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Resilience in the shadow of systemic risks

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Abstract

Systemic risks possess a high level of complexity and uncertainty that can be latent behind the veil of initial stress of possible disasters. They refer to, on the one hand, the functionality of interconnected systems and, on the other hand, the probability of indirect losses which can propagate through larger territories. Once considering the solid definition of resilience by the United Nations, the emphasis tends on systems' ability to different facets of disturbance rather than the performance of the sum of each singular entity confronting the main shock. This paper aims to provide a broader perspective and a systematic review focusing on the commons of resilience and systemic risks in the frame of risk mitigation. The outcomes highlight the urgency of multidisciplinary actions, which have not been achieved yet since the 1999s earthquakes.

Keywords: systemic risks, resilience, Kahramanmaraş Earthquakes

1. Introduction

The concept of resilience is described from two prevailing perspectives: engineering resilience and ecological resilience. Engineering resilience is bouncing back to the initial state after a disturbance. Consequently, this denotation displays the static features of the affected items. Therefore, the definition of engineering resilience seems incomplete once considering the broader definition of ecological resilience on which social resilience is also based. However, engineering resilience refers efficiency of function, whereas ecological resilience is related to the existence of function (Holling & Gunderson, 2002). By definition, engineering resilience represents the controllability of systems, while ecological resilience emphasizes the equilibrium of systems within their new features after external disturbance. Even though these two perspectives are considered flip-side, they provide a complementary approach to better understanding systemic risks.

Systemic risk refers to functional deformation or overwhelming of systems of which the negative impacts propagate through other systems and larger territories. Economic crises, breaks in the supply chains and indirect losses of disasters represent some specific examples of systemic risks. The rise of systemic risks can also be related to a high level of globalization. Today, instead of hosting the production of all local needs in place, the production process is dispersed worldwide to take advantage of location, labor force, sources and legal frame. Furthermore, this increasing connectivity boosts new collaborations of local actors to build a coherent network system to enhance innovation at all levels. A low frictional environment accommodated by these networks makes long distances closer with a high volume of exchange and mobility. As expected, these complex systems also provide a convenient milieu for the propagation of adverse conditions. Here, systemic risks take to the stage as unpredictable, less controllable and sophisticated actors.

This paper aims to provide a broader perspective and a systematic review focusing on the commons of resilience and systemic risks in the frame of risk mitigation. In the first section, the review of systemic risks is presented. In the next section, components of resilience are evaluated in the frame of urban systems. The following section is devoted to the systemic impacts of

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earthquake disasters in Türkiye, emphasizing the 2023 Kahramanmaraş earthquakes. In the final part, the concluding remarks are drawn.

2. Review of Systemic Risks

Risk, as a notion, holds uncertainty and probability, which discuss estimations of conditions and consequences for an undefined time slot in the future. From the broader perspective of the definition, risk-taking behavior may have resulted either positively or negatively. However, confronting natural or technological hazards, there would not be any winner among risk-takers. The classical risk analysis approach covers the probability of a threat and vulnerability of exposed objects. In several cases, the value of assets is also included in the equation. In recent decades, the tendency to improve innovative approaches in the risk analysis field has arisen due to the compounding and cascading impacts of disasters. The prospective methods have been expected to enfold dynamic features and propagation of risks which can be delineated according to the root causes of disasters. Systemic risks, from this viewpoint, are located on the main focus of risk challenges.

To move forward on systemic risks, a brief look through system theory (system approach) would enable us to highlight the general approach to the systems. The systems theory is based on studies in different fields by different disciplines (Mingers & White, 2010). In Bertalanffy's general systems theory (1969), each system and its sub-systems are considered a unified structure formed by the interdependent parts within itself and their interaction with each other and with their environment, as they are open systems. A continuous development/evolution with new features acquired as a result of continuous interactions between parts and the self-organization of this open system through feedback are among the defining features of this system (Bertalanffy, 1969; Skyttner, 2005). This theory has experienced rich interaction with fields such as complexity, system dynamics and cybernetics and also had a significant impact on Luhmann's theory of social systems (Montuori, 2011; Luhmann, 1995). Forrester (1970), who gave valuable contributions to the development of system dynamics, was interested in modeling dynamic system behaviors such as the industrial supply chain and the movements of the population in the city with the current flow, information, feedback and delay relationships (Mingers & White, 2010). In his studies, Forrester used system analysis as a tool in urban planning in which he considered cities complex systems (Forrester, 1970). He analyzed critical factors in the development of the cities and promoted the urban dynamics model to estimate the future of urban areas (Forrester, 1969). Another model in the discipline of urban and regional planning with the systems approach was launched by McLoughlin (1969). He developed cybernetic models to understand better and estimate the interaction between human and their physical environment and, consequently, their impacts on changes. System theory studies where cities are considered complex systems enriched risk management and sustainability research (Bach et al., 2020). For instance, as one of the most notable contributions to the concept of resilience, Holling (1973) based his study on system theory on delineating ecological systems' resilience which provides a novel approach to the field of risk reduction (Alexander, 2013).

