

Urban strategies to promote resilient cities The case of enhancing Historic Cairo response to urban fire

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ABSTRACT : *This research tackles disaster prevention problems in dense urban areas, concentrating on the urban fire challenge in Historic Cairo district, Egypt, through disaster risk management approach. The study area suffers from the strike of several urban fire outbreaks, that resulted in disfiguring historic monuments and destroying unregulated traditional markets. Therefore, the study investigates the significance of hazard management and how can urban strategies improve the city resilient through reducing the impact of natural and man-made threats. The main findings of the research are the determination of the vulnerability factors in Historic Cairo district, either regarding management deficiency or issues related to the existing urban form. It is found that the absence of the mitigation and preparedness phases is the main problem in the risk management cycle in the case study. Additionally, the coping initiatives adopted by local authorities to address risks are random and insufficient. The study concludes with recommendations which invoke incorporating hazard management stages (pre disaster, during disaster and post disaster) into the process of evolving development planning. Finally, solutions are offered to mitigate, prepare, respond and recover from fire disasters in the case study. The solutions include urban policies, land-use planning, urban design outlines, safety regulation and public awareness and training.*

KEYWORDS *City Vulnerability, Resilient City, Safety-Based Urban Design, Urban Fire, City Hazards.*

I. INTRODUCTION

The international debate concerning disaster risk has increased significantly during the last decade, mainly due to the interaction of multiple factors, which have worsened the severity of hazards, threatening the city functionality or even its existence. A disaster is considered an unexpected accident resulting from natural or man-made factors or both, that causes the loss of life or injury, property-damage, social and economic disruption or environmental degradation, while a hazard refers to any natural or human-made phenomenon/event that when exposed to vulnerable elements may cause loss of life or damage to property and the environment [1]. There are a number of reasons for the increasing frequency and intensity of disasters facing the cities nowadays. One of the key reasons is the growing vulnerability due to augmented urban populations and density [2]. Other reasons boosting city's vulnerability are the decline of ecosystems, decaying infrastructure and unsafe building stocks, uncoordinated emergency services, adverse effects of climate change and finally, weak local governance and insufficient participation by local stakeholders in planning and urban management [3].

Historical Old Cairo is one of the vulnerable districts in Cairo city, prone to man-made disasters, as it suffers from high density (21500/km²), old decaying houses, narrow street, and the invasion of heterogeneous land uses and activities. Presiding cumulative problems caused several fire outbreaks in the previous few years. Fire hazards that strike the priceless historical building, residential and commercial areas, jeopardizing the lives of the local residents, and weaken the local economy. Therefore, it is crucial that designated development plans to concentrate on resilience, in order to enhance the district's ability to resist, adapt, and to respond flexibly to threats and thereby ward off potential damage [4]. Strategies and policies can be developed to address the city's vulnerability, and to cope with future shocks and stresses, as part of an overall vision to make cities of all sizes and profiles more resilient and livable.

II. CREATING RESILIENT CITIES AND NEIGHBORHOODS

2.1 What is a resilient city?

Resilience refers to is the ability of a system to respond flexibly to situational changes and to confounding factors without changing into a different state [4]. It is also discussed in both human and ecological systems by their capacities for adaptation to these external stresses and shocks. Thus, it could be concluded that a resilient city is one that has developed capacities to help absorb future shocks and stresses to its social, economic, and technical systems and infrastructures, so as to still be able to maintain essentially the same functions, structures,

systems, and identity [5]. A resilient city is able to minimize and manage vulnerability, which is a set of conditions and processes resulting from physical, social, economic and environmental factors, that increase the susceptibility of a community, property or environment to the impact of hazards. For example an urban community with poorly constructed houses living in a flood prone area are more vulnerable to floods [7].

To build a resilient city it is important to understand Disaster Risk Reduction (DRR) as a tool aiming at avoiding or reducing the damage caused by hazards through the principles of prevention, and considering it in the development and the application of policies, rules and regulations [7]. Adopting suitable urban planning and building design strategies can increase the city's ability to better respond and adapt to the economic, social, and physical stresses they will face as they confront the challenges of increasing energy scarcity, climate change, and population change [5].

