CZECH UNIVERSITY OF LIFE SCIENCES
FACULTY OF ENVIRONMENTAL SCIENCES
LANDSCAPE PLANNING PROGRAMME

ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE

Spatial Planning of Earthquake Disaster in Affected Cities

Master Thesis

Case Study: Spitak, Armenia

AUTHOR: BC. arch. Tovmas Khachatryan

SUPERVISOR: DOC. PETER A. KUMBLE MLA, PH.D.

PRAGUE 2020

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Environmental Sciences

DIPLOMA THESIS ASSIGNMENT

Bc. arch. Tovmas Khachatryan, BA

Landscape Engineering
Landscape Planning

Thesis title

Spatial Planning for Earthquake Disaster Mitigantion in Affected Areas: Case Study Spitak, Armenia

Objectives of thesis

The main objective of this masters thesis project is to use the urban disaster prevention approach to formulate a design proposal for the city of Spitak, Armenia. With this, the research and design goal aims at creating an effective emergency shelter system and a continual relief corridor.

To address the aim, there are two research questions:
1. How can a relief zone contribute to mitigating a post disaster scenario?
2. How to use this relief zone or evacuation zone for preventative disaster planning and design in Spitak and elsewhere.

Methodology

1. The student will conduct a thorough review of current literature on planning for disaster recovery in crisis zones, specifically focusing on earth quake mitigation. Literature should be exploring techniques used for pre disaster and post disaster strategies.

Original student work will investigate public policies for pre event safety such as the administrative structures necessary to ensure a rapid response once an event takes place to minimize loss of human life. Literature should also detail how to better plan urban areas (building codes, scale of open spaces and streets, and other infrastructure) for post event disaster recovery. Literature should be exploring recent events in New Zealand, Japan, Philippines, Indonesia, USA, and Armenia and other locations.

From this, the student will make a few different scenarios for his site based on his readings and then compare each in greater detail, using references to literature to support these proposals.

2. Case Study: Spitak Armenia

3. Proposed planning and design solutions as well as administrative policies that local and state government must implement to be better prepared for future crisis.

The proposed extent of the thesis

60 pages

Keywords

earth quake, disaster relief, preventative planning

Recommended information sources

Nichols, D.R. and J.M. Buchanan-Banks. Seismic Hazards and Land Use Planning. 1974. US Department of the Interior, Geological Survey Circular 690. Colorado: Denver.
Olshansky, Rovbert. B. 2001. Land Use pLanning for Seismic Safety: The Los Angeles County Experience 1971-1994. APA Journal. 67:2. pp 173-185
Saunders, Wendy, S.A and Margaret Kilvington. 2016. Innovative land use planning for natural hazard risk reduction: A consequence driven approach for New Zealand. international Journal of Disaster Reduction. 18: 244-255.
William Spangle and Associates. 1980. Land Use Planning After Earthquakes. National Science Foundation Grant. OPRM. Washington: DC

Expected date of thesis defence

2019/20 SS – FES

The Diploma Thesis Supervisor

doc. Peter Kumble, Ph.D.

Supervising department

Department of Land Use and Improvement

Advisor of thesis

Henry Hanson

Electronic approval: 18. 3. 2019
prof. Ing. Petr Sklenička, CSc.
Head of department

Electronic approval: 9. 3. 2020
prof. RNDr. Vladimír Bejček, CSc.
Dean

Prague on 19. 06. 2020

ACKNOWLEDGEMENT

Hereby, I declare that this diploma thesis is a presentation of my original research work and that no other sources were used other than what is cited.

Prague ....
(author’s signature)

PREFACE

I offer my utmost thanks to my thesis advisor, Doc. Peter A. Kumble MLA, Ph.D who has provided guidance, support and thoughtful comments all the way through the past year of my graduate journey. This research thesis could not have been completed without his advice and encouragement. I am also grateful to everyone with whom I consulted and offered their precious suggestions on how to improve my thesis. Finally, my appreciation goes to my parents and friends for their consistent encouragement, love and support throughout my study.

Abstract

Human security is one of humanity's most significant issues today. In the last century, given the frequency and severity of earthquakes, regional and Armenian solutions to earthquake and disaster mitigation have been given more attention. Armenia is one of the world's earthquake-affected countries, and Armenians and urban planners have increased attempts to minimize its disastrous effects. Therefore, developing and enhancing existing and successful urban disaster reduction public space played an essential role in disaster preparedness. Lessons from the Spitak Earthquake in Lori district and other instances indicate that city parks and green space played a significant role in evacuating refugee disasters and preventing the spread of after-shock flames. In this thesis, I introduce a new design concept, the Earthquake Disaster Relief Corridor, as a method for disaster relief by open space construction. European and Japanese disaster response literature used to gain experience in protection, disaster victims rescue, and restoration disaster recovery.

Keywords

Disaster, mitigation, relief, earthquake, urban, corridor, Armenia.

Abstrakt

Lidská bezpečnost je jedním z nejvýznamnějších problémů dneška. V posledním století, vzhledem k četnosti a závažnosti zemětřesení, byly regionní a arménské sdělovače zemětřesení a zmírňování katastrof dány málem pozornosti. Arménie je jedním z největších světových zemětřesením ovlivněných zemětřesení a Arméni a městští pronásledovatelé zvýšili pozornost, aby minimalizovali své katastrofální účinky. V důsledku toho, rozvoje a posílení stávajících a úspěšných redukcí městské katastrofy došlo k zásadní rétorice v oblasti preparedness katastrofy. Méně než zemětřesení Spitak v okrese Lori a další případy naznačují, že městské arkarky a zelené space byly významnými rvačky při evakuaci uprchlických uprchlíků a při prevenci plamenů následného shaloru. V této diplomové práci představuji nový design s názvem Relief Relief Relief Relief, který je metodou pro pomoc při katastrofách způsobenou strukturou. Evropská a evropská janeánská literatura o katastrofách využívaná k získání experience v protection, záchraně obětí katastrof a restroratio katastrofě obnovení.

Kličová slova

Katastrofa, zmírnit, úleva, zemětřesení, městský, corridor, Arménie.

Table of Content

1. Introduction

Regional disaster problems have confronted a more complex situation ever since the 20th century. People are giving more and more attention to the prediction and prevention of disasters. On the one hand, certain natural factors such as global climate change and tectonic activity in a new active era, floods, earthquakes, tsunami, and other natural disasters have occurred more often. The 1960 Valdivia earthquake, the 2005 American Hurricane Katrina, and so on, for example.
On the other hand, while the city population and density were overgrowing, the threats of urban disasters were also increasing at the back of urban development. The urban development has increased the risk and loss of urban accidents to some degree. The earthquake tragedy was one of the many natural disasters that could do the worst harm. The statistics show that Asia, then America, Europe, Africa, and Oceania, have been the worst hit by natural disasters over the last 100 years.

In Asia, the number of natural disasters exceeded its height in 21 century: around 17,000 deaths in the Indian earthquake of 2001, 87,000–100,000 deaths in the earthquake of 2005, more than 300,000 deaths in the tsunami of 2004; nearly 140,000 deaths in the typhoon of Burma in 2008, more than 80,000 deaths in the earthquake in China in 1976 and etc.
The scientific community has evidence on five earthquakes in Armenia, and the worst in 1268 was in Ilkhanate, Antioch, and about 60,000 lives taken.
We do recognize that natural disasters always predicted, but we can minimize hazards. The first and swift relief was critical after the earthquake. The rescue group had decided that "golden 72 hours" was the safest time to rescue during disasters. In the "golden 72 hours," they felt that the patients had an extreme mortality probability. But, the earthquakes have always destroyed the roads, cables, water and sewerage infrastructure.

