select suitable methods and approaches concerning their research questions, rather than about some preconceived biases (JOHNSON; ONWUEGBUZIE, 2004). With this in mind, pragmatism can be considered the philosophy of mixed methods. Mixed methods research is, generally speaking, an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints of qualitative and quantitative research (JOHNSON; ONWUEGBUZIE; TURNER, 2007).

The main basic designs of the mixed methods are: (a) the convergent parallel (simultaneous) design, also called triangulation, (b) the explanatory sequential design, (c) the exploratory sequential design, and (d) the embedded design (Figure 5)(CRESWELL, 2012). The purpose of the first design is to simultaneously collect both quantitative and qualitative data, to merge the data, and to use the results to understand a research problem (Figure 5a); whereas the sequential design (Figure 5b, 3c), the data collection and process occur in two phases, with one form of data collection following and informing the other. The purpose of the last design is to collect quantitative and qualitative data simultaneously or sequentially but to have one form of data play a supportive role to the other form of data (Figure 5d).

Some studies in the disaster field apply mixed methods with the above-mentioned designs. For instance, in a parallel design study, Massazza, Brewin and Joffe (2019) investigated the perceptions of causation for the earthquake damage. They gathered both quantitative from questionnaires and qualitative data from interviews, analysed both datasets separately, compared and interpreted the results by triangulation. Applying this research design, they concluded that both results supported each other. Ferdous *et al. (*2018), in an explanatory sequential design study, applied questionnaires to obtain quantitative results, and then refine or elaborate these findings through an in-depth qualitative exploration in the second phase through focus groups. Unlike the convergent design, the two different forms of data do not have to converge or integrate. Whereas, Vanelli *et al.* (2020) applied an embedded design study and added qualitative data into a quantitative design. They gathered quantitative and qualitative data simultaneously, respectively, from instrumental and documentary evidence, but the qualitative data had a supportive role.



Source: Creswell (2012).

Figure 5. Main types of mixed designs: (a) the convergent parallel (simultaneous) design, (b) the explanatory sequential design, (c) the exploratory sequential design, and (d) the embedded design; *QUAN=QUAL* means an equal emphasis on both data forms, *QUAN > qual* means an emphasis on quantitative data, and *quan < QUAL* means an emphasis on qualitative data.

However, mixed methods are still now less frequently applied in disaster research (RUSCA; DI BALDASSARRE, 2019; VANELLI; KOBIYAMA; BRITO, 2022). Against this background and recognizing the Anthropocene (ELLIS, 2017; KNITTER *et al.*, 2019; ZIEGLER, 2019), the interdisciplinary researchers should investigate socio-natural phenomena in an integrative approach because human and Earth systems are interrelated. Geographers that cross social and natural sciences, as well as socio-hydrologists and other socio-natural scientists, are called for working together, which allows to better understand the interwoven between societal and environmental factors.

Integration as plurality

In the present study, we suggested that dichotomous thinking can be overcome by an integrative approach. Although two components are combined, the individual characteristics are retained. The parts constitute the "unity" and interact with each other in a dynamic system. With this in mind, we presented several dichotomies related to disaster studies and proposed integrative approaches that can contribute to overcoming this dichotomous thinking (Table 2). Figure 6 illustrates this idea of dichotomous and integrative approaches.

In the previous section 2, we suggested that rethinking data can be the first step for overcoming the dichotomous thinking in disasters research. This fact is due to data being the basis of the DIKW hierarchy. Concerning negative interactions between natural hazards and socio-technological vulnerabilities that can result in disaster, then both physical and social data are equally and simultaneously required for a better understanding of how to minimize or avoid the disaster occurrence. Although each researcher's background influences their own perspective of the study, social and natural researchers with a common research goal and sharing methods can cross the boundaries of their disciplines (interdisciplinary). Hence, mixed methods are more suitable than just qualitative or quantitative techniques for systematic and non-systematic data collection and processing.