The fundamental theories on risk assessment have created more inclusive and integrated frameworks by transforming the approaches in different disciplines at every stage of society's transition from the industrial revolution to modernization and today to digitalization. Ulrich Beck's 1986 Risk Society and Antony Giddens' 1990 Consequences of Modernity pioneered the discussion of the relations between risk and society in the scientific world. Beck (1986) drew attention to the new risks produced by modern society by revealing the relationships between socia l and spatial differences and risk formations. Giddens (1990) defines modernity as risk culture. He states that in this culture, an advanced specialization and focus are required to identify risks, but this may cause the problem of needing to be able to connect with the whole. In both works, it has been emphasized that as a result of globalization and increased interaction between systems, both the distribution and spread of risks and the size of their impact have grown. Luhmann (1986) and Habermas (1987) examined risks through the systems approach. Luhmann (1986) describes the environmental and social systems of modern society as a production system. He states that the interaction and communication between systems should also be considered in the context of risks since the output of one system is the input of another. Although Habermas (1987) has a similar approach, he argues that interactions and communications between systems should be examined at the public sphere level, including social, cultural and economic components. Even though the referred studies of these four distinguished scholars did not put systemic risks in words, it is clear that they warned the scientific community about such complex disruptions. In the OECD's report, dated back to 2003, systemic risks are included in the assessment of new risks for the 21st century. In the report, critical topics within the scope of the development and impacts of systemic risks due to natural and anthropogenic threats are defined as follows:

- Increasing mobility and complex inter-system structuring: In addition to human mobility, spatial mobility of products and production processes are expressed in this chapter. Problems in the natural environment and quality of life caused by human activities and production systems have begun to show their medium and long-term effects (e.g., climate change), revealing the necessity of evaluating systemic risks at regional and international levels.

- Increasing density of settlements and human activities: Urbanization and rapid population growth cause increased risks in hazard-prone areas. In addition, excessive loads on the infrastructure and social and economic systems of high-density settlements make these systems vulnerable and consequently increase systemic risks.

- Increasing risks and uncertainties: It has been observed that the collateral and the systemic impacts of disasters have tended to increase in recent years. This situation causes uncertainties to augment and traditional methods to be insufficient in risk assessment.

- Exchange of responsibilities between stakeholder groups or actors: Risk management approaches that are centralized and structured on a command system are likely to be inadequate in the future. Therefore, it is necessary to increase risk awareness, ensure cooperation, produce a coherent and applicable legal framework, and develop international instruments when necessary.

- Social change and perception of risks: With modernization, society's perspective, perception and reactions to old risks (such as earthquakes) and new risks (such as technological) differ.

In the systemic risk literature, the features on the spatial, social, economic and cultural environments align with the 2003 report of the OECD. In addition to the increase in population and population density (Rosa et al., 2014), construction on sensitive and hazardous areas (Rundle et al., 1996) and the threats posed by increased consumption on the resource system (Rosa et al., 2004) are listed as the main factors of systemic risks. Moreover, the presence of multiple and non-linear interactions and reflections (Klinke & Renn, 2000) due to the interdependence (dependence) between technical (technological), social and cultural systems affect systemic risks. Systemic risks refer to the probability of deterioration in the system's functioning rather than the deterioration of individual structures or components in any system (Kaufman & Scott, 2003). Systemic risks are also defined as risks that can cross borders. Here, the definition of cross-border is expressed as beyond the natural and administrative borders (Hannigan, 2012). This propagation which may occur in sub-systems and is likely to affect the upper systems, cannot be explained by fragmented approaches in the assessment and management of systemic risks based on subjected areas or geographical units (Lidskog et al., 2010). Rosa et al. (2014) produced a list of what systemic risks are not instead of defining what systemic risks are. If the risk is at an acceptable level and can be simplified, if the uncertainties regarding its occurrence or impacts can be eliminated, and if the entire society is safe by keeping the risk under control, the presence of systemic risk cannot be mentioned.

The critiques on the cities in the post-industrial era (Anthropocene) have been focused on diversity, connections and complexity (Rocha et al., 2015; Zinn, 2016; Cutter, 2021). Since the diversity of consumption-based products in urban areas is provided as a result of the commercial networks developed by the settlement rather than its production, this system of relations is complicated by numerous intermediary structures. While the entire system offers advantages in meeting the needs and development of settlements, any problem that may develop at any point in the system can spread through established networks. In this context, it is suggested that cities should create a controlled network system and transform it into a more autonomous structure to ensure diversity within their borders (Keys et al., 2019; Elmqvist et al., 2021). As a result of rapid urbanization and migration, the inadequacy of urban infrastructure and social services in the face of concentration in urban areas increases systemic risks (Chen et al., 2019). Furthermore, in the urban economic system, while single product-oriented developments create obstacles to economic diversity and decrease job opportunities, they may also cause favorable conditions for systemic risks (Ma, 2020).

The debate on delineating systemic risks has been limited to more than just the scientific milieu. Following the spark generated by the OECD report in 2003, in preparing the Sustainable Development Goals, systemic risks have also been considered as a new lens to achieve risk-informed sustainable development (Figure 1) (UNDRR, 2019). Four main framework channels on risk reduction, sustainability, climate change and human settlements have been associated with ensuring focus on systems' interconnectivity to be prepared to deal with future risks. Furthermore, as indicated in Figure 1, a notable shift from the hazard-based approach to the social dimension of risks included several disciplines for risk reduction. Today, state-of-the-art on risk issues implies a holistic perspective on impact chains and systemic risks.

It is worth noting that systemic risks are crucial problems of the modern world due to their great potential to cause new Black Swans that have been named and described by Taleb (2007). Even though the re-occurrence of natural hazards is considered probable, the impact chains may cause "highly improbable" systemic failures. Therefore, novel approaches for analyzing systemic risks introduce a critical research area in evaluating impact chains of disasters (Centeno et al., 2015). Furthermore, these new approaches are expected to be integrated with risk management systems (Renn & Klinke, 2004; Schweizer & Renn, 2019; Renn et al., 2020; Schweizer, 2021; UNDRR, 2022; Trump et al., 2017).