Before the writing process begins, I started my research on this topic, gathering data, reading articles and papers. The process's starting point was through literature. Then in the thesis, I'll clarify why I chose Spitak as the case study and why building a region is a safe way to mitigate the earthquake damage. It also clearly illustrates why Spitak is chosen as a case study and how to create a place by reducing earthquake risks. I'll also provide answers to questions about what definitions I'm using and how the current land-use clashes with my proposed region, etc. Eventually, I'll explain how I collected data and evaluated the interview and knowledge database results. How can Spitak relief zone be planned?

2. Aim and research question

Hence my main aim in this thesis was to use the urban disaster planning method to devise a design plan for the Lori district, Spitak's central city area, to create a successful emergency shelter network, a continuous relief corridor, and modern practical architecture. This thesis contains two research questions:

Question 1. How can a relief zone contribute to disaster mitigation?

The theoretical analysis is going to answer this question. There are three things to be discussed: Disaster reduction park network, spatial cognition, disaster evacuation human behavior. The value of disaster prevention will address, focusing on the literature review and case study. I will also examine the approach to urban risk management and catastrophe avoidance in Germany, Japan, and China from these documents and can help to have clear guidelines on the avoidance of environmental accidents accessible public space and in planning plans, extract specific strategies for its execution.

Question 2. In the case of Spitak, Lori, Armenia, how can a relief zone be designed?

The new design of the urban disaster relief area, in the form of a design plan in the district of Lori, Spitak, will answer this question. In emergency management preparation through the urban development and earthquake disaster relief road. The research will clarify how the training and corridors for disaster prevention operates within the study area.

3. Literature review

3.1. Earthquake Disaster and Mitigation

3.1.1 Urban Disasters

Disasters are bringing chaos to every point on the earth every year with different levels of destruction. The history of human civilization is also a history of human struggle with disasters (Wang, 2011). Globally, some countries have solved the consequences of catastrophes well. However, on the other hand, it still nearly impossible to predict some disaster, and a severe aggravation still exists in many parts of the earth. The worse thing is that the impulse of the worldwide urban disaster was hard to compose, and the overall tendency was still degenerating. For example, those countries which stimulated dynamic development and enrichment urbanization had a significant issue with this situation. (Zhang, 2004). The city is a symbol of human civilization, but also the natural result of human destruction. (Zhang, 2004).

Although however, there are different types of disasters: tsunami, hurricane, tornado. earthquake disaster can bring enormous damage this type of disaster can result in the most massive loss of life and property, especially in Asian counties, where the number of earthquakes is considerable, especially in Iran, China, and Indonesia. (Wang, 2011).The main the problem for these counties is that locate at the active belt of crustal movement. The earthquake can cause the construction to collapse, damage the equipment, floods, fires, gas diffusion, the spread of plague, explosions, and other secondary distractions.
The worse is the ground movement of a strong earthquake can also trigger other geological disasters such as mudslides, landslides, and ground liquefaction, which can amplify thedestruction of constructions collapse and be a cause of massive damages. (Wang, 2011). In this chapter, will be presented the urban disaster and urban disaster reduction, the secondary earthquake disasters and the earthquake disaster mitigation in the night, the current situation of the earthquake disaster, and share the experiences of different countries, their solutions of trying to predict or how to struggle with earthquake disaster.

As the definition of the urban natural disaster is made clear, disaster studies and tactics for disaster prevention and mitigation, such as the formulation of a countermeasure or a government policy, become more productive.
(Yoshiaki Kawata,1995, p1).
First, let us start with the definitions of the " city," and how the settlement is becoming "city." Mostly, the description of a city is giving according to the range of the population. In 1947 in Japan, it must have 30,000 or more population to be a city, but this number increased in 1954 to 50,000 or more. Nowadays, there are more than 200 cities with 100, 000 or more population. On the other hand, there is still no exact global definition of the city. (Yoshiaki Kawata,1991, p2).The bigger the city is, the larger the disaster prevention potential is, this relationship, however, cannot be applied to our society.
(Yoshiaki Kawata,1991, p2).

Li (2001) defines that city as a disaster body, caused by natural, human-made, or both of the reasons that damaged the urban ecological environment, materials, construction, and development of the humanities, especially brought harm to life and property (Li, 2001, p1). The city is a compositely artificial ecosystem by natural, social, and economical.
The intensive population and property, various types of production, and living facilities are associated with each other, which makes the city extremely fragile when face with disasters (Li, 2001, p56).
Kawata (1991) has identified four fundamental reasons that illustrate the phenomenon of what is a disaster:

1) Disaster is a phenomenon that occurs intermittently with low or high frequency. In particular, an extreme force that causes catastrophe occurs at a low rate, so it difficult to maintain investment in disaster prevention.
(Yoshiaki Kawata,1991, p3)

2) Disaster countermeasures against new types of damage rarely carried out as a future investment.(YoshiakKawata,1991,p3

3) Total maintenance of city infrastructure is an imbalance because of the population and societal capital concentrate rapidly within a short period.

4) There is a significant risk of occurrence of a phenomenon whose law of causality is unclear; however, predicted results by simulation could not be applied because available modeling is appropriate.
(Yoshiaki Kawata,1991, p3).
From these points, the following classification can develop according to the characteristics of an urban natural disaster. According to these points, Yoshiaki Kawata (1991) define three rankings of an urban natural disaster:

Urbanizing natural disaster: disaster occurring during the period that residential areas and urban infrastructures develop in rural areas. This type of disaster is mostly seen now in developing countries, because of the natural the environment which is not artificially controlled, that is why it can refer to as a disaster controlled by the natural environment.

Pseudo-urban natural disasters: this one is a disaster with less human impact, though urban infrastructure, especially the lifeline system, is a collapse. The typical example of this type of disaster is in San-Francisco, California, by the Loma Prieta earthquake of 1989 and in Sendai by Miyagiken-Oki earthquake of 1978.
(Yoshiaki Kawata,1991, p4).

On the other hand, generally, urban disasters can divide into two parts: natural and human-made disasters. First, a natural disaster is complicated to predict and monitor; mainly, it can only be passive preclusion, and the earthquake disaster is the first on the list of being unpredictable.
(Xie, 2004)

However, human-made disasters are the opposite; they are predictable and controllable; in a case, that right methods and actions can take in time.
(Xie, 2004).

As a consequence, disaster reduction or prevention is the critical measure for natural disasters, rather than avoiding them.

Generally speaking, city-related natural disasters include earthquakes, fires, floods, storms, and other geological disasters. (Xie, 2004).
From ancient time's human civilization and urban disaster always was in disparity. The urban disasters, huge damages, collapses of cities, and worldwide deaths were a reflection of the people's awareness and action to prevention theses disasters. Now, more and more countries accepting urban disaster linked to the fact that people were less informed about the actions and awareness of disaster prevention. That is why nowadays, more and more volunteers, civil government, and public organizations devoted themselves to spread and inform people knowledge, and actions about disaster prevention or reduction and evacuation. (Wang, 2011).

This way is synchronizing people and the urban environment, and it is not a dream anymore, that society will be in harmony with the situation. (Xie, 2004).
As is already know, urban disasters can be a cause of massive destruction and deaths.

3.1.2. Dangers of urban disaster

Firstly, it harms citizens and visitors, different types of disease, and death. Second, disasters have a disproportionable effect on urban areas. Weaknesses not readily apparent in pre-disaster times surface as longstanding structural and substantive problems become prominent: environmental abuses are exposed; the local economy falters; municipal services collapse; social and political rifts widen, and cultural resources that give identity to such places disappear (Birch, 2006) .

