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-Araştırma Makalesi-

Dirençliliğin Temelleri

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Öz
Uzun bir geçmişe sahip olmasına karşın, dirençlilik kavramının afet yönetimi kapsamında kullanılmaya başlanması son 20-30 yıllık süreye denk gelmektedir. Dirençlilik düşüncesi, sistemlerin (ya da şehirlerin) dışarıdan gelen büyük etkilerin doğurduğu yeni duruma uyum sağlama kapasitesi ile ilgilidir. Bu makalede, dirençlilik terimi teorik çerçeve ve örnek olaylar kapsamında tartışılmıştır. Ayrıca, dirençlililiğin, hasargörebilirlik ve sürdürülebilirlik kavramlarıyla olan ilişkileri geniş bir perspektifte sunulmaktadır. Makalenin tartışma bölümünde, İstanbul'un farklı özellikleri, risk azaltma anlamında, güçlü ve zayıf yönleri değerlendirilmiştir.

Anahtar Kelimeler: dirençlilik, teorik çerçeve, İstanbul

Radix of Resilience

Abstract
Even though resilience has a long history, the usage of this term in disaster management sets in the last decades. The idea of resilience is related to adaptation capacity of systems (urban areas) to the new conditions created by radical disturbances. In this paper, the term resilience is discussed from the theoretical frame and case studies. Furthermore, relationship of resilience with vulnerability and sustainability is given to provide a broader perspective. In the discussion part, Istanbul is evaluated from different aspects to reveal its weaknesses and strengths regarding to risk reduction.

Keyword: resilience, theoretical framework, Istanbul

1. INTRODUCTION

After the Brundtland Report in 1987, the term sustainability had shown an extensive propagation through several disciplines. Even though the term has been widely used to achieve better conditions in the future without sacrificing current assets, the performance parameters, tools to be used or logic frame have not been clearly set due to too many definitions. On the one hand definitions which have been developed since 1990s eased to understand what sustainability refers to, on the other hand the over-usage of the term damaged the essence of the idea. It was 1712 when the term sustainability was mentioned first time by Hans Carl von Carlowitz to draw attention to un-controlled consumption of forests to obtain necessary timber for mining industry. Likewise, the Brundtland Report emphasized on deterioration of natural resources which would have un-reparable consequences at every level of human activities in medium-to-long term. It is quite obvious that the premiere appearances of the term sustainability had been due to "early warning" for the existence of human kind on the planet earth.

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Within the new millennium, we have met a new term: resilience. In fact, the term resilience has a long standing history comparing to sustainability's past. The roots of resilience date back to the early 17th century when Francis Bacon (1625) first time used the term resilience to refer "resile" (Alexander, 2013). According to the Online Etymology Dictionary, this Latin originated word refers "act of rebounding" and since the late 1800s, it has the meaning of "elasticity". Alexander (2013) narrates the long journey of the term resilience from literature to field of mechanics, ecology and psychology and then its adoption "*by social research and sustainability science*" (Figure 1). He summarizes the migration of resilience among different disciples as: "*In rhetoric and literature, resilience is a concept that is free to find its own level. In mechanics, it is an innate quality of materials, and thus one needs to alter the inherent characteristics of the material if one wants to increase it. Hence, it is a calculable property determined, in the main, experimentally. Resilience in ecological systems is about how they preserve their integrity, while in social systems the concept is more complex and diffuse.*" (Alexander, 2013: 2714). It is worthy to underline the last part of the quotation as a stimulus that Adam Rose captured and declared as the term of "*resilience is in danger of becoming a vacuous buzzword from overuse and ambiguity*" (Rose, 2007: 384). Furthermore, Linkov et al., drawn attention to the same issue as: "*Resilience, as a property of a system, must transition from just a buzzword to an operational paradigm for system management, especially under future climate change.*" (Linkov et al., 2014: 407). Once the definition of resilience has broaden, from the perspective of applied science, it jeopardizes quantification, measurement, calculation and evaluation of efficiency in framing resilience in the real world cases. Conversely, from the perspective of social science, qualitative measurement is employed to solve complex problems, following a well-designed logic frame. This controversial approach which is a product of tension between applied and social sciences has been sort of resolved by Bruneau et al.'s manuscript (2003) which focuses on definition of performance measures and evaluation system of resilience.

To define resilience, vulnerability would be a good reference to complement and to comprehend the term resilience. Firstly, it is crucial to understand that resilience and vulnerability are not opposite concepts where if the one is present, the other is absent. In other words, the relation between resilience and vulnerability can be explained with "yin and yang" in Chinese philosophy. The duality which is symbolized in yin and yang (and also visualized with taichi symbol) shows the connectivity and equilibrium of forces. Briefly, we can always find some vulnerabilities in resilient systems and, *vice versa*, there are always some resilient components in vulnerable systems.

In a simple Google search on the terms of resilience and vulnerability, we can reach around 65 million documents on resilience, 93 million documents on vulnerability and 56.5 million documents consisting of both resilience and vulnerability. Figure 2 shows the percentage of mention of resilience and vulnerability over time. The graph has been produced by the Google Books Ngram Viewer. It is clear that the rise of the term vulnerability dates back the beginning of 20th century and the sharp increase in 1950s. Regarding to the term resilience, even though its usage was wider than vulnerability from late 1800s to mid-1900s, its dramatic raise was around 1970s when Holling introduced his famous manuscript on resilience (Holling, 1973).

The aim of this paper is to discuss definitions on resilience and vulnerability from the perspective of natural hazards and disaster management. The theoretical part on resilience in the chapter 2 is followed by a chapter devoted to discuss resilience and vulnerability in the frame of recent disasters. Chapter 4 introduces the spatial and temporal aspects of both resilience and vulnerability. In the chapter 5, in the light of definitions given in the previous parts, resilience and vulnerability of Istanbul is discussed.