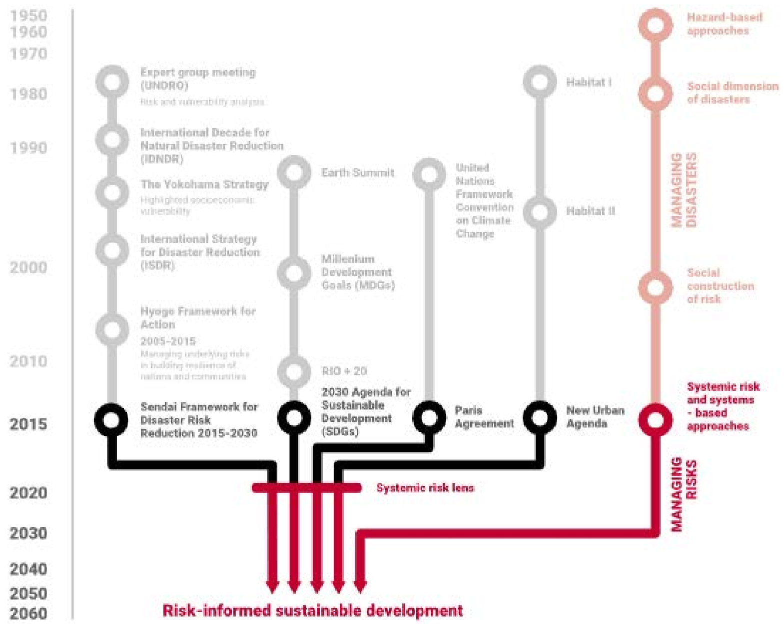

Figure 1 Risk reduction – a journey through time and space (UNDRR, 2019; pp:25)

3. Resilience of systems

According to the UNISDR (2009), resilience is defined as: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.". This long and comprehensive definition covers different components of resilience. The first segment (system, community, society) refers to the dynamic features and complexity; the second one (resist, absorb, accommodate to, recover) points out the adaptive capacity confronting disturbance; the third one (timely, efficient) is about the governance; and the last part (essential basic structures, functions) presents the integrity and performance against external shocks (Kundak, 2017). In the long journey of the concept of resilience since the 1970s, many prominent definitions have been presented in the various scientific fields to understand its components better and improve its implementation methods. Within the acknowledgment of broad literature on resilience, the systemic perspective of the resilience debate has been focused on here.

As a simplified presentation of a typical system, a set of related entities and sub-systems forms integrity to ensure their existence and functioning (Figure 2). The urban system (S in Figure 2) can be taken as an example to study the systems' dynamics. It covers sub-systems (S1) of production, services, transportation and infrastructure. Likewise, each sub-system includes entities (or sub-sub-systems) such as infrastructural systems consisting of water, sewerage, electricity, natural gas and communication (S2). All the components of the systems interact with each other at certain levels. For instance, the electric system (S2), a part of the infrastructural system, has a more significant impact than the other entities on the functioning of the sub-systems (S1). Similarly, some sub-systems may directly affect the entities of the other sub-system rather than affecting the entire sub-system. For example, the degradation of ecological systems and climate change may cause bottlenecks in water supply and consequently affect the urban water system. On the other hand, it is worth noting that all systems (e.g., cities) establish linkages with other systems (e.g., cities) to enhance interactions and exchanges among them.