The worst while the urban disasters can be visible, at the same time, it is harming dwellers and socio-cultures. The issue is that any destruction can recover. Still, psychological and spiritual-cultural damage of people is complicated to recover in a short period, and the psychological impact on a specific population becomes a significant problem because they would care in their whole lifetime. (Liu, 1996). Another aspect of this problem of physical damage is the transfer and regularity of the psychological impact. It means that the psychological effect of urban disasters could be spread quickly from the harmed sites to the non-harmed areas, which is transitivity that will damage the typical region's life cycle. In the same way, the victims would transfer, record, or share the effect of disasters through writing, language, and other methods. (Alba-Bertrand, 2003).This kind of psychological impact may continue existing in the next generations, which is continuity (Liu, 1996).

During any disaster, the city's vulnerability is very conspicuous, and the economic losses, the toll of dead and injured becoming an enormous problem for cities. Moreover, the big question is not only population but also the functioning of the city network because if that city is very strong integrated into city function, the failure of one will be the reason for other systems collapse. The simple example is the pipeline infrastructure damage and traffic disruption during building destruction. (Jiang, 2005).Dwellers have a pressing need for the city's function, so that kind of network collapse can be the reason for social chaos. Those cities which play essential roles in national economic construction, such as the National capital and the financial center cities, once they are in the event of catastrophic damage, its influence would not only affect the city itself but also spread to the whole country, even to the world (Jiang, 2005).

Nowadays, the losses and damage caused by natural disasters increased each year in the world. Taking into account the report of EM-DAT, which includes all worldwide disasters from 1993 to 2013, almost 6,873 natural disasters happened in this period, which claimed 1.35 million lives or nearly 68,000 lives on average each year and affected 218 million people on average per annum during these 20 years. (EM-DATA Database,2016).
Specifically, tsunami and earthquake killed more people than all other types of disaster put together, claiming nearly 750,000 lives between 1994 and 2013. Tsunamis were the deadliest sub-type of the earthquake, with an average of 79 deaths for every 1,000 people, compared to four deaths per 1,000 for ground movements. This makes tsunamis almost twenty times more deadly than ground movements.
(EM-DATA Database,2016).

Moreover, according to the same EM-DAT data, China and the USA had the highest number of disasters between 1994 and 2013, due to their scale, population density, and landmasses. On the other hand, among the continents, Asia is in first place with disaster numbers and affected population, with 3.3 billion in India and China alone. However, to present to quantity if people affected per 100,000 head of population, the Mongolia and Eritrea were the most -affected countries in the world. Essential human losses in absolute terms and relative to the scale of its population due to the toll of the 2010 earthquake.
(EM-DATA Database,2016).

3.2. Disaster risk reduction
3.2.1 Case study: China

The largest project is in the Natural forest production area and the other parts, mostly under forest protection projects. The main goals of the program are protecting stable and forest, as well as controlling the sand storm. Anti earthquake and water storage programs are also one of the main aims of the disaster reduction project in China. The main water storages located along two main rivers on the eastern part: Yellow and Yangtze River, which has an enormous role for water crisis driven by population rising. The main antiearthquake cities, such as Sichuan Province, Shandong, are located in the middle and eastern parts of the country. Disaster reduction urban planning is a general planning designation of precaution against earthquakes, floods, wind disasters, and other natural disasters. It concludes urban anti-fire planning, urban anti-flood (tide flood) planning, urban antiearthquake planning, civil air defense, and so on (Jiao, 2006).

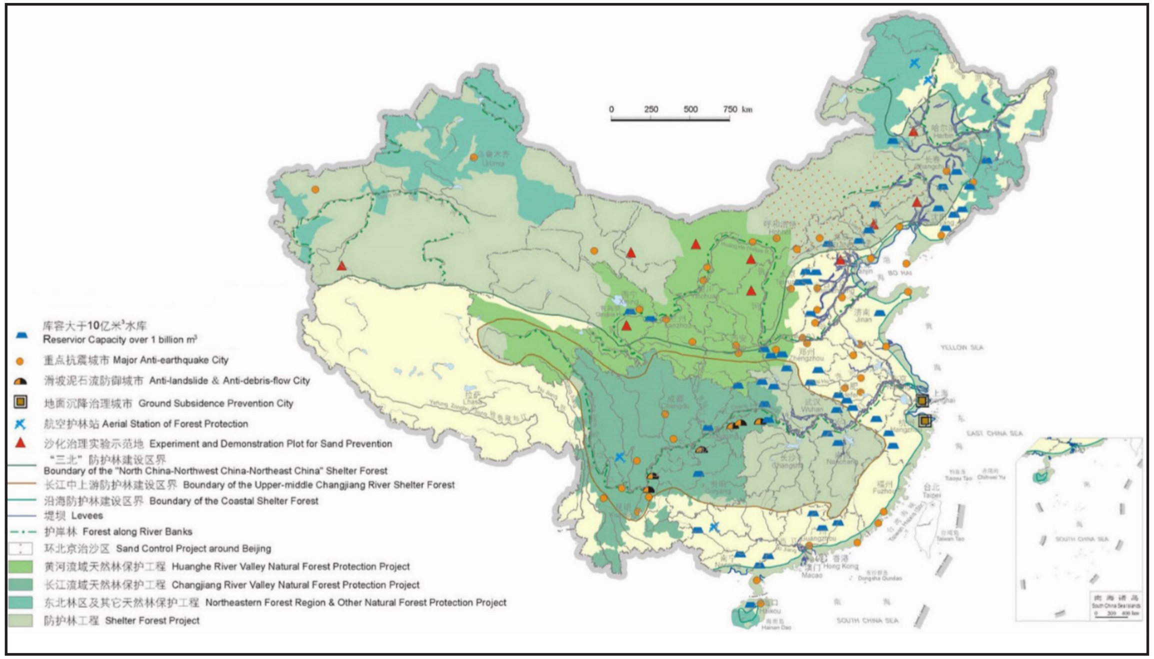


Figure 1: Distribution of Key Projects for Natural Disaster Reduction in China
Source: Shi Peijun, Atlas of natural disasters system of China, 2003

From a full view, urban planning of disaster reduction refers to various countermeasures that, based on the overall land planning and preservation, taken the common construction planning purposes as the goals, prevented or reduced disaster losses and avoided extensive damages, etc. (Li, 2001).
Urban disaster prevention project is not including anti-earthquake cities or water storages, but also should seriously take into account the land use of disaster areas, topography, relief facilities, a combination of public space and refugees, and as not less important the urban transportation system. (Xie,2003).
Globally, urban or spatial planning for urban disaster reduction referred to specific measures to prevent disaster, by increasing the number of municipal shelters and facilities, reconstruct and re-newal old buildings and providing anti-fire green belts, and designing more green space and wide roads. Also, anti-disasters inspection should add to the urban planning acceptance (Wang, 2005).

3.2.2 Disaster risk reduction in Latin America

Degraded ecosystem and poverty, both badly planning and management of urban resources result of disaster risk, in the context of urbanization.
The process called The Disaster Risk Reduction (DPR) in some cities in Latin America shows the results of making risk reduction as one of the main parts of local urban development. One of the main points is the excellent information about risk assessment, cooperation between dwellers and government, and linkage between regional, provincial, national levels. (ELLA, 2017).
DPR process has excellent examples of integrated risk management in different cities' development plans in Latin America. Some of the most advanced developed systems of DPR integrated and developed in Colombia. Moreover, disaster prevention as a factor of urban development and the spatial plan has been integrated into the cities of Manizales and Bogota. (ELLA, 2017).