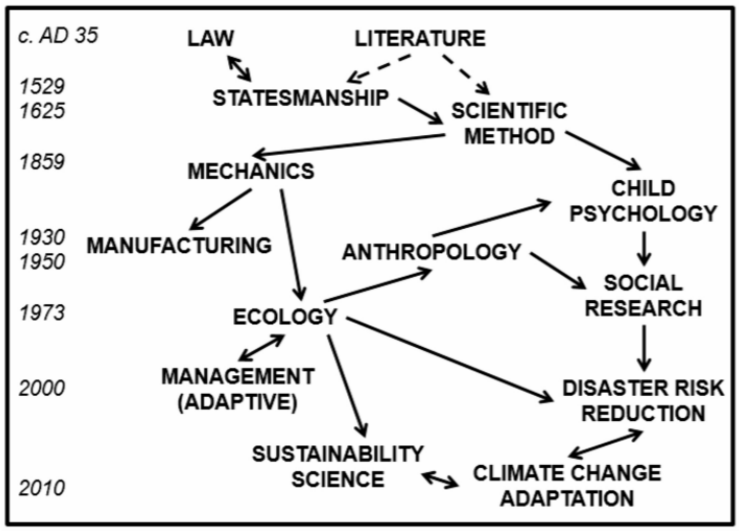

Figure 1 - Schematic diagram of the evolution of the term “resilience” (Alexander, 2013: 2714)

Figure 2 – Ngram of resilience and vulnerability

2. RESILIENCE

Resilience, by origin, refers physical ability of an object to turn back to initial position. This definition is convenient for physical structures where resilience can be delineated as the flip side of vulnerability. However, considering ecological and social systems, this bouncing back means that after any disturbance, these systems would regain their initial susceptible position and therefore, they would be vulnerable again for future threats (Kundak, 2013). Holling (1973) investigated resilience of ecological systems and reached to the conclusion that if a system returns to initial position (or equilibrium state) after a disturbance, it shows the “stability” of the system. However, a system can be very resilient and fluctuate at the same time. Therefore, ecological resilience enfolds different inherent and/or latent factors than engineering resilience does (Holling, 1996). Gunderson and Holling published the book

Panarchy in 2001 in which they introduce a theoretical perspective on human and natural systems emphasizing their dynamic and evolutionary nature. They provide an adaptive cycle to show how a system persists. The cycle (which has the infinity form, but open ended because it is likely to be transformed to prevail over disturbance) involves four phases where: the first phase refers growth and exploitation; the second phase refers conservation of the system; the third phase refers release due to changes in circumstances; and finally the fourth phase refers reorganization of the system with most adaptive entities (Figure 3).

Subsequent definitions of resilience in the 2000s have focused on the ability of systems to survive under extra-ordinary conditions, to adapt new settings and to retain identity and function (Abel and Langston, 2001; Adger et al., 2005; Klein et al., 2003; Walker et al., 2004). The definition of social and community resilience has been inspired by ecological resilience approach and has broadened the meaning. Capacity of learning by experiences (see Carpenter et al., 2001; Bankhoff et al., 2004) and ability to take collective actions (see Coles and Buckle, 2004; Pfefferbaum et al., 2005) have become new notions to delineate social resilience. Handmer and Dovers (1996) have provided a valuable contribution to the definition of social (community) resilience with the distinction of reactive and proactive resilience where the later one implies a system accepting the change and improving its capability of adapting to new conditions. Furthermore, Handmer and Dovers (1996) invoked ecology and disaster research as they are "*two areas of human experience where change and the interaction of human and natural systems have been addressed before*" and they share the "*attention paid to systems approach to the problems*".

According to the comprehensive research of Alexander (2013) on etymology of resilience, "resiliency" was used by American observers who had visited Japan aftermath of two major earthquakes occurred in 1854 (ref. Tomes, 1857). The usage of resilience in the contemporary disaster literature is mostly linked with vulnerability. Regarding to robustness of a system, they are opposite concepts (Gallopin, 2006), however, as resilience embeds the opportunity for change and transformation, it goes far beyond the assumptions of vulnerability (ENSURE, 2010). For instance, a city is considered as vulnerable because of the old building stock (robustness) and as resilient due to the resource allocation for risk mitigation activities (adaptability and transformability). The components of social resilience associate with human capital, from individual level through community level. Learning is a crucial part of individual capacity (Chuvarajan, 2006) to foresee and cope with future disturbances (Folke et al., 2002). Besides, learning represents accumulated experience (Folke et al., 2002, Berkes et al., 2002) which enables the community to produce social memory for preparing the system to change, building resilience, and for coping with surprise (Adger et al., 2005). Social networks, on the other hand, contribute the productivity in a community and enhance social capital (Parker et al., 2009; Sapountzaki, 2010). Furthermore, stronger networks intensify social cohesion which is defined as sense of community. In the recent years, a vivid discussion on the relationship between resilience and sustainability has been going on. Is resilience as an umbrella concept covering sustainability? Or is resilience as a component of sustainability? Or are resilience and sustainability independent concepts? Marchese et al. (2018) represent a comprehensive literature review to reveal the root causes of these questions and to answer them. They reach to a conclusion that positioning of these two concepts differ according to the "*lenses*" or angle where one looks at. The novelty offered by this paper is to encourage the scientific society to cogitate on issues "*to minimize*

conflicts and maximize synergies between sustainability and resilience" (Marchese et al., 2018: 1279).