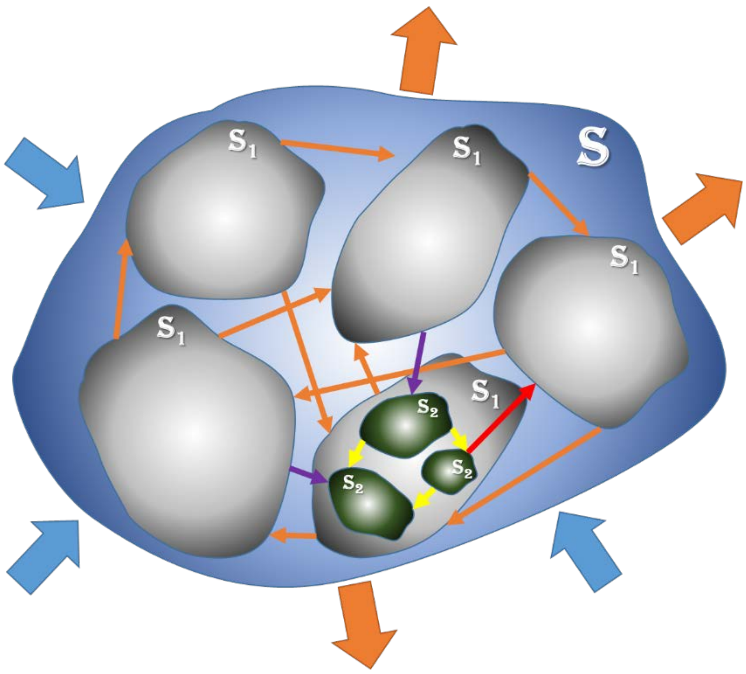

Figure 2 System, sub-systems and entities

The large systems (e.g., large cities) are so big that it is not possible to turn them upside down completely (Gunderson et al., 2002). In other words, these systems are not affected by short-term or relatively small disturbances due to their size. Their resilience mostly depends on redundancy (Folke et al., 2002; Godshalk, 2003; Adger et al., 2005; McDaniels et al., 2008; Xu et al., 2021) in the form of multi-nucleus structures and alternatives. Furthermore, the diversity of the systems is evaluated as a significant attribute that generates redundancy to build resilience in complex systems (Folke et al., 2002; Fiksel, 2003; Godshalk, 2003; Adger et al., 2005; Chuvarajan, 2006; Berkes et al., 2002; Marcus & Colding, 2014). Even though the complexity increases uncertainties, it allows the systems to persist. What has been described so far shows that large systems are not unbreakable but hard to break. Once the large systems confront an intense disturbance that they cannot cope with, it leads to internal functional failures and adverse impacts on neighboring systems (Holling & Gunderson, 2002). This violent scene is where systemic risks show up. For example, large cities perform the role of primacy in the hierarchical structure of their geography and high centrality in the global network. This positioning allows large cities to establish numerous connections not only in exchanging goods and services but also socially and culturally. As mentioned in the previous part, these connections are also convenient for systemic risks to travel and propagate. Furthermore, the real challenge comes with systems that correspond to different scales, cross-scales and dynamic structures, where the focus on one scale misleads the evaluation of the probable impacts (Pritchard, L. Jr. & Sanderson, 2002; Pritchard, 2000; Chuvarajan, 2006). Another most mentioned attribute of resilience is robustness which can be relied on the resistance and stability of any system against inevitable shocks (Folke et al., 2002; Godshalk, 2003; Bruneau et al., 2003; Adger et al., 2005; Van der Veen & Logtmeijer, 2005; Chuvarajan, 2006; UNESCAP, 2008; XU et al., 2021). On the one hand, robustness defines how the systems are strong enough to stay steady; on the other hand, due to a rigid structure can cause obstacles to flexibility. From this viewpoint, Holling and Gunderson (2002) question resilience to develop a social and ecological perspective based on dynamic attributes. Considering resilience as resistance, “it is not an ideal in itself” and “it can be the enemy of adaptive change” (Holling & Gunderson, 2002, pp31-32). Therefore, the systems need creative destruction (Schumpeter, 1950) to move forward by developing innovation and entrepreneurial activities such as startups and unicorns of our era. It is worth noting that systems without precession, transformation and improvement perish.

To delineate resilience through the lens of systemic risks, time and spatial parameters play a crucial role. Temporal parameters cover the historical background of current conditions and consequences, as well as the response, recovery and mitigation phases of risk management activities. Spatial parameters refer to directly affected areas by the calamity and indirectly affected geography by the losses. In Figure 3, three different notations have been combined to reveal processes related to resilience and systemic risks. Blaikie et al. (1994) produced a comprehensive diagram to show the root causes and progression of vulnerability. At the starting point, limited access to critical resources and ideological approaches create a susceptible environment that would subsequently develop vulnerabilities. Next, the lack of institutional and administrative cohesion and macro scale dynamics increase and propagate vulnerabilities in the systems' functioning. Finally, after a long journey, accumulating all inconvenient decisions and implementation leads to unsafe conditions.

The second part of Figure 3 emphasizes the impact chain of disasters on a small piece of an urban system (Kundak, 2023). Once considering the given hazard as an earthquake, the initial impacts of an earthquake are shown with black arrows. At first, buildings, roads, infrastructure systems and industrial facilities receive damage. The red arrows indicate the first-level impacts that the initial damages can cause. Damage to buildings causes loss of life and injuries and leads to road closures and failures in infrastructure. Fires, explosions and leaks can follow damage to industrial facilities. Damage to roads slows search and rescue operations down, while damage to infrastructure (natural gas, electrical systems) increases the number of casualties. Yellow arrows correspond to the second level of the impact chain. Explosions and fires at industrial facilities may cause damage to buildings nearby, as well as probable leakages, which can increase the number of casualties. In addition, depending on their location, these facilities are likely to affect search and rescue and evacuation operations. Therefore, these disruptions make it difficult to respond to disaster victims on time.

The last part of Figure 3 focuses on the systemic impacts of a disaster. Past disasters have shown that indirect impacts are not limited to the most affected areas; contrary, direct losses have impacts on functioning and production activities which can be considered a wide range of systemic impacts. In the aftermath of disasters, the length of the recovery process depends on preparedness for this process. In a typical risk or disaster management procedure, even though there is a strong emphasis on the response phase, the recovery process is mainly evaluated as a reconstruction business. Furthermore, in the lack of recovery plans, fragmented implementations would present potential problems regarding urbanization and future development. The long recovery process causes a decrease in the quality of life of not only survivors but also all inhabitants of the affected area. This may cause obstacles in social inclusion and disruption in social capital. At the individual level, a long recovery process does not help to ease the impacts of post-traumatic syndrome. At the community level, the label “disaster survivor” turns from a deep empathy into an exclusion. The polarization in the community leads to erosion in trust which creates a handicap in social cohesion. Migration is another expected consequence of large-scale disasters, which transfer disaster impacts to other settlements that are unprepared for a sudden and mass population flow. Besides physical damages to business units, including industry, services and commerce, the losses in the community result in business disruption and a reduction in production. There are two facets of this scene. First, it causes challenges in access to basic needs and services for those living in the disaster area. Second, the pause in businesses affects the production sphere either at a regional or national scale because of the breaks in the supply chain. The overall losses of disasters are counted by their representation in the GDP rather than absolute values. Greater losses indicate the long and drastic economic recovery process, which would result in inflation and poverty nationwide.

4. Discussion: Kahramanmaraş Earthquakes

Until February 2023, the earthquakes of Erzincan (1939) and Kocaeli (1999) were the most devastating disasters in the history of the Republic of Türkiye. On December 27th, 1939, at 01:57, an earthquake with Mw 7.9 occurred in Erzincan, which also affected a large territory including Tokat, Ordu and Samsun (KRDAE, 2023). Because of the limited communication technologies of the time and the vast damage in the affected geography, the government informed the earthquake in the early morning. Before the major earthquake, on November 21st, 1939, Erzincan had been hit with a Mw 5.9 earthquake where many buildings received severe damage and 43 inhabitants lost their lives (KRDAE, 2023). Accordingly, it can be assumed that the buildings damaged in the previous earthquake were destroyed in the earthquake on December 27th. The Erzincan earthquake caused 116.720 buildings to collapse and killed 32.968 people (KRDAE, 2023). Due to the harsh winter and railroads deformed by the earthquake, it took a while to reach the affected areas. The most iconic decision on disaster response and recovery took place after the Erzincan earthquake. The prisons in the disaster area collapsed or suffered severe damage and were uninhabitable. Fethi Okyar, the Minister of Justice, proposed to employ prisoners and detainees to support disaster response and recovery activities and suspend their execution (Haçin, 2014). After the decision taken in January, in April 1939, prisoners and detainees were released due to a new amnesty law. In the post-disaster period, many survivors were guided to move to other cities such as Istanbul, Ankara, İzmir, Adana, Bursa and Giresun. Until the summer of 1940, some turned back to Erzincan and some established a new life in the cities where they had moved after the earthquake (Haçin, 2014).