The ELLA (2017) defined several actions that should be taken for Disaster Risk Reduction process:
Risk mapping: it illustrated the risk map which contains information about weather, the characteristics of area and infrastructure. Micro-zoning: it includes information on risk distribution, regions with similar risks, the map which shows the type of construction and infrastructure.

Updating building codes: contain information about building characteristics.

Land-use regulations: prohibit or limit urban development in hazard-prone areas

Retrofitting: reconstruction and modifications for existing buildings. (ELLA, 2017).

Innovative security devices for low-income groups: risk transfer tools for those that cannot access individual protection for their assets. Engagement: include low-income affected groups living in high-risk zones.
One of the benefits of DPR programs is the integration of civil society education, and with different stakeholders' collaboration to decrease the vulnerability of disasters.
A good example is a joint action, which idea relocated to the people who were living on steep slopes to a safer place, which successfully have done by good collaboration between government, university, and community groups.
Moreover, the same groups redesigning the land into parks and stabilized the slopes, which become significant relief corridors. (ELLA, 2017).
The different program called Slope Guardians, which provide training to 112 household women living area risk zones for raising awareness, various projects for slope stabilization, problems, and communicating report skills, to others.

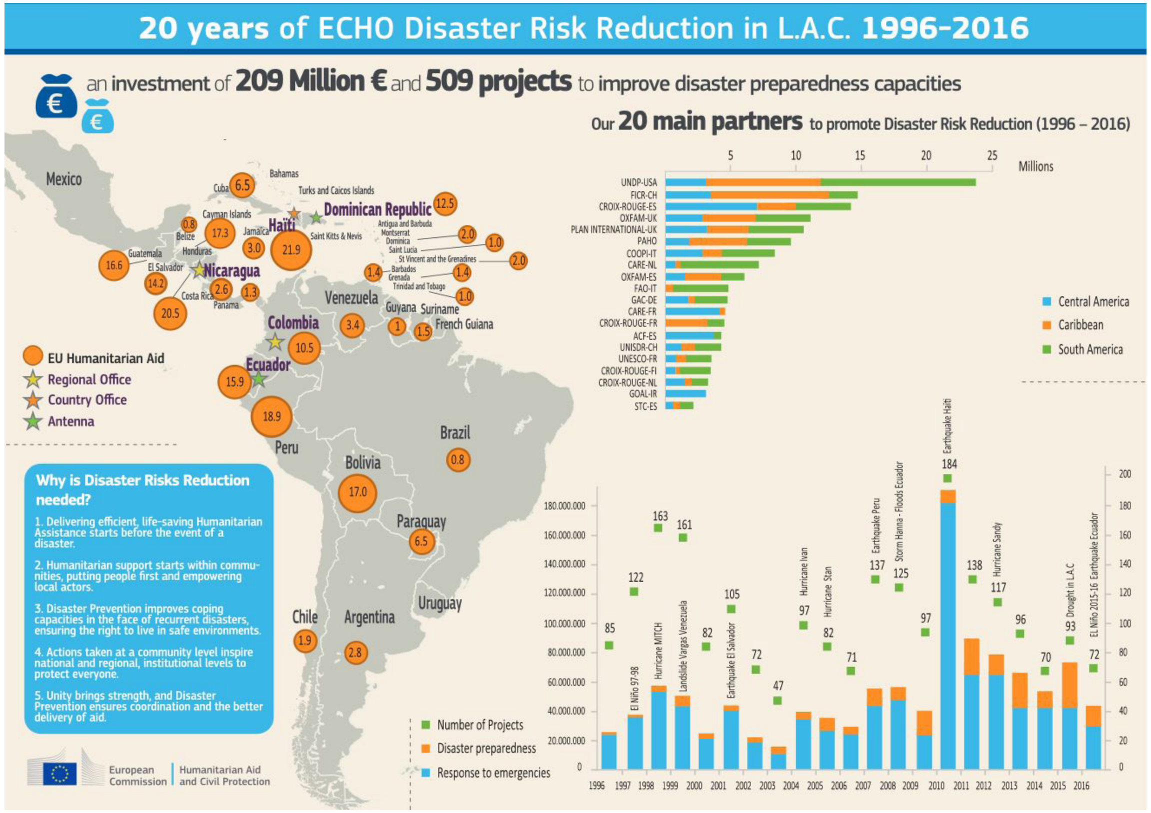


Figure 2: 20 years of ECHO Disaster Risk Reduction in L.A.C. 1996 - 2016
Source: https://ec.europa.eu

Government and other NGO's providing a team of professionals, engineers, and technicians who are supported for environmental management and sustainability. (ELLA, 2017).
Also, there are some NGOs programmed that even the government wants to adopt. A good instance is a program launched by Doctor Without Borders organization, whose purpose is subduing society health vulnerability due to natural disasters. This program evolved into a reason to improve drainage systems,vegetation, slope stabilization, building reconstruction, waste management. (ELLA, 2017).
Another excellent experience of NGO's, government and locals collaboration proved the ability to learn the skills from past problems and disasters. 2003 and 2007 are the years of flooding in Sante Fe, Argentina, which showed the absence of civil and emergency actions for risk reduction from the government. On the other hand, the NGO Canoas, which was the local NGO, realized the importance of risk reduction while providing emergency aid after floods. (ELLA, 2017).
As the other NGOs they Canoas also started providing awareness programmed in five districts, with risk reduction training, preparation of community, and emergency maps. In 2009-2010 they experienced their knowledge during a new flood in the same city, and the results showed that the preparation level of Canoas was pretty high, and also, the government actions were through the whole town. (ELLA, 2017).
As a result, the importance of civil society has been significant and very high, with discussions on risk disaster topics, and forming new proposals and suggestions for underlying the importance of risk factors. One of the critical organizations of conferences was Network for Social Studies in Disaster Prevention in Latin America cites. They have a unique database of disasters at all scales. In some cases, the data can be used for better understanding some actions on risk disaster, and how accident triggers others can be the reason for multiple disasters, rather than formulating it as an only one massive disaster. (ELLA, 2017).

3.3. Earthquake disaster and current situation

3.3.1 Earthquake disaster

Since the 1960s, taking into account data of the UN, the economic wound caused by the disasters had been quadrupled. Moreover, compared with other types of catastrophe, earthquake disasters made the most life and capital loss. Mainly, the urban areas located on the earthquake belt zones can be caused by colossal destruction, even the collapse of whole cities(Fan, 2002).The earthquakes catastrophic explosions on the urban survival lifeline network system make the city function disappear, and the urban living is on the brink of paralysis (Fan, 2002). The earthquake has mainly three types of fault, and all these types can be a reason for interpolating earthquakes: standard, reverse, and strike-slip.Two of them nearly the same: normal and reverse. These two types of fault are examples of dip-slip. In these types, the displacement along the error is in the same direction of dip, and vertical movement.