2.2 Disasters and hazards facing cities

Disaster vulnerability is on the rise, due to the wave of intense social, environmental changes as human actions has triggered profound alterations of the functions of many ecosystems, provoking amplified worldwide effects. For example, the relations between deforestation and landslides, floods and water management regimes, climate change and the sea level rise. To plan urban disaster prevention, it is essential to consider all possible disasters such as natural disasters, including flooding caused by torrential concentrated rainfall, storm surges, strong winds, landslides, rockfalls, tornadoes, droughts, earthquakes, cyclones, hurricanes, volcanic eruptions, etc. Additionally, there are man-made disasters which include, chemical accidents, oil spills, radiological accidents, conflicts/wars, mass population displacement, forest fires etc. [6],[8],[2]. Moreover, the increased instability of the global economic system and social polarization at the global scale, leave poor population around the globe defenseless to cope with risk. Adequate mitigation strategy costs are also inaccessible to them and the impact of disasters may easily become a fatal blow to their frail economies with long-lasting consequences [6].

III. MANAGING THE HAZARDS IN THE CITY

The goals of Disaster Management are to reduce, or avoid, losses from hazards; assure prompt assistance to victims; and achieve rapid and effective recovery [9]. Capacity to combat disasters in most of the developing countries is particularly weak, as disaster management strategies and programs need to be built into ongoing developmental efforts, linking it to broader economic development. A number of stakeholders, at the global, national, sub-regional and local levels need to come together with different resources to deal with disaster mitigation. Initiatives dealing with disasters need first to examine and assess disasters, as well as circumstances underlying their occurrence. The disaster management process includes the shaping of public policies and plans that either modify the causes of disasters or mitigate their effects on people, property, and infrastructure [10]. "Fig. 1"

3.1 Disaster Management and Environmental Design

Disaster Management is understood as a set of interconnected actions to reduce risk and formulate post-disaster strategies towards recovery. The approach includes the following stages of a disaster or an emergency situation [11],[9].

A. Pre-disaster (mitigation and disaster preparedness): Mitigation relates to activities or measures in avoiding a disaster, or minimizing the damage it causes. Preparedness on the other hand, contains all activities and measures in case a disaster strikes.

B. During a disaster (response): The activities carried out during the course of a disaster, or directly after it strikes, aiming at reducing casualties and preventing further damages.

C. Post disaster (recovery): Know also as bounce back stage, where efforts to repair the damages and restore the environment after the disaster has passed, to its original state.

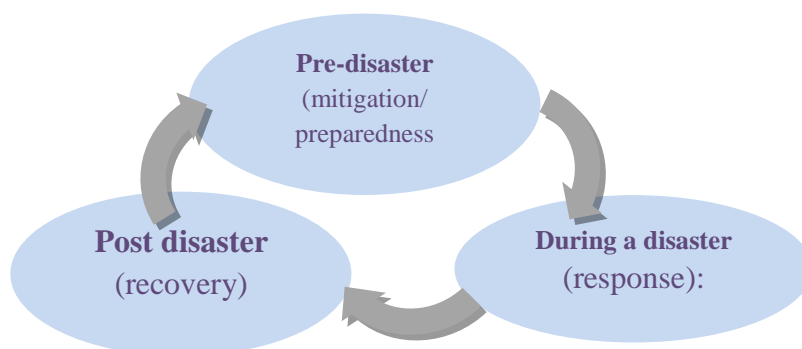


Figure 1. Disaster management cycle

3.2 Urban policies for disaster management

In order to create a disaster management plan the following strategies are essential" Fig.2" [3],[6],[12].

- Create institutional capacity by ensuring that disaster risk reduction is a national and local priority. Ensure the participation of citizen groups and civil society and that all the departments understand their role in disaster risk reduction and preparedness. It is important to build participatory alliances and partnerships among these entities, in order to map out responsibilities and activities.
- Assign a budget for disaster risk reduction and provide incentives for public sector to invest in reducing the risks they face.
- Identify, assess and monitor disaster risks. Update these data, share among all of concerned organizations and groups, and use them as a basis for urban development plans and decisions "Fig.3".
- Develop learning and decision-making tools that can be used for disaster mitigation, including the creation of disaster maps, mitigation plans etc.
- Install early warning systems and emergency management capacities and hold regular public preparedness drills.
- Utilize land-use planning, risk compliant, building regulations, environmental, social and economic measures to reduce risk factors. For example, invest in maintaining critical infrastructure that reduces risk, such as flood drainage.
- Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards.
- Enhance understanding and awareness toward disasters, using education programs and training to build a culture of safety and resilience at all levels.
- Put the needs of the affected population at the center of attention after a disaster occurs, and prioritize rebuilding homes and livelihoods.