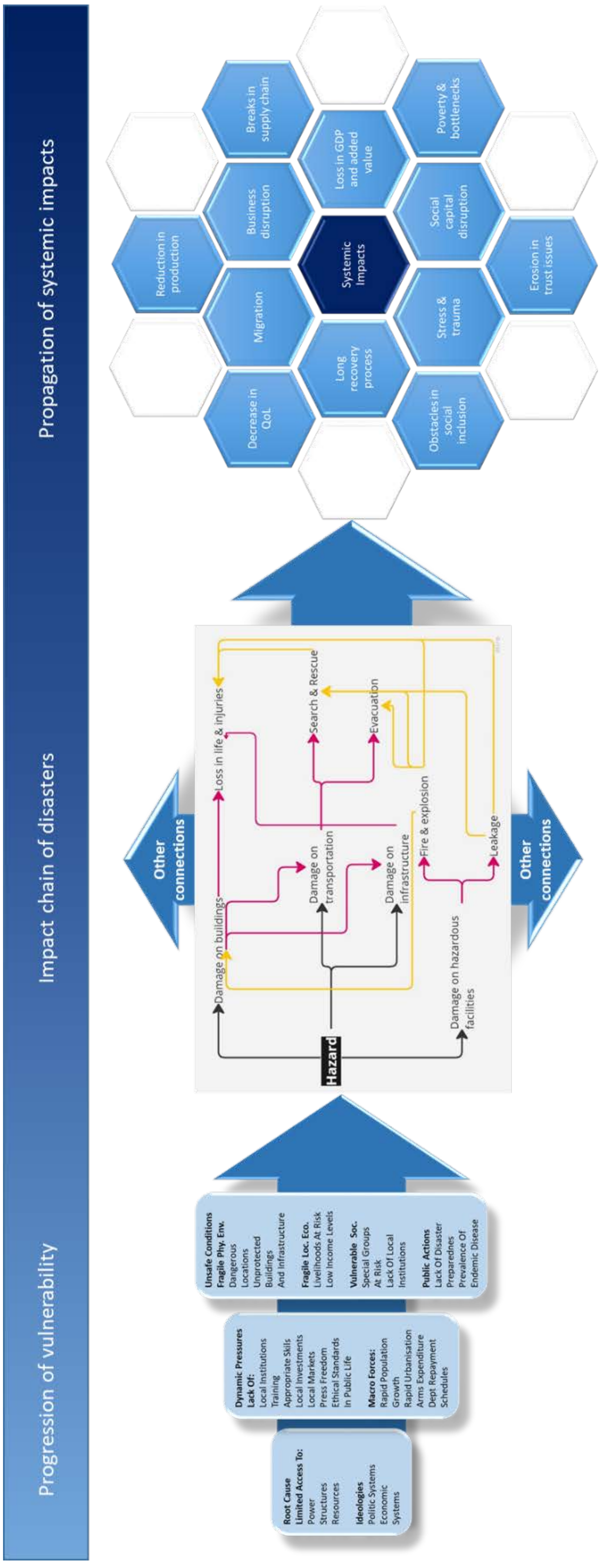

Figure 3 Comprehensive view of disasters

On August 17th, 1999, at 03:02, an earthquake with Mw 7.4 occurred in Gölcük/Kocaeli. According to the official records, 18,373 people lost their lives, 48,901 people were injured, 96,796 houses and 15,939 workplaces were destroyed or heavily damaged. About 250.000 people became homeless and many had to move to other cities (T.B.M.M., 2010). As a more specific example, Südaş (2004) stated that approximately 25% of the residents of Gölcük affected by the 1999 earthquake migrated. According to the reports prepared after the 1999 earthquake, the economic losses caused by the earthquake were around 10 billion USD, corresponding to approximately 4% of GDP (World Bank, 1999; Bibbee et al., 2000). In the damage report prepared by the Turkish Earthquake Foundation, direct losses are estimated to be over 5 billion dollars (Özmen, 2000). On the other hand, this major disaster in Kocaeli, where about 23% of the intermediate goods in Türkiye's manufacturing industry are produced, led to an increase in the import of intermediate goods across the country (Kotil et al., 2007). Therefore, the Kocaeli earthquake is considered notable and a milestone in many aspects. First, it was the first time that Türkiye experienced a big na-tech disaster due to the fire at the Tüpraş Oil Refinery and the leakage and release of toxic substances by industrial facilities. Second, the earthquake showed how cities became vulnerable in the last decades due to rapid population growth and disregard for regulations on construction and planning. Third, with a new perspective, the paradigm shifted from disaster management to risk management. The establishment of novel tools such as the Turkish Catastrophe Insurance Pool (TCIP) in 2000, the law on building consultancy in 2001, the Disaster and Emergency Management Authority (AFAD) in 2009, Türkiye's National Disaster Response Plan in 2012 and the Urban Transformation Law in 2012 had been evaluated as significant progress to cope with disasters and reduce risks.