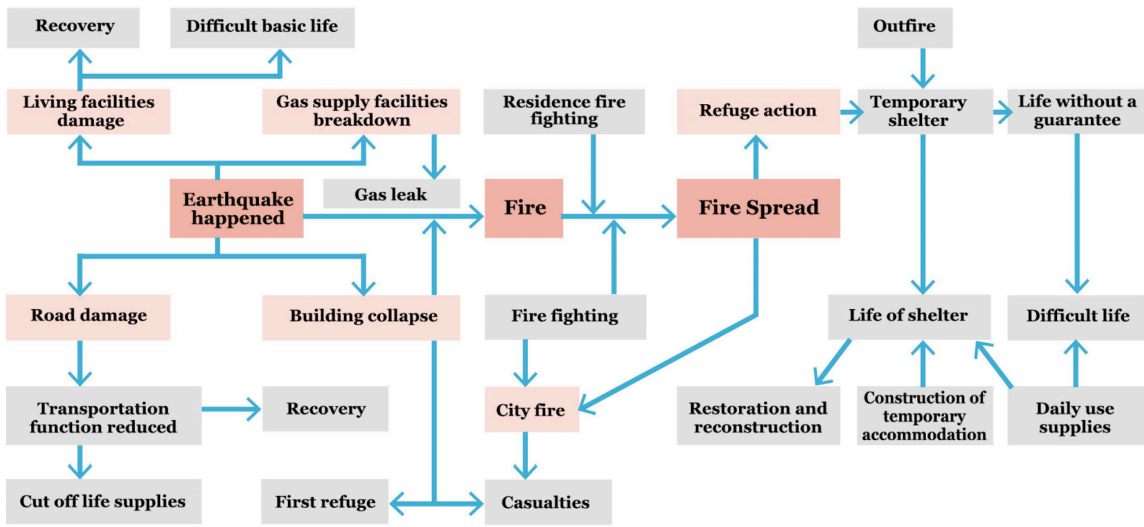


Figure 3: Earthquake disaster state diagram
Source: Sun Jian, Study on Design of Urban Disaster-prevention Park, 2010

Normal faults mainly happening in zones where the shell stretched such as divergent boundary, on the other hand, the reverse defects can occur in zones, where the tank is being compressed such as divergent boundary, on the other hand, the opposite errors can occur in zones, where the container is being compressed such as a concurrentboundary. (Ohnaka, M. 2013). The strike-slip faults are different from the previous two. This type is more steep structures, where two pieces of the failure slip horizontally past each other. (Ohnaka, M. 2013). Also, there is a type of slip called oblique-slip, this is a component of dip-slip and strike-slip faults, and these two can because of many earthquakes. (Ohnaka, M. 2013).Mainly reverse faults are associated with the strongest earthquakes and megathrust earthquakes, which magnitude is mostly 8.0 or more. On the other hand, the strike-slip flaws, mainly continental transforms, associated with earthquakes up to 8.0, and the common mistakes are usually less than seven magnitudes. The dangerous thing is that every unit increase in magnitude is roughly thirtyfold risen in the energy released. For example, the magnitude 6.0 earthquake can release nearly 30 times more potent than a 5.0 the magnitude and the earthquake with a 7.0 magnitude can release 900 times more energy than 5.0. The fascinating The exciting fact that 10.000 atomic bombs like those used during WW II can release the same amount of energy as an 8.6 magnitude earthquake.
(Wyss, M. 1979).

3.3.2. Current situation of earthquake disaster

As figure 4 illustrates, the worldwide earthquake disasters happened from 1900 - 2017. The countries such as the USA, Indonesia, Japan, China, and Latin American countries have a significantly high number of earthquake disasters. The highest amount of earthquakes disaster happened in Latin America and Asia. The earthquakes with 9.0 or higher magnitude happened only five-time, two of them in both America continents, and 3 of them in Asia. On the other hand, countries such as Russia and African countries have a slight risk of earthquake disasters. And the Greenland is no exception. There didn't happen any earthquake during this period.

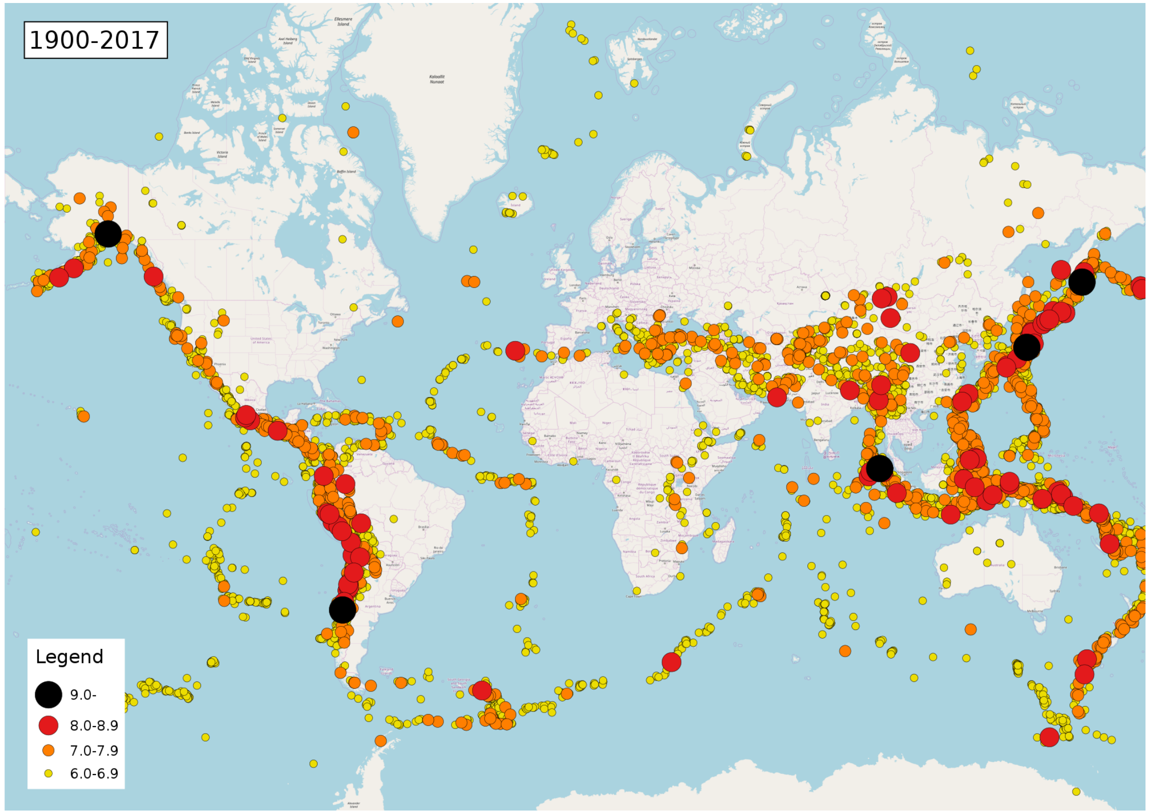


Figure 4: Earthquakes from 1900 - 2017
Source: earthquake.usgs.gov

The global seismic hazard map (Figure 5) illustrate the zones with high and low earthquake disaster risk. As it shown, the western part of both Americas have a significant risk of earthquake disaster. The middle and eastern Asia also has a very high chance of earthquakes. The Pacific zone is one of them, and the only 80% of earthquakes on each are happening there. The other one with 15% of global earthquakes is the Eurasian zone or Mediterranean-Himalayan belt. But as it mentioned upper, the northeast part, close to Artantida has a shallow risk of this type of disasters, such as central Africa, Greenland and western parts of both Americas.