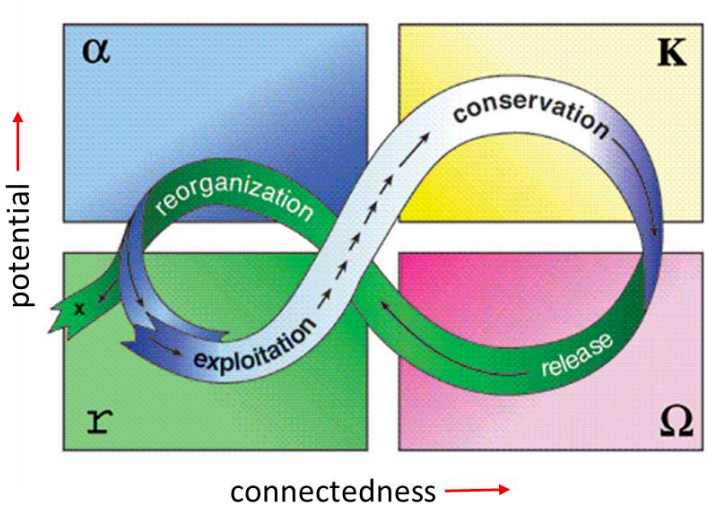

Figure 3 – Ecosystem functions (Gunderson and Holling, 2001: 34)

UNISDR (2009) defines resilience 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 definition refers several crucial points in understanding resilience. First, the subject is given as *system*, *community* or *society* where it mentions about a dynamic and open structure which represents high complexity. Second, the desired (or expected) behavior (or action) of the subject is defined as *resist*, *absorb*, *accommodate to* and *recover* where it refers adaptive capacity. Herein, we can understand that the definition of resilience in mechanics is not applicable. Even though a system is not rigid enough to resist external disturbances, its ability to transform and accommodate to a newer condition might be its strength. Third, preparedness is referred with terms *timely* and *efficient manner*. These two words are also the bases of disaster response or more precisely disaster logistics which should be designed and exercised prior of any peril. Here the terms can be related to interaction, performance and dialogue which also refer governance. Lastly, *essential basic structures* and *functions* reflect the main idea that resilient systems are defined as systems which are able to protect their integrity and performance against external shocks.

The definition and parameters of resilience are mostly given according to the perspective and scientific field of authors (see ENSURE, 2010). The main common point of these definitions is that resilience is a way to improve a strategy/behavior to be able to survive and to adapt against external shifts/impacts. In the Figure 4, the most emphasized key words to define resilience are given into three categories in which each antecedent category is a precondition of the subsequent. Basically, to construct resilience, the main ingredients are: *resource, latitude (redundancy), networks (social and institutional), information, experience, knowledge, diversity and robustness*. In the case of urban resilience, as an example, these are the assets of a settlement considering all physical, social, economic, environmental and institutional structures and their interactions among each other. For instance, metropolitan cities are often identified difficult to manage because of their size and complex structures, as well as their connections with other larger and/or smaller systems (settlements). However,

regarding to the accessibility to resources, redundancy and diversity, large cities have advantages comparing to the others. Medium and small size cities, on the other hand, possess available environment for social networking and collective action. All these components, cited above, are expected to be performed by *innovation, creativity, flexibility, collaboration, self-reliance and feedbacks*. It is clear that resilience is a dynamic process which is expected to accommodate the system to newer conditions. Furthermore, it requires an integrated approach rather than fragmented focal such as solely engineering or social or institutional perspective. Once achieving desirable level, the crucial point is to sustain/manage resilience by *self-organization, increasing learning and individual capacity and rapid response*. The terms given in italics are pieces of resilience puzzle revealed after many striking events, nevertheless the whole picture has not been fulfilled yet.

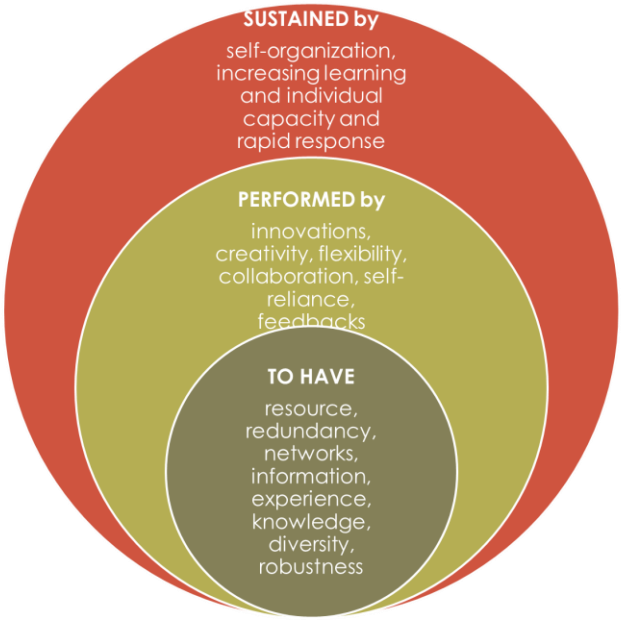

Figure 4 – Key words of resilience

3. RESILIENCE AND VULNERABILITY AT SCENE

It is often difficult to have in a consensus on setting appropriate resilience indicators because these usually become apparent after a disaster/hazard. Due to past experiences on disaster field, we may call a settlement as resilient according to:

- the range of damage of a given settlement faced with an natural/technological hazard
- the functioning ratio of services/emergencies after math of a disaster
- the length of the recovery period
- the ratio of external assistance (national/international) to recovery
- the efficiency of rehabilitation/mitigation process after disaster

Resilience is strongly related with coping capacity during and after a disaster strikes and also adaptive capacity at the aftermath of the event. Besides the absolute numbers of disasters which are very important to comprehend the severity of the events, their representative percentages in each category (population, economic assets, buildings etc.) are more relevant to figure out the coping and adaptive capacity of the affected area. For instance, when economic losses due to a disaster and recovery costs exceed certain level in the national

income (usually GDP is used), it is likely that this country needs international monetary assistance which is often given as credits (e.i. Haiti Earthquake in 2010). This situation brings additional burden to the affected country. Another example is, as experienced after the Hurricane Katrina in 2005, that social structure (social capital) of a region might be damaged in an un-recoverable way which leads forced migration flows and dramatic changes in the demographic structure.