On February 6th, 2023, at 04:17, an earthquake occurred with a Mw 7.7 in Pazarcık/Kahramanmaraş and lasted for 65 seconds. Then it was followed by a Mw 6.8 aftershock 11 minutes later. About 9 hours later, another earthquake occurred with a Mw 7.6 in Elbistan/Kahramanmaraş and lasted for 45 seconds. Considering the length of shaking, they are longer and even, respectively, than the 1999 Kocaeli earthquake, which lasted 45 seconds. As it can be noticed, even the aftershock of the earthquakes is bigger than the 2003 Bingöl and 2020 Elazığ earthquakes. On February 20th, 2023, two aftershocks with Mw 6.4 (at 20:04) and Mw 5.8 (at 20:07) occurred in Samandağ/Hatay. By March 15th, 2023, more than 15000 aftershocks occurred in the affected zone, of which 44 are between Mw 5.0-5.9 and three are between Mw 6.0-6.9 (KRDAE, 2023) (Figure 4). To understand the impact of these earthquakes on physical structures, the horizontal and vertical ground acceleration records are given in Figure 5 with the comparison of significant earthquakes in Türkiye since 1990. For instance, both acceleration records of the Pazarcık earthquake are 3,5 and 4,3 times higher, respectively of those in Kocaeli earthquake 1999 (İlki et al., 2023). As the gravity is 1.0, a horizontal acceleration of 1.38 and a vertical acceleration of 1.08 reveal the severity of the ground motion.

The February 2023 earthquakes affected 11 provinces, mainly Kahramanmaraş, Hatay, Adıyaman and Malatya. These 11 provinces represent about 16% of the total population of Türkiye. The tremors caused more than 50.000 loss of life, hundred-thousands of injured people and more than 2,5 million homeless. As the final official records have not been announced yet, the figures as of March 6th, 2023, help to understand the severity of physical losses (Table 1). In the 11 affected provinces, there are more than 2,6 million buildings, of which 89% are for residential purposes. Between February 6th and March 6th, 2023, about 34% of the total housing units have been controlled to define damage level. In Kahramanmaraş, Hatay, Adıyaman and Malatya, the ratio is more than 50%. Among the investigated housing units, 27% are either collapsed or heavily damaged, 7% are moderately damaged and 66% are slightly damaged. Even though the investigation processes have not been concluded yet in the most affected provinces, the share of collapsed and heavily damaged buildings reaches 20-25% of the total. After the earthquakes, without official confirmation, about 5 million people moved to other cities, mostly Ankara, Antalya and Mersin, according to the declarations of real estate experts and local agents. So far, the challenging living conditions of the disaster areas and lasting aftershocks discourage people from turning back.

From the view of the national economy, the affected area represents almost 10% of the GDP in 2021 (Table 2). More specifically, the region generates a notable contribution to the national income due to agricultural, industrial and manufacturing activities. Furthermore, the share of the region in export is 9%, where Gaziantep is leading with 4,64%, then Hatay 1,57% and Adana 1,33% are following respectively. Still, it is too early to assess direct and indirect losses, yet some estimations based on the current market values and loss ratio of the Kocaeli earthquake have been reported. According to the World Bank (2023), the direct economic loss by physical damage is approximately 34,2 billion USD representing 4% of the GDP in 2021. The Presidency of Strategy and Budget (2023) denoted that the total direct and indirect economic losses may reach 103,6 billion USD, 9% of the expected GDP in 2023. Yılmaz (2023) presented probable lowest and highest losses that vary between 77,4-104,8 billion USD, equivalent to 8,6-11,6% of the GDP in 2021.

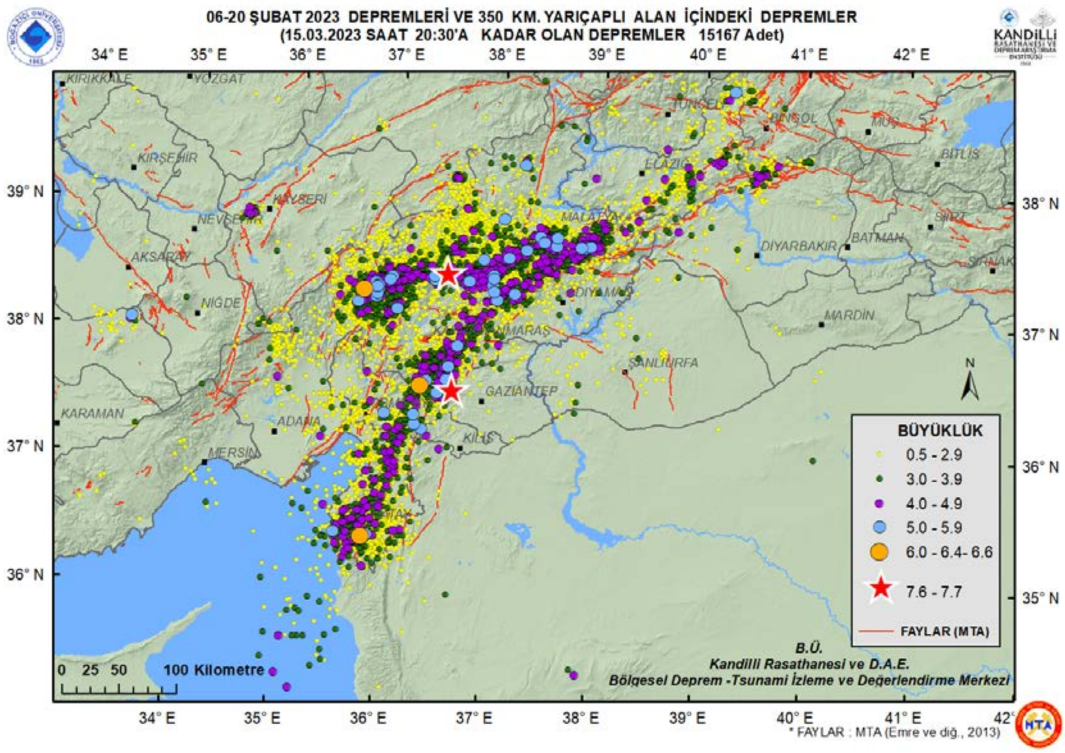

Figure 4 Epicenter of Kahramanmaraş Earthquakes and aftershocks (KRDAE, 2023)