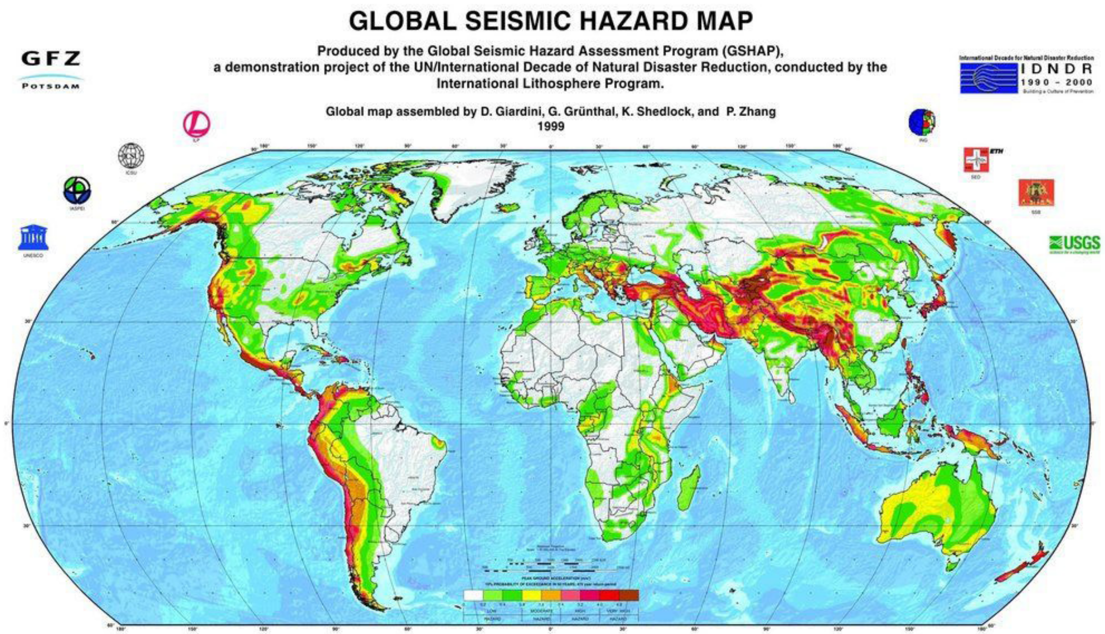


Figure 5: Global Seismic Hazard Map
Source: GSHAP-World Map of Seismic Hazard (Giardini et al., 1999; Shedlock et al.,

3.3.3. Lists of 21st-century earthquakes

List of costliest earthquakes				
Rank	Damage (USD)	Magnitude	Location	Date
1	360 b	9,0	Japan	1-Mar-11
2	150 b	7.9	China	12-May-08
3	140 b	6.1	New Zeland	22-Feb
4	28 b	6.8	Japan	23-Oct-04
5	16 b	6.3	Italy	6-Apr-09
6	15,8 b	5.8	Italy	20-May-12
7	15 - 30 b	8.8	Chile	27-Feb-10
8	10 b	7.8	Nepal	25-Apr-15
9	7,8 - 8,5 b	7,0	Haiti	12-Jan-10
10	7,5 b	7,0	Japan	16-Apr-16

Figure 6 : List of costliest earthquakes
Source: Statista.com

List of Deadliest Earthquakes				
Rank	Fatalities	Magnitude	Location	Date
1	316,000	7,0	Haiti	12-Jan-10
2	227,898	9,1	Indonesia, Indean Ocean	26-Dec-04
3	87,587	7,9	China	12-May-08
4	87,351	7,6	Pakistan	8-Oct-05
5	26,271	6,6	Iran	26-Dec-03
6	20,896	9,0	Japan	11-Mar-11
7	20,085	7,7	India	26-Jan-01
8	8,964	7,8	Nepal	25-Apr-06
9	5,782	6,4	Indonesia	26-May-06
10	4,340	7,5	Indonesia	28-Sep-18
11	2,968	6,9	China	13-Apr-10
12	2,266	6,8	Algeria	21-May-03
13	1,313	8,6	Indonesia	28-Mar-05
14	1,115	7,6	Indonesia	30-Sep-09
15	1,000	7,4	Afghanistan	3-Mar-02

Figure 7 : List of deadliest earthquakes
Source: Statista.com

List of Largest Earthquakes by Magnitude			
Rank	Magnitude	Location	Date
1	9,1	Indonesia, Indean Ocean, Sumatra	26-Dec-04
2	9,0	Japan, Tohoku, Pacific Ocean	11-Mar-11
3	8,8	Chile, Maule	27-Feb-10
4	8,6	Indonesia, Sumatra	28-Mar-05
5	8,6	Indonesia, Sumatra	11-Apr-12
6	8,5	Indonesia, Sumatra	12-Sep-07

Figure 8 : List of largest earthquakes by magnitude
Source: Statista.com

Largest Earthquakes by Year				
Year	Magnitude	Deaths	Location	Date
2019	8,0	2	Peru	26-May
2018	8,2	0	Fiji	19-Aug
2017	8,2	98	Mexico	8-Sep
2016	7,9	0	Papua New Guinea	17-Dec
2015	8,3	14	Chile	16-Sep
2014	8,2	6	Chile	1-Apr
2013	8,.3	0	Russia	24-May
2012	8,6	10	Indonesia, Indian Ocean	11-Apr
2011	9,0	20,896	Japan	11-Mar
2010	8,8	525	Chile	27-Feb
2009	8,1	192	Samoa	29-Sep
2008	7,9	87,587	China	12-May
2007	8,5	23	Indonesia	12-Sep
2006	8,3	0	Russia	15-Nov
2005	8,6	1313	Indonesia	28-Mar
2004	9,1	227,898	Indonesia, Indian Ocean	26-Dec
2003	8,3	0	Japan	25-Sep
2002	7,9	0	United States	3-Nov
2001	8,4	145	Peru	23-Jun

Figure 9 : List of largest earthquakes year
Source: Statista.com

3.3.4. Secondary disaster

The definition or meaning of secondary disasters is initiated by a primary disaster like tsunami or fire prompted by an earthquake disaster. In most cases, the secondary disaster can be more dangerous and cause many more problems and deaths than a primary disaster. (http://www.businessdictionary.com/definition/secondary-disaster.html#ixzz2xAJKNV1A) . Landslides, mudslides, floods, fires, tsunamis, epidemics, gas leaks, the diffusion of radioactive substances, explosions, etc. are the type of secondary disaster type caused by the earthquake. It means the series of different disasters prompted by the earthquake disaster, and as a the result, it can be the destruction of buildings or infrastructure, ground collapse, or cause problems of the lifeline system. Mainly, buildings, facilities or any structural collapse can be the cause of secondary disasters, and that's why secondary disaster is more dangerous than a primary disaster. During the earthquake disaster, the possibility of destruction to structures or facilities increase rapidly. (Sibson R.H., 1982).

Fire is the most regularly seen and the rigorous secondary disaster which can be prompted by an earthquake disaster. The cause of the light can be some explosive substances, any hazardous materials, gas leakage and electricity, and also broken ovens in buildings, which can be caused by strong vibrations. (Scawthorn, Charles 2005).

The main principle of the tsunami-generating or forming is the displacement of a large volume of water of the sea, and this displacement is mainly caused by earthquakes,

volcanic eruptions, or landslides. Usually, the seismic point or zone should be within 50kiloneters or more under the sea, and 6.5 Richter earthquakes are enough for forming a tsunami. (Wells, John C. 1990).

Fluctuations that can be originated by the earthquake disaster can be the cause of the floods.

Generally, the flood is an overflow of water from river banks. Intense waves can quickly destroy any dams and houses located near a water beach or bank. (Jay (2011). Of course, a tsunami is a hazardous type of disaster for marginal areas, but the freezing disaster type is also dangerous if the earthquake happened in winter. Also, there are different types of secondary human-made disasters for example" blind suspension " of wrestling, squeeze, trampling which happening when people, for example, jumping from the buildings during the earthquake, or they are gathering in public spaces. (Zhong,2008). There are also new types of secondary disasters, one of them is "glass rain" disaster which can occur after the collapse of skyscrapers or high-rise glass structures, the other one is "memory destruction " disaster which can be generated by the damage of information storage system, etc. (Zhong,2008).