In a domino effect, knowledge sharing between scientists and stakeholders can be an essential part for better understanding interwoven between societal and environmental processes and co-developing solutions. Traditional knowledge holds vast observational data of the natural phenomenon and can help modern science to understand and analyse natural hazards in more precise ways (DEKENS, 2008). The integration of traditional, local, and scientific knowledge is likely to provide a more useful and context-specific basis for climate adaptation planning (NALAU *et al.*, 2017). For instance, the Simeulueans community in Indonesia employed strategies based on their traditional knowledge to deal with a Tsunami in 2004, and within 78,000 Simeulueans only seven lost their lives, while 200,000 people died in the rest of Indonesia, (LAMBERT; SCOTT, 2019). Rai and Khawas (2019) described several successful issues about DRR in Asia, where traditional knowledge and scientific research are used in an integrative approach. The exchanges of perspectives between people, managers, and scientists contribute to the production of shared understandings, where implicit and tacit knowledge is transformed into support decision-making, enhancing the credibility and deployment of the final results (DE BRITO; EVERS; DELOS SANTOS ALMORADIE, 2018). Hence, the cooperation between indigenous communities, stakeholders, and scientists enables the characteristics of each societal context to be respected, generating community-based solutions, instead of generic technocratic productions (RAI; KHAWAS, 2019).

Table 2. Dichotomies related to disasters triggered by natural hazards and proposed integrative approaches.

Dichotomous approach		Suggestions of Integrative approach
Component A	**Component B**	
Social environment	Natural environment	Socio-natural / Real-world
Quantitative data	Qualitative data	Quanti-Qualitative data
Systematic data	Non-systematic data	-
Quantitative method	Qualitative method	Mixed method
Natural science	Social science	Interdisciplinary science
Stakeholders participation / Indigenous and Traditional knowledge	Experts / Scientific knowledge	Transdisciplinary science
Hazard	Vulnerability	Risk
Structural measures	Non-structural measures	Interwoven structural and non-structural measures / Integrated measures/ Mixed measures
Global	Local	Glocal
Urban areas	Rural areas	Ruralization of urban areas / Rural and urban in synergy
Physical Geography	Human Geography	Geography
Hydrology	Social sciences	Socio-hydrology
Geomorphology	Social sciences	Sociogeomorphology
Western philosophy	Eastern philosophy	-