Susceptibility to losses which is usually driven by systemic vulnerability, may cause mal-functioning of the system (either transportation, communication and, so on). At this point, redundancy and diversity are the keywords to define the concept of resilience. The ability to use or to create different alternatives to enable the systems working at optimum levels can reduce collateral losses and impacts. For instance, in the Kocaeli Earthquake, redundancy played crucial role by the means of road network. Despite the high capacity transportation road was not functional because of the fire at TUPRAS Oil Refinery, alternatives roads were usable for search and rescue activities.

The length of the recovery period is another indicator to assess resilience of the affected region. It covers not only physical reconstruction and rehabilitation but also to enhance social capital and to revitalize economic structure. Aftermath of the Kocaeli Earthquake, it took 24-48 hours for railways, 18 days for highway, 8-9 days for electricity to recover (Byers et al 2000). At the Kobe Earthquake, it took 7 days for electricity, 15 days for telephone lines, 91 days for water system, 3 months for Shinkansen railway and 20 months for Hanshin expressway to recover (The City of Kobe, 2008). The large impact at the Kocaeli earthquake was experienced on industrial facilities where TUPRAS Oil Refinery turned back into his normal capacity in September 2000, approximately one year later of the occurrence of the earthquake. Again, once comparing the Kocaeli and the Kobe earthquakes, in one hand economic structure of Kocaeli has been recovered and gained its previous power at the national economy, on the other hand the city of Kobe and Hyogo Prefecture, despite all recovery, reconstruction and rehabilitation process, haven't turned back yet to their previous position at the Japanese economy.

In some cases, national/international assistance, as credits and donations, is necessary to give a quick acceleration for recovery process. At this point, the ability of the self-recovery of the affected area reveals as a resilience indicator. This ability is related to collaboration, self-reliance, diversity, organization and self-capacity. After the Hurricane Katrina, the USA recovered the losses mostly from its national budget and with some symbolic donation. After the Kocaeli Earthquake, the Turkish Government allocated about 6 billion USD for earthquake victims and reconstruction process. Additionally, Turkey received approximately 3.5 billion USD credits from international bodies. In 1999, the GDP of Turkey was about 250 billion USD. Once looking at the same figures after the Haiti Earthquake, we see that the international monetary support to the country is around 3.2 billion USD so far whereas the GDP of the country for the year 2009 has been 7 billion USD.

In order to reveal the changing aspects of both vulnerability and resilience, various examples from recent past disasters have been given in the previous paragraphs. The most relevant example which would lead the further steps of this research is the comparison of the root reasons of vulnerabilities, some critical examples on resilience and impacts of the Kobe

Earthquake (1995) and the Kocaeli Earthquake (1999). In both case studies, in the recovery processes of Kobe and Kocaeli, the main target to achieve was to organize cities as a way they would never experience such a devastating event. In Kobe, several medium to large scale restoration projects were set in and in Kocaeli case, the city of Adapazari was relocated in another place. From this perspective, Figure 5 shows basic elements/reasons/indicators related to vulnerability and resilience in these two case studies. It is worthy to note that, the indications at the cells do not conflict each other by the means of the flip side of each other.

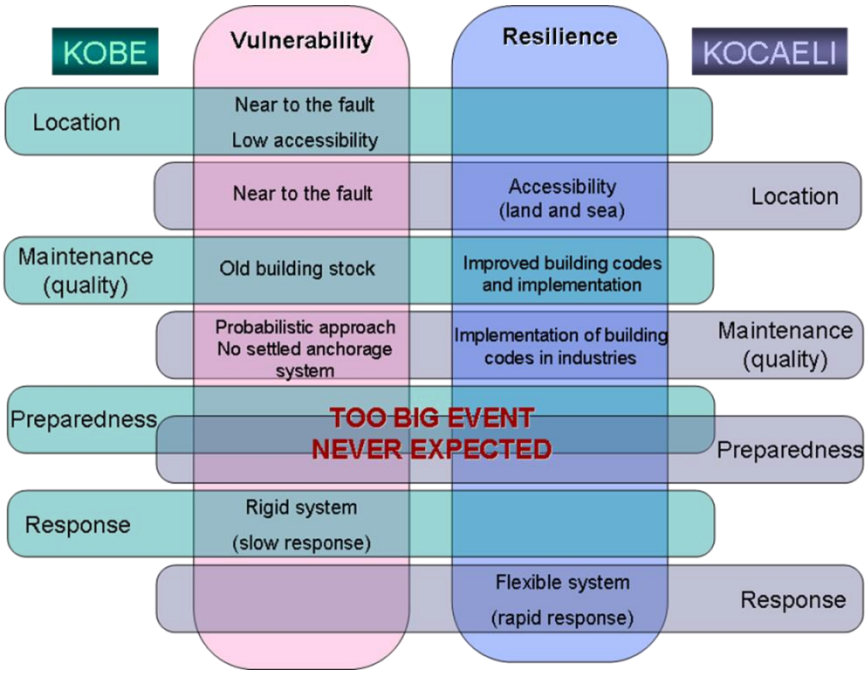

Figure 5 - Comparison of Kobe and Kocaeli earthquakes according to their vulnerabilities an resilience factors (ENSURE, 2009)

Consequently, crucial remarks of the evaluation of these devastating events are as follows:

a) Location of an industrial facility may not be favorable considering natural hazards, however precautions taken would make them resistant and resilient at the same time,
b) Accessibility is crucial not only for industries but also other components of urban areas (residence and commercial). In transportation system, diversity of nodes and alternatives are favorable.
c) In every city there are and there will be old building stock either historic or abandoned. Rehabilitation or restoration of these areas can enhance socio-economic structure of the community in one hand and to prevent some extent collateral hazards following natural phenomena.
d) Implementation of building codes and building consultancy are to be achieved for safer settlements. Furthermore, for hazardous facilities the regulations should be reconsidered in accordance with natural hazards.
e) In the response stage of disaster management system, alternatives and plans should be designed according to different scenarios from most probable through worst-case. Therefore trainings in industrial facilities can be organized accordingly.