3.3.5 Secondary fire disaster

As it was already mentioned, the secondary fire disaster is the most dangerous and most common among the others. This type of disaster has caused the most losses in the USA and Japan. It is a crucial problem, mostly for Japan.
The example is a great earthquake that happened in Kanto in 1923, where 90% of deaths caused by fire disaster.
The earthquakes in 1983 and 1984 in the US are examples of how much danger can be fire after the earthquake. (Zhao, 2008).
Fire following earthquakes in 1949 in Los Angeles and San Francisco in 1989 caused huge losses of human life and property. The scenario for the post-earthquake fire must consider structural and structural damage, initial and spread fires, wind, building density, water.(Jiangrong, 2008).
The construction area is the essential factor of the occurrence of earthquake fire, in a case when the density of buildings and population is not very close to each other. It can be assumed that "The incidence of the secondary fire also basically follows the above rules, but there are some new features." This statement is coming through analysis of historical statistics of fire disaster cases with a combination of main characteristics of earthquakes. (Zhendong, 2008).

According to the results of urban residential buildings earthquake damage prediction, the incidence of fire caused by the shock can be calculated by the following equation (Li, 2000) :

$$\lambda=\mu mAm/\ A+\rho$$

λ - the incidence of fire;

A - area of residential community buildings;

ρ -the incidence of community civil fire;

Am - the area above moderate damage;

μm - fire density under the condition above moderate damage.

The estimation of the possibility of fire in the structures shows that if the structures contain explosive materials; there is a high probability of fire if there is severe damage to the building. On the other hand, if the building will stay untouched, there is less risk of fire.
Taking account above analysis of earthquake disaster can be assumed an earthquake disaster is an undeniable urban disaster.it means that the urban relief zones are very significant, and mainly, it can be open spaces with a lot of vegetation, which also can play a beneficial role during fire disaster and be a safe evacuation corridor for dwellers. (Li, 2000).

There are two terrible cases of fire following the earthquake disaster.
The first one was the Great earthquake in Kanto in 1923. More than a million suffers and 90,000 deaths, and 90% of which died in the burning fire. (Chi, 2011).
Yokohama Park was one of the emergency places, and it was full of people who run from earthquakes and explosions. Unfortunately, when the wind changed the direction, people started to jump into the pool, trying to escape from fire. The intense fire "boiled" the water and burned people's hairs. (Nyst, M. 2006).
People couldn't be able to find any other place. More than 24,000 people died in that Park; the smoke and fire was the leading cause. At the same time, people who located on the other beach were in the same situation, even worse. Thousands of people jumped into the sea, trying to get some boats, but a few minutes after the oil store close to the beach exploded, and approximately 100,000 tons of oil dropped into Yokohama Bay. More than 3000 people died in the burning sea. (Nishimura, T. 2006).

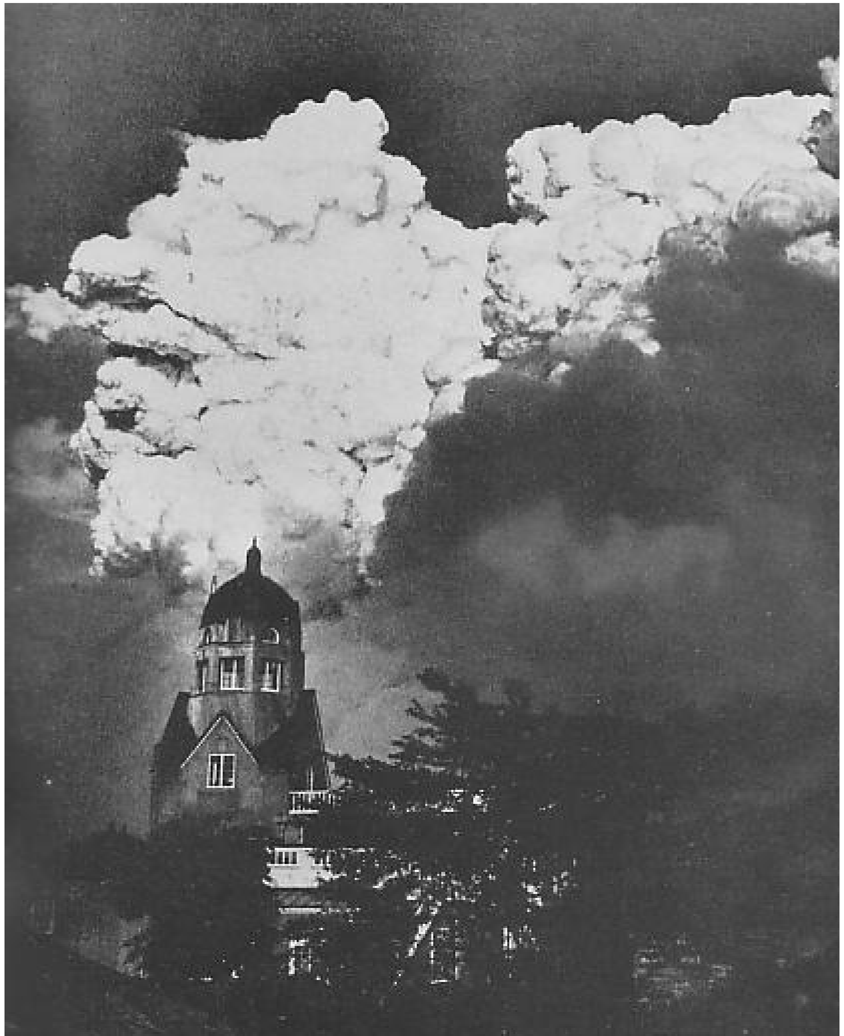


Figure 10: The fire clouds over Kantō, as seen from some distance away.
Source:"THE RECONSTRUCTION OF TOKYO" published by Tokyo City.

The second case was the earthquake in San Francisco in 1906. Subsequent fires caused approximately 90% of total damage. Over 30 fires prompt by gas mains destroy nearly 25,000 structures on 490 city blocks, and that's only in 3 days.(The Roebling Construction The company,1906). The most massive fire started accidentally on Hayes Street by a woman who was making breakfast for her family, and then it named as the "Ham and Eggs Fire." The other fires started because of untrained firefighters who used dynamites in a reason to make firebreaks by way of demolishing structures. The fire chief Dennis T. Sullivan died from injuries. Overall, the fires burned for four days and nights. (David Starr Branner, 1907).

Figure 11: Burning of the Mission District
Source: Chadwick, H. D.
(US Gov War Department.

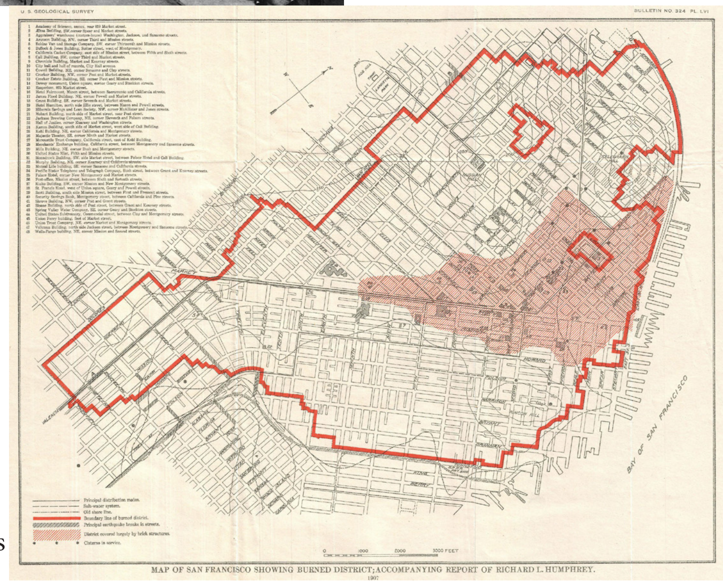


Figure 12:Burning of the Mission District
Source: Geographicus Rare Antique Maps

3.4. Evacuation at night

Taking account of the data from earthquake specialist, the main number of earthquakes happened between 7 pm and 6 am. Comparatively, earthquakes occurred in the daytime are less than in the night (Zhang, 2008). The earthquakes disaster, which more happened during the night, has their astronomic and physical explanation, in one phrase, the moon gravity. That gravity generated waves when earth crust in the risky stage, and here the severity is like a detonator, and the seismic power ruptured all power at once. The 70% of earthquakes happened during the night, like the earthquake in San Francisco, or the Great Tangshan earthquake. (Zhang, 2008).