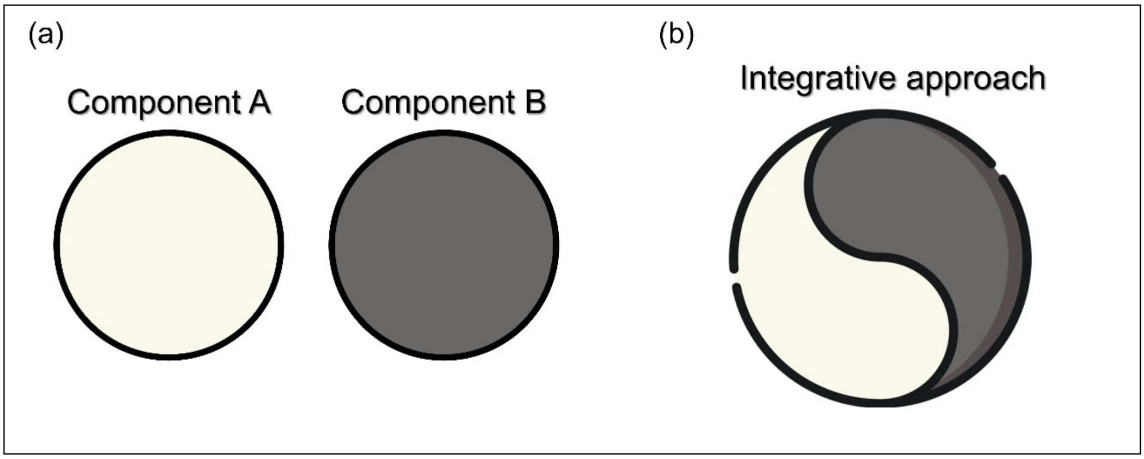


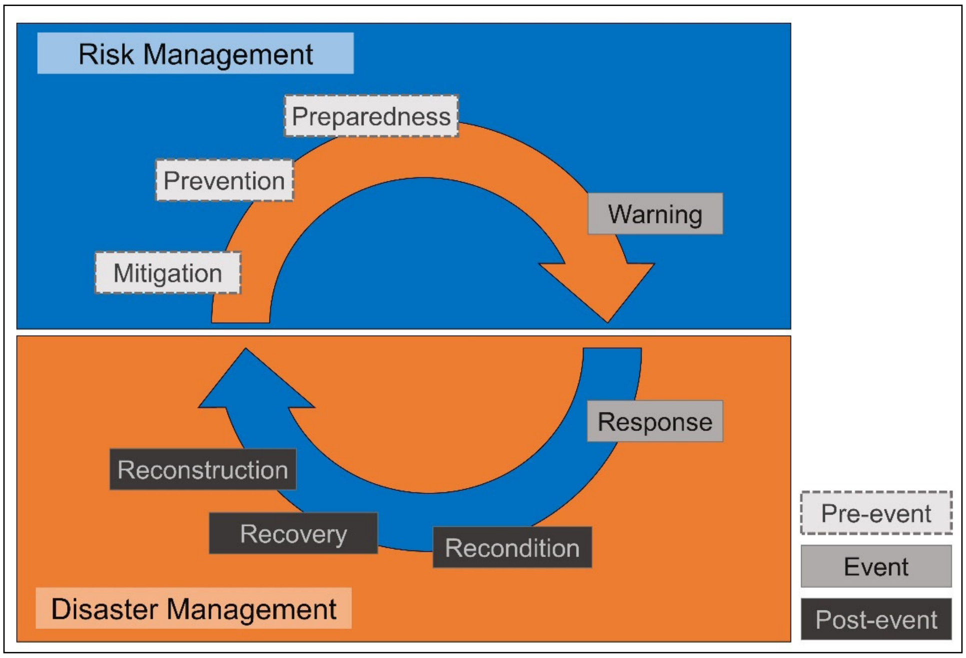
Figure 6. (a) Dichotomous approach: two components on opposite sides; (b) Integrative approach: two components shaping one unity.

However, several scientists mainly from natural sciences have resistance to indigenous or traditional knowledge, which difficult integrative process. Action to reduce the gap is observed in sciences and policies, especially related to the holistic approach of sustainable development. The challenges arising from climate change will force society to adapt to different environmental dynamics. However, its success will rely not only on the human capacity of adaptation (LOUCKS; STEDINGER; STAKHIV, 2006) but on the capacity of sciences and government to induce the necessary changes.

Although natural disasters are multifaceted, the disciplinary dichotomy influences the perspective assumed in disaster studies. Overall, two approaches predominate in the studies: the hazard paradigm and the vulnerability paradigm (GAILLARD; MERCER, 2013; GILBERT, 1995). The first paradigm focuses on natural hazards as independent variables and communities as dependent variables react against an external agent (hazard). Otherwise, the vulnerability paradigm focuses on social aspects, where the disaster is no longer experienced purely as a reaction to a natural phenomenon; rather, it can be seen as an action, a result, and, more precisely, as a social consequence. The hazard and vulnerability paradigms evince dichotomous thinking in natural disaster research (VANELLI; KOBIYAMA, 2021).

As presented in Table 2, the risk is a result of an integrative approach, but due to dichotomous thinking, this term is used with different definitions and applications that differ among various sciences. In natural sciences, the risk is a variable, a measurable element, therefore it can be presented as an equation and used to indicate when action is needed. As a complementary opposite, in social sciences, the risk is a social object and concentrates on understanding human behavior (VEYRET, 2015). However, inhabited space is a coupled system between social and natural interactions.

The management strategies for DRR consist of three interlinked steps: pre-event, event, and post-event (Figure 7) (VANELLI; KOBIYAMA, 2021). With this in mind, the cycle of disaster management is constituted by proactive actions in disaster risk management (mitigation, prevention, preparedness, and warning) and reactive actions in disaster management (disaster response, recondition, recovery, and reconstruction). Although current advances allow predicting events and communicating the population through a warning in a proactive way, the chaotic nature of natural extreme events and social behavior can generate a range of diversity of phenomena, where reactive actions are essential to minimize the negative impacts. Therefore, both proactive and reactive actions are fundamental to reducing disaster losses and impacts.



Source: From Vanelli and Kobiyama (2021).

Figure 7. The disaster management cycle. Blue and orange are the international colors of Civil Protection.