4. SPATIAL AND TEMPORAL ASPECTS OF RESILIENCE AND VULNERABILITY

In an urban system, resilience and vulnerability can be observed in physical, economic and social patterns. Buildings, public facilities, plants and infrastructures are the components of physical assets. Economic assets are related with market and insurances. It can be divided in macro and micro level as the division in economy. Population in a city and organizational and institutional pattern of this population refer the social asset. The coping and adapting capacity of a population affects directly the social system. Cities are composed of these physical, demographic, social and economic systems. Moreover cities are not sum of these systems, there is also a strong interaction among these systems. Any action in a system could have also reaction to another one. So these interactions make the city system complex and challenging. To deal with this complexity, scaling could be a useful method (Figure 6). To analyze vulnerability, **scale** can be evaluated in two different perspectives: space as scale and space as location:

Space as Scale: In several disciplines (i.e. urban planning, environmental sciences, economics etc.), problems and/or issues are examined at different levels (scales). There are two main reasons (benefits) for that: (a) different scales give different kind of information (such as comparison of countries, regions or cities) which would be useful to solve problems and/or reveal the facts; and (b) available databases usually fit on different scales according to their resolutions. Furthermore, regarding to natural hazards, their impacts may vary from micro through mega level.

Space as Location: Location can be defined into two categories: (a) distance to the source of hazard; and (b) effects of local conditions/traditions on settlements. While the first one is always taken into account in risk analysis, the latter seems more critical as it refers traditional building construction style and type as well as capacity of communities in mitigation and coping with perils.

Time: It is favorable to define time parameter into two groups: (a) time as disaster management cycle and (b) time as development of vulnerability/resilience. In the first group, time indicator represents disaster by the means of warning period, impact period and recovery period. During this time span, the efficiency of intervenes and successive vulnerabilities are taken into account. The second group represents a relatively larger time span which covers progression of vulnerabilities and breaking points in the history of disasters. It is obvious that cities have not become vulnerable overnight. The root causes and successive false decisions make cities vulnerable not only by the means of artefacts but also social, cultural and economic structure. On the other hand, each country or city has its own breaking point in history caused by an external disturbance such as natural and/or technological disaster. These events may play a crucial role not to repeat the same mistakes and to enhance a system to protect themselves from similar perils.

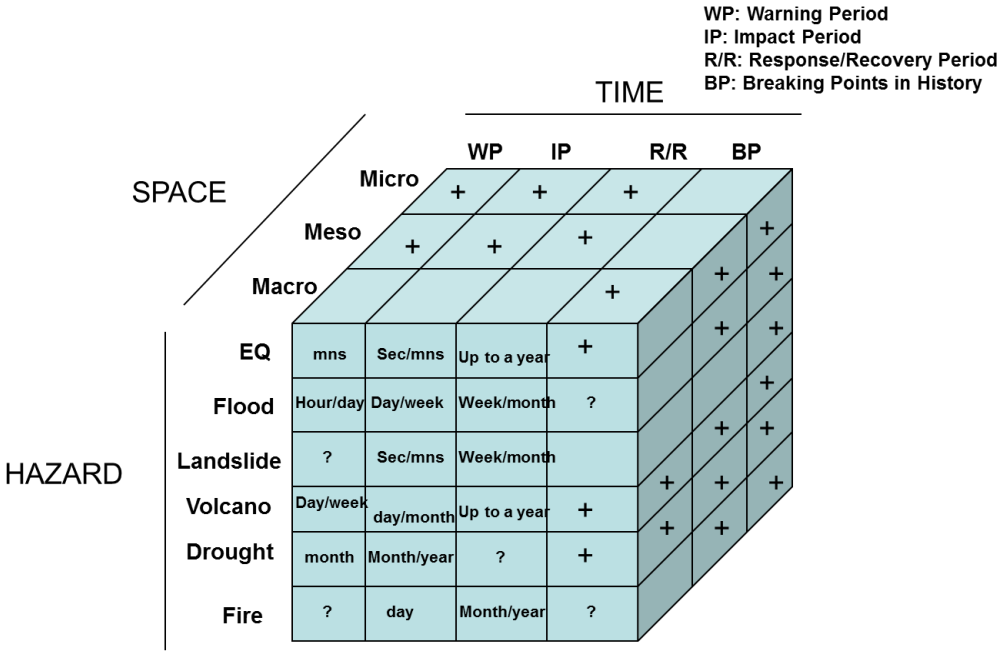

Figure 6 – Relationships among time-space-hazard

4.1 Hazard-Space relationship

Natural hazards, according to their types, have impacts from micro scale through macro scale. For instance while landslides directly affect a certain point at local level, earthquakes have impacts on larger territories according to their magnitude. Furthermore, volcanic eruptions are the one of the best examples to show how far ashes may travel. On the other hand, besides the impacts of these natural events focus on a given area, the collateral impacts may propagate in an extend geography and systems. This propagation shows that hazards hit once, but they may transform to another form – to a fire, inundation etc. – according to the vulnerability level of exposed elements. Settlements differ each other not only because their size and their function but also their urban pattern and usage of local materials in construction. Especially rural areas still keep their traditional characteristics in buildings by the means of design and materials. This feature, on the one hand, can be evaluated as vulnerability as contemporary construction techniques and methods are not applied, on the other hand, once these structures receive damages their recovery process is likely to be quick because of the easy access of both material and handymen to rebuild.