The ongoing recovery process in the earthquake-affected provinces and the lack of reliable and coherent data make the presentation of a comprehensive discussion difficult without any misleading speculations. Nevertheless, following the tangible consequences of the February 2023 earthquakes, some remarks should be noted. The Disaster and Emergency Management Authority initiated the preparation of the Provincial Level Disaster Risk Reduction Plans in 2019 in pilot provinces and then, by the end of 2021, all provinces concluded their plans. These plans enclose the delineation of threats and exposure obtained by previous scientific research and the available database from institutions, different scenarios to reveal risks and strategies in risk mitigation and preparedness. In other words, even though the framework of the plans presents a new perspective, the scientific information on the hazards and vulnerability of settlements has been there for quite a long time, and yet nothing has been done. Referring to the progression of vulnerability diagram by Blakie et al. (1994), the accumulation of adverse decisions on urban plans resulted in a chaotic scene in the earthquake-affected provinces. Besides the performance of the response phase is another research topic related to administrative structures, the field operations, such as search and rescue activities, remained inadequate because of the complexity of the disaster. Regarding the systemic impacts of these earthquakes, in the medium to long term, some bottlenecks are estimated not only in the economy but also in the humanitarian aspect.

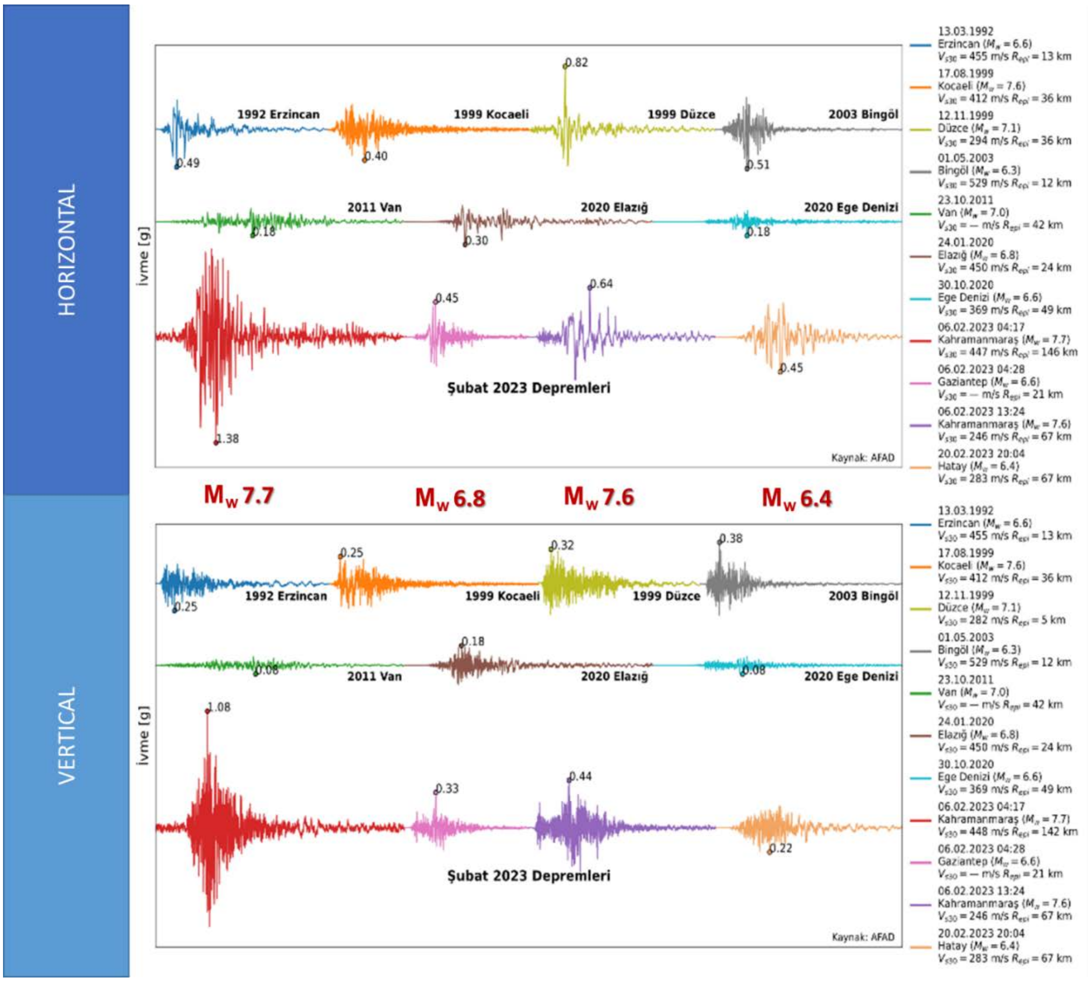

Figure 5 Comparison of ground acceleration records of major earthquakes in Türkiye since 1990 (İlki et al., 2023)

Table 1 Buildings and damage assessment of housing units (Source: The Presidency of Strategy and Budget, 2023)