The disaster management cycle is translated into structural and non-structural measures. Structural measures are any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard resistance and resilience in structures or systems (UNDRR, 2009). Examples of structural measures are dams, flood levees, ocean wave barriers, evacuation shelters, among others. While, non-structural measures are any measure not involving physical construction that uses knowledge, practice, or agreement to reduce risks and impacts, in particular through policies and laws, public awareness-raising, training, and education (UNDRR, 2009), for instance, early warning, evacuation plan, and emergency response preparedness. In summary, structural measures are engineering solutions that act as physical barriers to events and non-structural measures include social solutions. Both the measures have advantages and limitations and they should be planned in an integrated way. For instance, the construction of levees (structural measure) can allow the population to have more time to evacuate their houses according to an evacuation plan (non-structural measure); but, at the same time, education for awareness-raising should be practiced, because the levees can generate a false sense of security – high trust in the structural measure – that reduces coping capacities thereby increasing social vulnerability (DI BALDASSARRE *et al.*, 2019).

The management strategies for DRR require to overcome the dichotomy in the global × local spatial scale. Because, in the real world, spatial scales are interdependent: the origin can be local but consequences are global, just as, causes can originate globally but their impacts are/will be local (LOURENÇO, 2014). The sociologist Robertson (1994) and the geographer Swyngedouw (2004), proposed the concept of "glocal" based on the business Japanese concept, aiming to express the connections between both scales. Understanding the heterogeneous characteristics of the local scale and how they affect the global dynamics has the same relevance as understanding the connections and influences that occur on a global scale and the consequences on a local scale. In this case, the example of the Covid-19 pandemic can help in presenting the 'glocal' scale. There are homogeneous characteristics at the global scale, but the human, material, economic, and environmental losses, and impacts are different by the locally-heterogeneous characteristics.

The idea of extreme opposites can also be observed in the municipalities' separation into rural and urban areas. The urbanization process in modern societies refers to the large numbers of people concentrated in relatively small areas. To do this, this process is a set of rejection of vegetation, soil, and rainwater, because vegetation and soil are removed, the soil surface is covered with materials like concrete and stone (soil sealing) and the runoff is accelerated (KOBIYAMA, 2000). So, urban areas are disconnected from the natural environment. In this context, a more integrative proposal is the ruralization of urban areas, in other words, to reincorporate plants, recover soil and retain rainwater (KOBIYAMA, 2000; KOBIYAMA; CAMPAGNOLO; FAGUNDES, 2021). This idea is aligned with Nature-Based Solutions. In 2013, the Chinese government officially initiated the "Sponge City Program" in 30 pilot Chinese cities (QI *et al.*, 2021), a similar idea of ruralization.

In the last decades, some hyphenated sciences have been developed seeking to involve physical and social sciences, for instance, hyphenated hydrology with social sciences (McCurley; JAWITZ, 2017). Hydrology is the science of water and water is essential to human life maintenance and it can shape society and space. Thus, many combinations have been created for connecting both water and societal aspects, such as socio-hydrology, hydroeconomy, hydromitology, etno-hydrology, among others (KOBIYAMA *et al.*, 2020). Socio-hydrology, as an example of hyphenized hydrology, aims to study the coupled social and hydrological systems in an integrative approach. On other hand, inside some sciences can be observed the dichotomy between physical and social aspects. Despite one of the pioneers of the concept of nature-human connection in studies of disasters triggered by natural hazards was the geographer Gilbert F. White in 1945 (ALMEIDA, 2011; MONTE et al., 2021), Geography was subdivided into physical geography and social geography in the century 19th. According to Santos (2017), society causes and suffers transformation in the physical aspect of space, therefore it must be comprehended for its socio-spatial formation, in which physical, social and economic aspects are interdependent. Hence, geography and socio-hydrology and other socio-natural interdisciplinary sciences must seek to reconcile the gaps created between sciences and between society and nature.

Therefore, the integrative approach we propose here does not mean a 'homogeneity' of the parts or components. The proposed approach considers that each perspective is relevant and has advantages and disadvantages (VANELLI; KOBIYAMA; BRITO, 2022). According to Cambridge Dictionary, "integration" means the action or process of joining or mixing with a different group of people and the action or process of combining two or more things. In dichotomous thinking, the focus is given to only one part at a time (Figure 8a and Figure 8b). Conversely, the integrative approach analyses the coupled system during all research steps (Figure 8d), not just "adding up" results (Figure 8c). As such, an integrative approach can provide a more holistic picture of the real world. Although it can be a challenge to implement, the integrative approach considers the mix of plurality and diversity of perspectives retaining the individual characteristics of each part. Working with the pluralism of philosophies, methodologies, backgrounds, and experiences can provide new ideas, perspectives, and potential solutions for complex problems (KRUEGER *et al.*, 2016; RANGECROFT *et al.*, 2021; SLATER; ROBINSON, 2020).