4.2 Hazard-Time relationship

The return-time, warning, impact and response/recovery periods of natural hazards differ from each other. Drought can be estimated months earlier that the prevention measures can be taken, on the other hand, early warning period for earthquakes is very short whereas the response and recovery period is quite longer. Certainly the length of this period depends on how the affected area is vulnerable. Some of the natural disasters are milestones for the memory of the affected region or country so that after their occurrence, radical actions are taken not to experience such a disaster once more. This phase is strongly related to improvement of resilience.

4.3 Space-Time Relationship

Independently from natural hazards, the relationship between space and time shows that warning period (early warning), impact period and response/recovery period concern micro and meso levels. However, despite the some events have local impacts, lessons learnt from them drive to adjust new system to achieve resilient communities. These breaking points at the history give great shifts on macro even mega scales.

5. DISCUSSION: IS ISTANBUL RESILIENT OR VULNERABLE?

To sum up all discussions and definitions on the term resilience, Istanbul would be a good example how an urban system inherently covers different components of resilience, vulnerability and sustainability. Istanbul has a quite long and vivid history on the world scene. The appropriate key word for this city would be *capital,* as it was the ruling city of three empires: Roman, Byzantine and Ottoman. During the history, Istanbul had to deal with devastating earthquakes, fires, epidemics and war destructions. Even though the city had to be rebuilt (or partially re-built) each time, it preserved its identity and power.

Since the 19th century when the last biggest earthquake occurred, Istanbul grew as faster as ever seen in its history. In the beginning of 1950s, the development of Turkish economy reinforced the dominant economic role of Istanbul in all over the country. In this period, the rapid population growth due to migration from rural part of the country caused rising density and expending urban area. However, the planning processes remained insufficient against this “rapid development” and Istanbul gained a complex and uncontrolled urban pattern. This may be seen as the beginnings of the more rapid transformation which was to follow after the war. Housing shortage created “gecekondu” phenomenon which can be translated from Turkish to English as “shelter built in a night” (squatter) that created a dual structure consisting of both legal and illegal housing stock in the city. Expansion of urban land in Istanbul showed linear development in the southern part of the city, from the eastern side to western side, parallel to the Northern Anatolian Fault. Both population and building density increased at the fringes of the city. Newly developed sub-centers and industrial areas enabled to change monocentric structure of Istanbul to polycentric structure. Despite, this development process tends to arrange inner-city flows and protects forest land in the northern part of the city, earthquake vulnerability increased in Istanbul. When 1999 Kocaeli earthquake hit the Marmara Region, in Istanbul, Avcılar and Tuzla were the most affected districts. In Istanbul 1-2% of the buildings were damaged, 454 people were killed and 3600 people were injured (Erdik et al, 2000).

Vulnerability and exposure indicators for Istanbul have been evaluated in different ways. For instance Davidson (1997) had used a set of indicator to compare the risks at megacities including Istanbul as a case. In her approach, vulnerability is described as “*how easily and severely a city’s physical infrastructure, population, economy and social-political system can be affected*”. Respectively to this definition, Istanbul is one of the vulnerable mega-cities of the world after Manila, Jakarta, Lima and Santiago. This macroscopic perspective gives a general idea in evaluation of vulnerability of different cities taking onto account the basic and common indicators. However, vulnerability has a more complex structure. For instance, Gencer (2007) defines vulnerability with a combination of (a) urban poverty; (b) uncontrolled and unsustainable urbanization and development; and (c) substandard urban administration focusing on the case study of Istanbul. In another study by Kundak (2006), decisions and

their reflections on land use pattern of Istanbul are major components increasing vulnerability and consequently earthquake risk. Once considering vulnerability, it is worthy to note that vulnerability is a product of a long term process which means cities cannot become vulnerable overnight and consequently it is appropriate to figure out resilience as a long term target to achieve.

A solid attempts to achieve urban resilience overlay with the mitigation period aftermath the 1999 earthquakes. Turkish Catastrophe Insurance Pool (TCIP) (called DASK in Turkish) was founded in September 27, 2000. TCIP has a sufficient financial resources due to premiums, re-insurance and additional financial support from World Bank in the case of emergency. In 2000, Istanbul Disaster Management Center under the Istanbul Governorship and Disaster Coordination Center under the Istanbul Metropolitan Municipality were established. In 2001, the law on Building Consultancy went in effect to ensure technical supervision of buildings in the construction process by an independent engineering body. In 2002, two comprehensive studies have been released: one was by Istanbul Greater Municipality and Japan International Cooperation Agency, and the other one was Boğaziçi University. The both studies include earthquake scenarios, vulnerability level of Istanbul and risky areas. In 2003, Istanbul Metropolitan Municipality, within the contribution of academic staff of 4 pioneering universities of Turkey (Istanbul Technical University, Boğaziçi University, Middle East Technical University and Yıldız Technical University) developed “Earthquake Master Plan” for Istanbul. Following negotiations between the Earthquakes and Megacities Initiative and Istanbul Metropolitan Municipality in 2004, the Municipality decided to have the Earthquake Master Plan for Istanbul (IEMP) evaluated by an International Team of Experts. The experts emphasized the importance of IEMP for the reduction of risk in Istanbul and considered the Zeytinburnu Pilot Project as the laboratory of this plan. The Zeytinburnu Pilot Project Framework is in response to the IMM and JICA report and the IEMP. The project is the first phase of the implementation of the IEMP. In 2005, the agreement of ISMEP Project was signed between Republic of Turkey and International Bank of Construction and Development. Istanbul Project Coordination Unit (IPCU) has been established within Istanbul Governorship, Special Provincial Administration to implement the Project. In 2005, Istanbul Metropolitan Planning and Design Office was established to prepare a comprehensive development plan for Istanbul targeting the year 2023. In 2007, new building code inured within a new chapter on building retrofitting. In 2009, Disaster and Emergency Management Presidency was established to ease disaster management coordination at national scale. In 2012, law on Urban Regeneration inured to provide legal tools to rehabilitate decayed and risky zones. Eventually, in 2013, Disaster and Emergency Management Presidency released Turkey’s National Disaster Response Plan to clarify duties and responsibilities of governmental bodies, private sector and NGO’s in the response process of any disaster. Furthermore, this plan provides information on collaboration and support mechanisms, as well as disaster logistics, referring 15 sub-regions.