	Nb. of Buildings	Residential Buildings		Housing Units	Damage assessment of housing units (as of March 6th, 2023)		Damage Control Report on Housing Units (as of March 6th, 2023): Collapsed/heavily damaged		Moderately damaged		Slightly Damaged		Collapsed-Heavily damaged units/total
		#	%		#	%	#	%	#	%	#	%	(%)
Adana	451.117	404.502	89,67	972.561	85.792	8,82	2.952	3,44	11.768	13,72	71.072	82,84	0,30
Adıyaman	120.496	107.242	89,00	216.744	147.700	68,14	56.256	38,09	18.715	12,67	72.729	49,24	25,96
Diyarbakır	225.679	199.138	88,24	563.295	133.034	23,62	8.602	6,47	11.209	8,43	113.223	85,11	1,53
Elazığ	123.713	106.569	86,14	292.406	42.829	14,65	10.156	23,71	1.522	3,55	31.151	72,73	3,47
Gaziantep	305.683	269.212	88,07	893.558	285.903	32,00	29.155	10,20	20.251	7,08	236.497	82,72	3,26
Hatay	406.849	357.467	87,86	847.380	430.529	50,81	215.255	50,00	25.957	6,03	189.317	43,97	25,40
Kahramanmaraş	243.153	219.351	90,21	481.362	278.350	57,83	99.326	35,68	17.887	6,43	161.137	57,89	20,63
Kilis	37.312	33.399	89,51	74.976	31.786	42,39	2.514	7,91	1.303	4,10	27.969	87,99	3,35
Malatya	178.987	159.896	89,33	345.536	192.085	55,59	71.519	37,23	12.801	6,66	107.765	56,10	20,70
Osmaniye	143.080	128.163	89,57	243.436	89.699	36,85	16.111	17,96	4.122	4,60	69.466	77,44	6,62
Şanlıurfa	382.628	347.902	90,92	718.063	211.605	29,47	6.163	2,91	6.041	2,85	199.401	94,23	0,86
Affected Region	2.618.697	2.332.841	89,08	5.649.317	1.929.312	34,15	518.009	26,85	131.576	6,82	1.279.727	66,33	9,17

Table 2 Share in GDP and total export of 11 provinces (Source: TURKSTAT 2021, TURKSTAT 2022)

	Share in GDP (%) (2021)	Share in GDP by kind of economic activity (%) (2021)						Share in total export (%) (2022)
		Agriculture	Industry	Manufact.	Construction	Services	Financial services	
Adana	2	2,5	2,2	2,1	1,7	1,9	1,5	1,33
Adıyaman	0,3	0,8	0,3	0,2	0,3	0,2	0,2	0,04
Diyarbakır	0,9	2,2	0,4	0,2	1,2	0,5	0,4	0,13
Elazığ	0,4	0,8	0,2	0,1	1,3	0,3	0,2	0,14
Gaziantep	2	1,3	3,6	4	1,7	1,5	0,8	4,64
Hatay	1,4	1,3	1,8	1,9	1	1,4	0,5	1,57
Kahramanmaraş	0,9	1,4	1,4	1,3	0,8	0,4	0,3	0,65
Kilis	0,1	0,2	0,1	0,1	0,1	0,1	0	0,04
Malatya	0,5	0,9	0,5	0,5	0,7	0,3	0,3	0,2
Osmaniye	0,4	0,6	0,7	0,7	0,3	0,2	0,1	0,16
Şanlıurfa	0,8	3	0,4	0,3	0,8	0,5	0,3	0,11
Affected Region	9,7	15	11,6	11,4	9,9	7,3	4,6	9,01

5. Conclusion

In the context of cities and urban systems, several common features stand out in studies on disasters: (1) a tendency to identify urban risks through structural damages (potential damages); (2) a focus on cities affected by recent earthquakes; and (3) the evaluation of data over a single period. Considering the direct and indirect effects of disasters, it has become apparent that not only do the settlements face damage, but also the wide geography through urban network systems is affected. On the other hand, the fact that cities and urban systems are dynamic structures reveals that the studies to be carried out in this field should cover time-dependent trends and changes. Furthermore, systemic risk studies display the weakest or puzzling linkages/relations in urban systems, which would cause further problems when confronting hazards. Therefore, the debate on urban resilience is expected to be rooted in the interconnected systems' existence and functioning.

Systemic risk studies show that disasters are devastating not only for the affected region but also for more extensive geography. In other words, the February 2023 earthquakes should be seen as a disaster not only for 11 provinces but for the whole of Türkiye. Likewise, after witnessing the recent earthquakes, the earthquake risk in Istanbul has become a crucial topic once more. However, the problem is not just related to Istanbul; it concerns around 30 million inhabitants in the Marmara Region. Until now, the controversial and fragmented implementations of urban regeneration tools did not respond to risk mitigation efficiently. Additionally, large-scale investments favoring the growth of Istanbul and the Marmara Region have increased the exposure. On the one hand, problems remain from the past, and on the other hand, there are new items in the system to tackle. Furthermore, Istanbul still has an increasing dominance in the contribution to the GDP and export compared to the other provinces. Indeed, not all troubles can be resolved in a short period, yet establishing realistic strategies with integrated actions would be able to raise urban resilience. Therefore, the recent initiatives at both local and central government levels to reduce risks should be evaluated as a second or ultimate chance for the entire country.

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Resume

Assoc.Prof. Seda Kundak received her Ph.D. (2006) in Urban Planning about earthquake risk analysis from ITU. She attended graduate programs on earthquake and disaster resilient cities at the University of Geneva, ETH Zurich and Kobe University. She completed her postdoctoral research at the Politecnico di Milano in the EU 7th Framework Program Project on vulnerability and urban resilience. Between 2008-2009, she contributed to the preparation of consultancy and training materials in the ISMEP (Istanbul Seismic Risk Mitigation and Emergency Preparedness Project) project. She has consulted and authored books published by Istanbul Governorship and AFAD on urban risks and risk mitigation efforts. She was a board member of the Society for Risk Analysis-Europe between 2012-2020 and organized the SRA-Europe Congress in Istanbul in 2014. She was the president of SRA-Europe between 2017-2019. In 2017, she was awarded the international Distinguished Lecturer award by the Society for Risk Analysis (SRA) and Sigma-Xi for her work on risk issues and contributions to science. In 2022, she received the SRA Fellow award for his work in the field of risk analysis and his initiatives to bring together risk researchers, especially in the Eastern and Southeastern Europe. She conducted national and international projects on risk perception, disaster logistics, urban crime and resilience. She is currently working as a leading partner in the PARATUS Project supported under the HORIZON Europe - Disaster Resilient Society 2021 call.