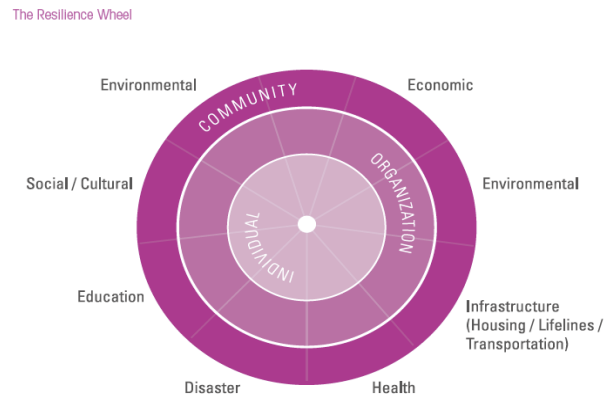


Figure 2: Factors crafting the city resilience
Source: UNISDR, 2012

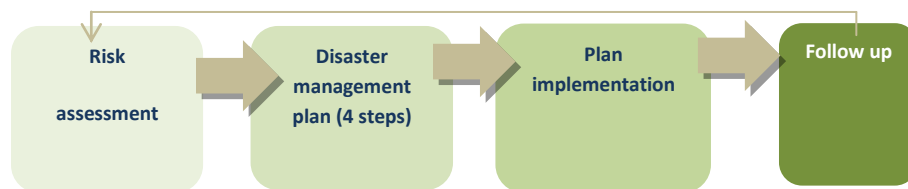


Figure3: Disaster management process

IV. CASE STUDY: HISTORIC CAIRO AND FIRE HAZARDS

4.1 Case study overview

Historic Cairo is home to a number of significant historical monuments that demonstrate the architectural wealth of the city. It is an outstanding example of an integrated urban fabric, expressing the long coexistence of different cultures and human interaction within its environment. It comprises a variety of unique settlements. As such, it was inscribed on the World Heritage List in 1979 under the title of "Islamic Cairo", recognizing its absolutely unquestionable historical, archaeological and urbanistic importance [13]. The case study is limited within the following borders "Fig. 4":

- Northern border: The northern Ayyubid wall and its two gates.
- Southern border: Bab Zuwaila and Ahmad Mahir Street.
- Eastern border: Salah Salim Street.
- Western border: Port Said Street.

The case study area is the home of distinct historic monuments that are considered masterpieces embodying incontestable architectural and artistic qualities. The area comprises fortifications and gates as Bab El Ftooh and Bab El Naser; significant mosques such as Al-Azhar, Al-Hakim; mausoleums

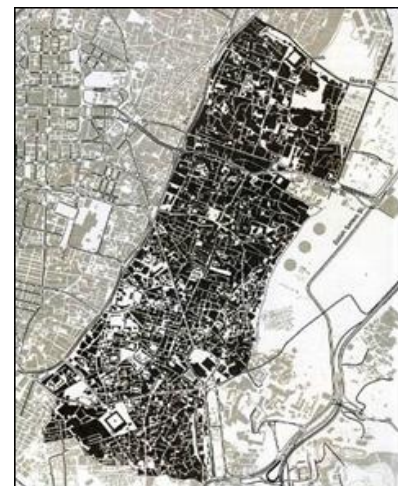


Figure. 4 Case study location

and shrines of outstanding importance to the history of monumental Islamic art. Other monuments are complex of Sultan Qalawun, the monuments of Al-Nasir Mohammad, Madrasa of Sultan Hasan, and the complex of Sultan Al-Ghuri [14] "Fig.5". Despite the fact that Historic Cairo comprises rich architectural heritage and historical fabric, it suffers from accumulated problems. These problems include socioeconomic pressures, poor infrastructure, illegal occupations, traffic and transportation issues [13].



Figure 5. Historic landmarks in the case study

4.2 Activities in the case study area

Besides being a tourist attraction, the area hosts traditional handicrafts markets as handmade tents, copper artwork, glass artwork, souvenir shops, spice market, gold market, restaurants and cafes "Fig. 6". Unfortunately, unusual commercial and manufacturing activities invaded the area, such as wholesale markets of fabrics and clothes, storages, food products, tobacco, leather, wood, paper and cardboard products, printing chemical material, manufacturing, medical supplies manufacturing plastic manufacturing, glazed pottery manufacturing, metals industries, and furniture repair [13].