Once considering all deficiencies that Istanbul carries out and the tangible attempts to achieve resilient city, it is necessary to evaluate the big picture through the lens of sustainability. As discussed by Kundak (2010), the city and its inhabitants would face some challenges. After the 1999 earthquakes, there has been an emergence of safe housing demand, especially far away from the fault line. This shift has caused a strong pressure on the natural reservoirs in the northern part of Istanbul. Furthermore, the new large scale

projects (the 3rd bridge, new airport, Canal Istanbul) augment the pressure day by day. Herein, the development process of the city has become the scene of conflict between nature and safety. The second challenge is on physical and social structure which has been perturbed due to regeneration projects. On the one hand, regeneration is a great tool to wipe out vulnerable physical structure of the city, on the other hand it usually destroy the social networks in certain zones. The latter is the consequence of high real estate values which are not usually affordable to people who used to live in this area. Therefore, herein, another conflict sets between social gentrification and safety.

6. CONCLUSION

In the last decades, the term of vulnerability has shifted from the strict engineering definition through a larger fan including social, economic, institutional, systemic, territorial and ecological features urban areas. Moreover, the term of resilience has penetrated through disaster terminology to consider not only the negative entities (vulnerabilities) but also positive entities (resilience) of disastrous events to discover how to improve safer settlements. In a first sight, even resilience seems the flip side of vulnerability, indeed, they may evaluate in a complementary perspective to each other. In order to make accurate assessment in both vulnerability and resilience, it is crucial to understand their conceptual framework, origins and approaches that this paper aims to achieve.

Both vulnerability and resilience are very dynamic, transferable, changeable and sensitive to interactions with each other. Especially in urban areas, identification and measurement of both concepts can be challenging. The case of Istanbul shows that each fragmented attempt has potential to cause conflicts. Herein, there is a need of comprehensive, inclusive and wider perspective to ensure the functioning of all sub-systems. Istanbul case raises some critical questions regarding to resilience and sustainability. If we delineate resilience as multi-faced and complex, why do we try to produce a standardized scheme to be applied in several cases? On the contrary, key concepts related to resilience should be considered as tools to offer tailored (case specific) solutions. If our risk reduction perspective is rooted on shifting vulnerable structures to resistant buildings, how do we assess resilience in urban areas? Even small interventions may reflect to the functioning of urban system. However, so far, no study on Istanbul has been conducted to investigate how these small interventions either increase or decrease the overall resilience and sustainability of the city.

7. REFERENCES

1. Abel, N., Langston, A. (2001) Evolution of a social-ecological System: Adaptation and resilience in the New South Wales Rangelands 1850 to 2020. Available at: http://www.cse.csiro.au/Research/aglands/nswrangelands/pubs/popular_articles/Draft_Paper.pdf [accessed 20 February 2015]
2. Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., Rockstrom, J. (2005), Social-Ecological Resilience to Coastal Disasters, *Science*, 309 (5737), pp. 1036-1039.
3. Alexander, D.E. (2013), Resilience and disaster risk reduction: an etymological journey, Natural Hazards and Earth System Sciences, 13, 2707–2716
4. Bacon, Francis: Sylva Sylvarum, or of Natural History in ten Centuries, Lee, W., London, 1625.
5. Bankoff, G., Frerks, G., Hilhorst, D. (2004), *Mapping vulnerability. Disasters, development and people*, Earthscan, London.