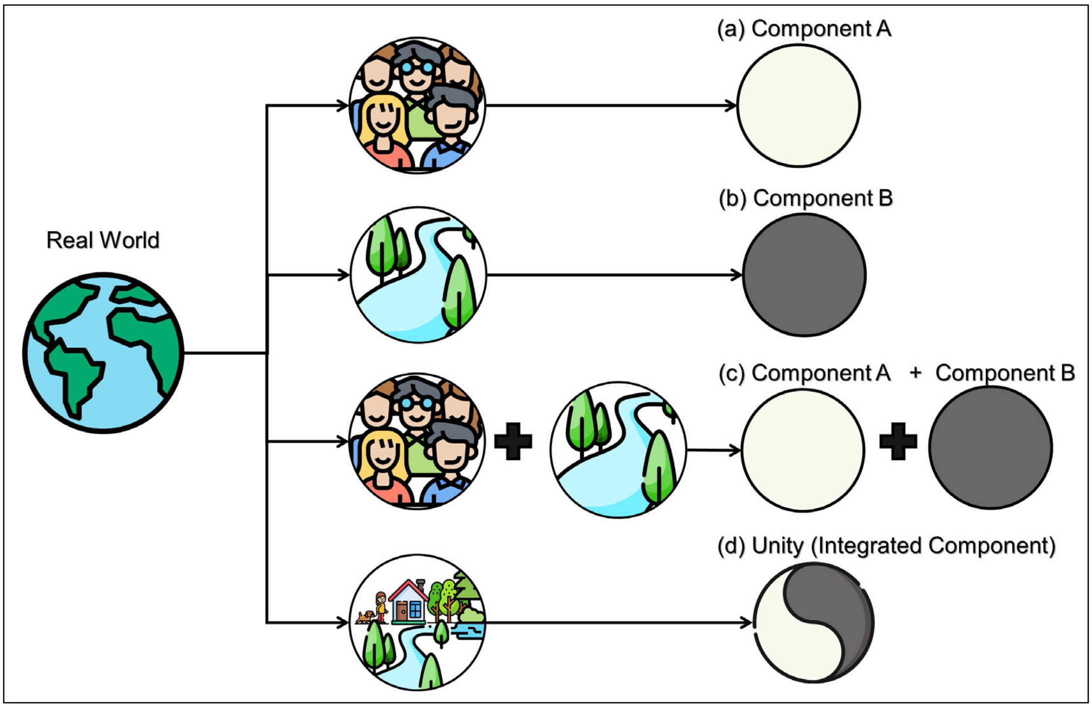


Figure 8. In dichotomous thinking, (a) and (b) single parts are individually analysed and; sometimes, (c) each researcher individually analyse one part and just "adding up" results; whereas in the proposed integrative approach (d) the interwoven phenomena are analysed in all research steps.

Final remarks

Disasters are multifaceted, complex problems, which are often investigated by following the perspectives of each science, disregarding interactions among disciplines. Although disciplinary-focused studies are needed to obtain a deep insight into physical or social processes, integrative approaches can provide targeted information about the interplay between social and physical aspects in a coupled system. To address this, we proposed here the use of an integrative approach based on eastern and western philosophy: “Yin-Yang” and “unity of opposites”, respectively.

We suggested that the current predominant dichotomous thinking should be overcome through this integrative approach, where the ”opposite” parts are complementary and equally valuable, but not homogeneous. In this context, integration means valuing different approaches, diversity, and plurality. We also presented and briefly discussed other dichotomous thinkings. All of them are relevant for obtaining effective DRR in an integrative way. However, given the data-related aspects from Sendai Framework presented in the introduction, we suggested that rethinking data gathering and processing corresponds to the first step for a better understanding of disaster risk in all its dimensions of societal and physical aspects.

We expect this discussion to stimulate thinking and exchange among scientists, opening the debate instead of closing it down and providing a single “final” solution for conducting integrative research. We hope to encourage geographers, social scientists, socio-hydrologists, sociogeomorphologists, and so forth, to take an integrative approach in their research.

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