Figure 6. Tradition activities in Historic Cairo

4.3 Urban fire risk and disasters in historic Cairo

Uncontrolled fire remains one of the major causes of death and property damage in today's society [15]. A fire outbreak in a densely built and highly populated urban area, will easily propagate to adjacent buildings, one after another. These occurrences are precisely problematic in historic sites where firebreak would adversely affect the historic area affecting its local and universal value. Additionally, fire outbreaks result in the loss of lives and assets of the local people, threaten the security of visitors, and finally disturb the local economy and tourism.

Unfournalty, fire outbreak is one of the most relevant threats in the case study area. Fire outbreaks caused the loss of several priceless monuments, including al-Mosafer'khanPalace in1998, when a fire in nearby vacant land being used as a garbage dump spread to wooden parts of the building, destroying it completely [13]. In 2007 fire broke out in Khan El Khalili, in 2015 the same happened in Haret El Yahood, then an oil factory in Bibarse street triggered a fire, that reached adjacent houses. More recently, in 2016 the 6th floor El Husien hospital burned (storage rooms) and El Rowee fire has brought down 238 shops and caused 82 casualties with an estimated loss of 400 million Egyptian pounds. Another incident is El Ghoria fire that resulted in burning 12 shops, estimated loss was about 50 million Egyptian pounds"Fig.7". It could be concluded that Historic Cairo is particularly prone to fire risk and no proper procedures are applied.



Figure7. Fire in Historic Cairo
Source:<http://www.dotmsr.com>

4.4 Vulnerabilities causing fire risk and disasters

Vulnerability factors participate in raising the risk possibility of fire outbreaks, therefore, understanding and analyzing such factors is fundamental in formulating risk reduction plans "Fig.8". Disaster management plans should be listed as a priority in the development or the regeneration projects in Historic Cairo. Contributing risk factors in the case study include the following "Table 1":

Table 1. Vulnerability factors participating in fire hazard in Historic Cairo

Category	Vulnerability factors
Urban form	The compactness of the urban fabric, if a fire outbreak occurs, it propagates to adjacent buildings easily, causing extensive damage in a short amount of time. Difficulty of access within the site, housing units which lack proper road access, is at high risk of not being assisted by fire engines and firefighters if fires occur. Vacant lands informally used as waste dumps, that locals burn to get rid of waste. The presence of numerous high rise buildings (most of them illegal) in narrow streets, with no access to fire fighting vehicles with ladders capable of reaching these heights.
Activities	Vast number of fire sources and fuels. The use of illegal wooden structures. Uncontrolled street vendors blocking the streets, preventing evacuation and assistance. The economic and domestic activities that use fire sources without appropriate protection measures. Illegal electricity connections causing a short circuit initiating a fire.
Facilities	The lack of adequate firefighting and mitigation facilities. The lack of fire alarms and smoke detectors in historic buildings. No automatic notification to emergency responders for prompt response, no automatic suppression systems. Very few shops owners possess working fire extinguishers. Old/poor electrical installations and poor conditions of electrical equipment that could result in a fire. No fire hydrants are available.
Maintenance and Management	Lack of evacuation plans No awareness and training programs for local residents with regards to fires and protecting lives as well as the historic buildings. Insufficient solid waste management. No hazard studies are performed to identify the most fragile zones. Post disaster assessments are performed only for historic monuments. Recover process involve removing debris, but rarely aims at reconstructing lost structures, as it is considered the responsibility of aggrieved population No training programs regarding reducing fire risks for those involved with managing historic sites. Egyptian building codes and regulations are not enforced.

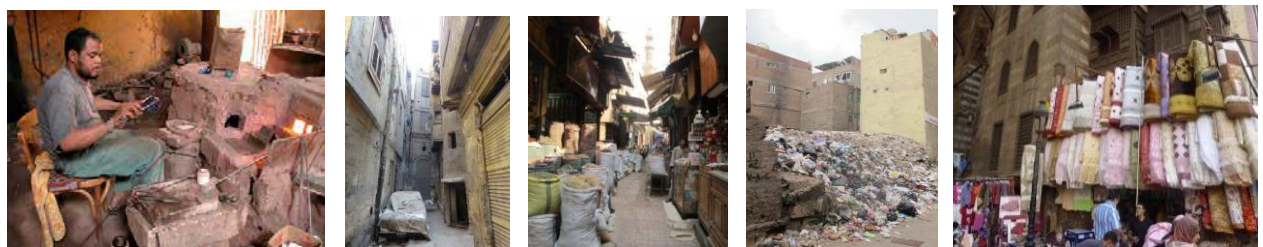


Figure 8. Vulnerability factors in Historic Cairo
Source: UNESCO World Heritage Centre, 2012.