6. Berkes, F., Colding, J., Folke C. (eds.)(2002), *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, Cambridge University Press, Cambridge.
7. Bruneau, M., Chang S.E., Eguchi R.T., Lee G.C., O'Rourke T.D., Reinhorn A.M., Shinozuka M., Tierney K.T., Wallace W.A., von Winterfeldt D. (2003), A framework to quantitatively assess and enhance the seismic resilience of communities, Earthquake Spectra, 19 (4), pp. 733–752.
8. Byers, W.G., Edwards, C., Tang, A., Eidinger, J., Roblee, C., Yashinsky, M., Bardet, J.P., Swift J. (2000), Performance of Transportation Systems After the 1999 Kocaeli Earthquake, Earthquake Spectra, 16 (S1), pp: 403-410.The City of Kobe, 2008
9. Carpenter, S.R., Walker B.H., Anderies, J.M. and Abel, N. (2001), From metaphor to measurement. Resilience of what to what?, *Ecosystems,* 4: 765-781.
10. Chuvarajan, A., Martel, I., Peterson, C. (2006), *A Strategic Approach for sustainability and resilience planning within municipalities*. Master thesis, Karlskrona: Blekinge Institute of Technology, Sweden.
11. Coles, E., Buckle, P. (2004) Developing community resilience as a foundation for effective disaster recovery, *Australian Journal of Emergency Management*, 19, pp. 6–15.
12. Davidson, R., 1997. An Urban Earthquake Disaster Risk Index, Doktora Tezi, The John A. Blume Earthquake Engineering Center, Department of Civil Engineering, Stanford University.
13. ENSURE Project (2009) Integration and Connection of Vulnerabilities – Integration of different vulnerabilities vs. Natural and Na-tech Hazards (Deliverable 2.2), FP7 European Project (2009-2011), http://www.ensureproject.eu/
14. ENSURE Project (Enhancing Resilience of Communities and Territories Facing Natural and Na-tech Hazards) (2010), European Commission 7th Framework Program. *WP 2: Integration and Connection of Vulnerabilities. Del2.2 – Integration of different vulnerabilities vs. Natural and Na-tech hazards*.
15. Erdik, M., Durukal, E., Biro, Y. ve Birgören, G., 2000. İstanbul'da Binalar için Deprem Riski ve Risk Azaltımına Yönelik Somut bir Öneri, İkinci İstanbul ve Deprem Sempozyumu, TMMOB İnsaat Mühendisleri Odası İstanbul Subesi, 27 Mayıs 2000, İstanbul Teknik Üniversitesi Maçka Kampüsü, 131-149.
16. Folke, C., Carpenter S., Elmqvist T., Gunderson L., Holling, C. S., Walker B., Bengtsson J., Berkes F., Colding J., Danell K., Falkenmark M., Gordon L., Kasperson R., Kautsky N., Kinzig A., Levin S., Mäler K.-G., Moberg F., Ohlsson L., Olsson P., Ostrom E., Reid W., Rockström J., Savenije H., U. Svedin., (2002), *Resilience and sustainable development:building adaptive capacity in a world of transformations*. Scientific Background Paper on Resilience for the process of The World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government.
17. Gallopin, G.C. (2006), Linkages between vulnerability, resilience, and adaptive capacity, *Global Environmental Change*, 16, pp. 293–303.
18. Gencer, E.A, 2007. The Interplay between Natural Disasters, Vulnerability and Sustainable Developments. PhD. Dissertation, Columbia University.
19. Gunderson, L.H., Holling, C.S (2001) *Panarchy. Understanding transformation in human and natural systems*, Island Press.

20. Handmer, J.W., Dovers, S. R.(1996), A typology of resilience: rethinking institutions for sustainable development*, Organization Environment*, 9, pp. 482-511.
21. Holling, C.S. (1996) Engineering resilience versus Ecological resilience. In: Schulze, P. (ed) *Engineering with ecological constrains*, National Academy, Washington, D.C., USA.
22. Holling. C.S., (1973), Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, pp. 1–23.
23. Klein, R.J.T., Nicholls, R.J., Thomalla, F. (2003), Resilience to Natural Hazards: How Useful is this Concept?, *Environmental Hazards*, 5, pp. 35-45.
24. Kundak, S. (2006), "Istanbul'da Deprem Risk Parametrelerinin Degerlendirilmesine Yönelik Bir Model Önerisi (A Model on the Evaluation of Earthquake Risk Parameters in Istanbul), Istanbul Technical University, Institute of Science, Urban and Regional Planning Division, Urban Planning Program, May 2006.
25. Kundak, S. (2010), Eds: S. Menoni, Risk Challenging - Publics, Scientists and Governments (Estimation of economic losses according to the earthquake scenarios for Istanbul), 155-166 pp., Londra, İngiltere, CRC Press - Taylor & Francis Group.
26. Kundak, S. (2013), Cascading and Unprecedented Effects of Disasters in Urban System. In: Huang, C., Kahraman, C. (eds.) *Intelligent Systems and Decision Making for Risk Analysis and Crisis Response*, CRS Press, pp. 743-748.
27. Linkov, I., Bridges, T., Creutzig, F., Decker, J., Fox-Lent, C., Kröger, W., Lambert, J.H., Levermann, A., Montreuil, B., Nathwani, J., Nyer, R., Renn, O., Scharte, B., Scheffler, A., Schreurs, M., Thiel-Clemen, T. (2014), Changing the resilience paradigm, Nature Climate Change, 4, 407-409.
28. Marchese, D., Reynolds, E., Bates, M.E., Morgan, H., Clark, S.S., Linkov, I. (2018), Resilience and sustainability: Similarities and differences in environmental management applications, Science of the Total Environment, 613-614, 1275-1283.
29. Online Etymology Dictionary, https://www.etymonline.com (visited November 2017)
30. Parker, D.J., Priest, S.J., Tapsell, S.M. (2009), Understanding and enhancing the public's behavioural response to flood warning information, *Meteorological Applications*, 16, pp. 103-114.
31. Pfefferbaum, B., Reissman, D., Pfefferbaum, R., Klomp, R., Gurwitch, R. (2005), Building resilience to mass trauma events. In: Doll, L., Bonzo, S., Mercy, J., Sleet, D. (Eds.) *Handbook on injury and violence prevention interventions,* Kluwer Academic Publishers, New York.
32. Rose, A. (2007) Economic resilience to natural and man-made disasters: Multidisciplinary origins and contextual dimensions, Environmental Hazards 7: 383–398.
33. Sapontzaki, K. (2010), Risk-reproduction cycles and risk positions in the social and geographical space, *Journal of Risk Research*, 13(4), pp. 411-427.
34. Tomes, R.: The Americans in Japan; An Abridgment of the Government Narrative of the U.S. Expedition to Japan Under Commodore Perry, D. Appleton, New York, 1857.
35. UNISDR (2009), Terminology on Disaster Risk Reduction. http://www.unisdr.org/eng/library/UNISDR-terminology-2009-eng.pdf
36. United Nations (UN) (1987), Our Common Future, The Brundtland Commision Report.
37. von Carlowitz, H.C., (1712), Sylvicultura Oeconomica.
38. Walker, B., Holling, C. S., Carpenter S. R., Kinzig, A.. (2004), Resilience, adaptability and transformability in social–ecological systems, *Ecology and Society* 9(2): 5.