4.5 Recommendations for a more resilient Historic Cairo

Fire Risk Management should be able to both, prevent or reduce the impact of fire on the physical environment and on human lives, as it should be able to secure resilience. A tailored fire strategy, comprising regulations, policies and voluntary efforts, should be developed with the participation of the following parties "Fig. 9":

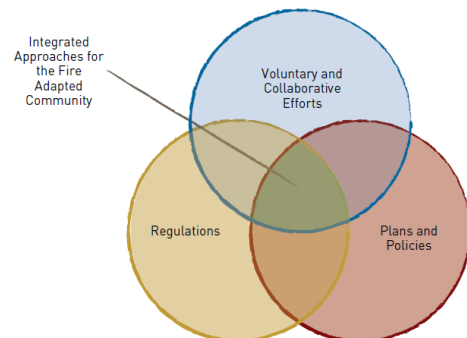
- 1- Professionals: The involvement of professionals and experts with the governmental sectors is crucial, including planners, scientists, engineers, architects, firefighting experts, socioeconomic experts, legal experts, and investors.
- 2-Community: Community must be involved in the protection of their cultural heritage. The community includes residents of Historic Cairo, business sectors as craftsmen and local businesses.
- 3- Stakeholders: Stakeholders are local and international institutions, development programs and non-governmental organizations that provide services in the site.
- 4- Media: The Media should raise awareness towards the value of the historic areas and the importance of following safety measurements.

The proposed four stage fire disaster management plan in the case study is as the following:

4.5.1 Mitigation phase

Goal: To eliminate or reduce the probability of disaster occurrence, or reduce the effects of unavoidable disasters. The interventions are:

- a) The creation of firebreak belts and space for emergency transport, roads, ensuring the permeability, to improve pedestrian mobility and accessibility for fire brigades"Fig 10".
- b) Enhance solid waste collection process, and provide official safe dumpsters.
- c) The securement of evacuation sites to be used if fire strikes.
- d) Relocate large-scale industrial and wholesale activities in other locations.
- e) Existing industrial and wholesale structures to be transformed into craft, retail or community service structures, to prevent unsafe flammable materials and fuel.
- f) Reassure that all constructions on the site correspond to building codes, buildings should apply regulations and safety codes.
- g) Prepare a vulnerability analysis and up-to-date data for the new plans.
- h) Provide public education related to conserving cultural heritage.
- i) Anticipate the level of damage that would occur according to vulnerability reasons.
- j) Provide setbacks and plot coverage to ensure that there is enough air circulation within the site, and to stop the fire flames from spreading all over and affecting other surrounding units.
- k) The adaptive reuse of monuments, listed buildings, and other buildings in the site should be encouraged, with activities that are compatible with the historic urban context.
- l) Add fire hydrants to the site.
- m) Infrastructure should be properly maintained, this includes electrical systems and infrastructure.



Figur 9. Disaster reduction plan components
Source: (FAC Coalition, 2014)

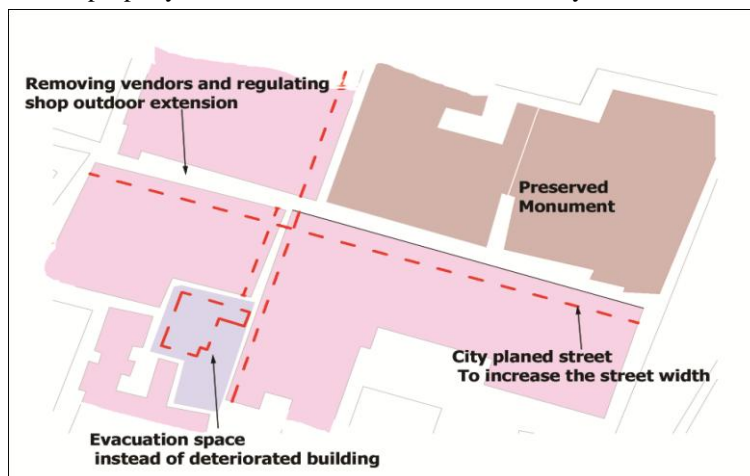


Figure 10. Redesigning an existing street in the case study to enhance its resilience.

4.5.2 Preparedness phase

Goal: To respond to any emergency situation through programs that strengthen the technical and managerial capacity of governments, organizations, and communities. Preparedness mechanisms and procedures are:

- a) Building early warning systems.
- b) Maintain appropriate infrastructure for emergency responders to undertake their work and to limit the impact of fires (fire hydrant system, reliable water supply/storage, etc.).
- c) Ensure that strategic reserves, equipment, water, medicines and other essentials are maintained.
- d) Practice emergency exercises/training; evacuation plans in cooperation with local civic defense agencies.
- e) Provide efficient mutual aid agreements.
- f) Ensure public information/education.
- g) Provide clearly designated escape routes and informative signage for residents. Signage placement should not only ensure visual clarity, but also ensure safety against acts of vandalism.
- h) Analyze the degree of emergency response difficulty, or how easy (or difficult) it is to conduct rescue activities in different spots in the site. Consider population density, building density, fire occurrence data, building/structural conditions, land use intensity, and water availability.
- i) Insure that evacuation routes are free from obstructions to ensure maximum accessibility.
- j) Insure that all buildings must meet or exceed the fireproof safety standards.
- k) Develop training, licensing for professionals, engineers and architects, as well as enforcement authorities.
- l) Continue to strengthen management and technical capabilities of those involved with managing historic sites, including capabilities related to Disaster Risk Management.

4.5.3 Response phase

Goal: To provide immediate assistance to maintain life, improve health and support the morale of the affected population until more permanent and sustainable solutions can be found. The actions are:

- a) Provide specific but limited aid, such as assisting refugees with transport, temporary shelter, food, and establish semi-permanent settlement in camps and other locations.
- b) Provide initial repairs to damaged infrastructure.
- c) Prepare a post-disaster assessment to help in the recover stage.

4.5.4 Recover phase

Goal: To help the affected population to restore their lives and provide the infrastructure that supports them. Recovery activities continue until all systems return to normal or better. Recovery measures, both short and long term are:

- a) Help to returning vital life-support systems to minimum operating standards.
- b) Provide temporary housing and the reconstruction process.
- c) Raise grants.
- d) Start in the restoration process for the damaged monuments.
- e) Offer necessary medical care.
- f) Perform economic impact studies.
- g) Prepare documentation of lessons learned.
- h) Perform "Disaster Emergency Building Risk" assessment for buildings that have sustained damage, in order to prevent building collapsing if a new fire occurred.
- i) Involve the private sector as volunteers.
- j) Provide programs to raise awareness of post-disaster recovery

V. CONCLUSION

Historic Cairo is prone to urban fires, due to the existence of multiple vulnerability aspects that amplify the fire hazard risk. The disaster management cycle presents a solution for enhancing Historic Cairo (case study) resilience. Quick interventions are required to safeguard precious monuments, valuable urban fabric and the lives of the local residents and their economy. It is found that this main problem in the case study is the complexity of the urban form, the uncontrolled activities, and the decayed infrastructure which all jeopardize the whole area. The study concluded that the area is in need of proper environmental designs to improve resilience, particularly in the mitigation phase. A phase where urban planners, designs and architectures are able to shape, alter and upgrade the physical environment to reduce the possibility of creating and spreading fire flames, since the ongoing unsupervised development processes in the historic site had increased the vulnerability to disasters. The preparedness stage likewise is not competent, as there is no focus on providing safety precautions, facility management, emergency plans. Regarding the response phase, it is limited to sending fire engines to salvage the site, while evacuation plans and local humanitarian organizations are absent. Finally, the response phase is found to be concerned principally with the historic monuments, more than the lost homes, workshop and

commercial businesses. Thus, it is recommended to consider revitalizing all aspects of the infected area. Despite the importance of disaster risk management, it is still at the preliminary stage among heritage professionals, who need to be introduced to new methodologies and principles. An integrated approach is mandatory in the field of disaster risk reduction, as it needs to be a part of the local development, to improve economic and social wellbeing. A main obstacle in Egypt is the lack of a database describing hazards and vulnerabilities creating them, therefore, it is hard to construct an efficient counter plan. Fire hazard awareness must be raised, and a collaboration of stakeholder, professionals, governmental authorities and citizens is critical to formulate a successful disaster risk plan to save our cultural heritage.

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