WIlliam Spence (1989) defines that earthquakes happened in this the period has the following characteristics:

Sudden and gradual:
It's harder to make any early warnings and take some actions to fight with disaster. For example, the earthquake of San Francisco in 1906 happened at 5:12 am, and this a time when the majority of people are in a deep sleep, known as "morning sleep." As a result, over 3,000 people died, and almost 80% of the city was destroyed. (Spence, William 1989).

More difficult evacuation and rescue:
Due to vision ability, people can see, observe much less than during the day, which of course making the removal much more complicated and even harder for emergency or firefighters.

The earthquake power can be enough to damage the lifeline infrastructure, for example, electricity, transportation, or water pipes, and after the secondary disasters will bring enormous destruction because people won't be able to take any actions, rather than during daytime. (Spence, William 1989).
GU (2012) defines the inner meaning or purpose of the roads, communication, space for human movement. During disasters, the general function of ways is evacuation and transportation. But on the other hand, during especially earthquake disaster the streets would probably be blocked or damaged, and that's the cause of the chaos of traffic infrastructure.

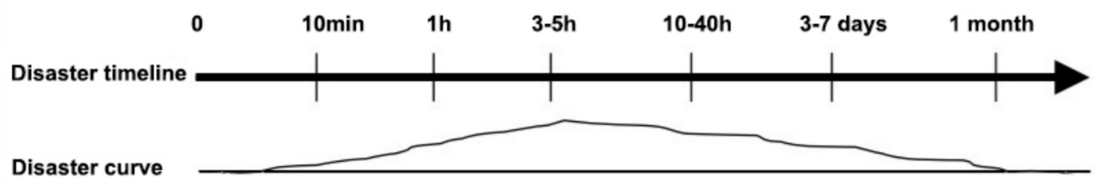
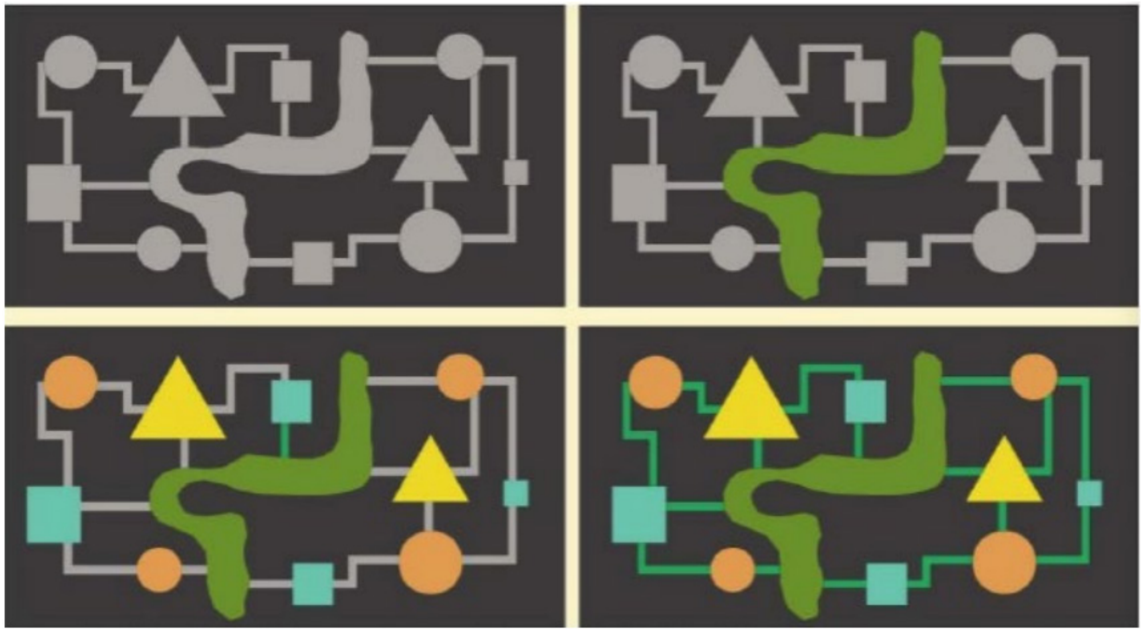


Figure 13: The relation between earthquake disaster curve and time
Source: www.arch.tku.edu.tw/campus

It's even worse during the night because of the destruction of the lighting system, and evacuation would be even harder because of the all urban spaces are connected by the road infrastructure, and in case if that infrastructure is blocked, the removal to the shelters of safer areas will be difficult. That's why it is very significant for a planner to take into account that during a disaster, the essential functions of road and lighting infrastructure should work correctly. This requires a higher disaster prevention road construction level. (The Australian Institute for Disaster Resilience).

Urban disaster space at night

Green disaster prevention space



Temporary disaster prevention space

Road network that connect all the prevention space connect all the prevention space

Figure 14: Improvement process of urban disaster prevention space at night (Gu Yi, 2012)

3.5. Urban Reilef Space Design

During the day, the public spaces have a useful promotion function, but on the other hand, there is a problem at night due to lack of facilities, and some urban places cannot achieve proper prevention functions. The advantages of civic and public spaces are their sufficient conditions for disaster prevention such as accessibility, open spaces, etc. (Folić, N K,2011).
Due to lack of infrastructures such as emergency illumination systems or systematic planning, when the disaster caused the collapse of those infrastructures in the night, it will make it more difficult to evacuate people to that urban or public space. (Kopić, Miloš,2011).
The following requirements, such as evacuation time and evacuation distance, can ensure the evacuation success ratio during the disaster.(Proulx, Guylene,1994).
Evacuation time: 1h/ person, 2h for all people. (Proulx, Guylene,1994).
Evacuation speed and distance: 2km, 2km/h. Approximately the usual walking speed is 4km/h; considering the elderly and children, the average speed is 2km/h. (Proulx, Guylene,1994).

Other relief action points: It's essential to take into account the density of the population and walking speed. Usually, the 1,5 person / m2 is the norm of free movement, in case 4 person / m2 can cause a slow jam, while in the case of 6 people/ m2, it will be impossible to move. The history shows that most of the dead body accumulations were in the small parts of streets, bridges, or near the shelter's entrance. According to this experience, this kind of minor pieces or other intersections should be wide enough or to have another emergency entrance. (Proulx, Guylene,1994).

According to the analysis above, the best way to ensure people's safety during a disaster is the quick evacuation. Still, many factors, such as buildings collapse or some infrastructure destruction, can block or even cover the roads. Also, the darkness and lack of night illumination systems can cause visual impairments, which can rapidly decrease the evacuation speed, extend the evacuation time.
(Mqueen, Curt,1994).

3.6. Disaster prevention park systems

3.6.1. Western countries' disaster prevention park systems

Disaster prevention park systems or urban green spaces originated during the Renaissance period. Many European cities, such as Catania, Italy, or Lisbon, Portugal, were formed in the earthquake zone. After the earthquake in 1693 in Sicily, there was crucial to change to original spatial or urban planning and to make more straight wide avenues and alleys, to plant more trees along both sides of roads and lanes and connect many big urban or public spaces by those avenues. (D. Ligresti1 & S. Grasso, 2011).

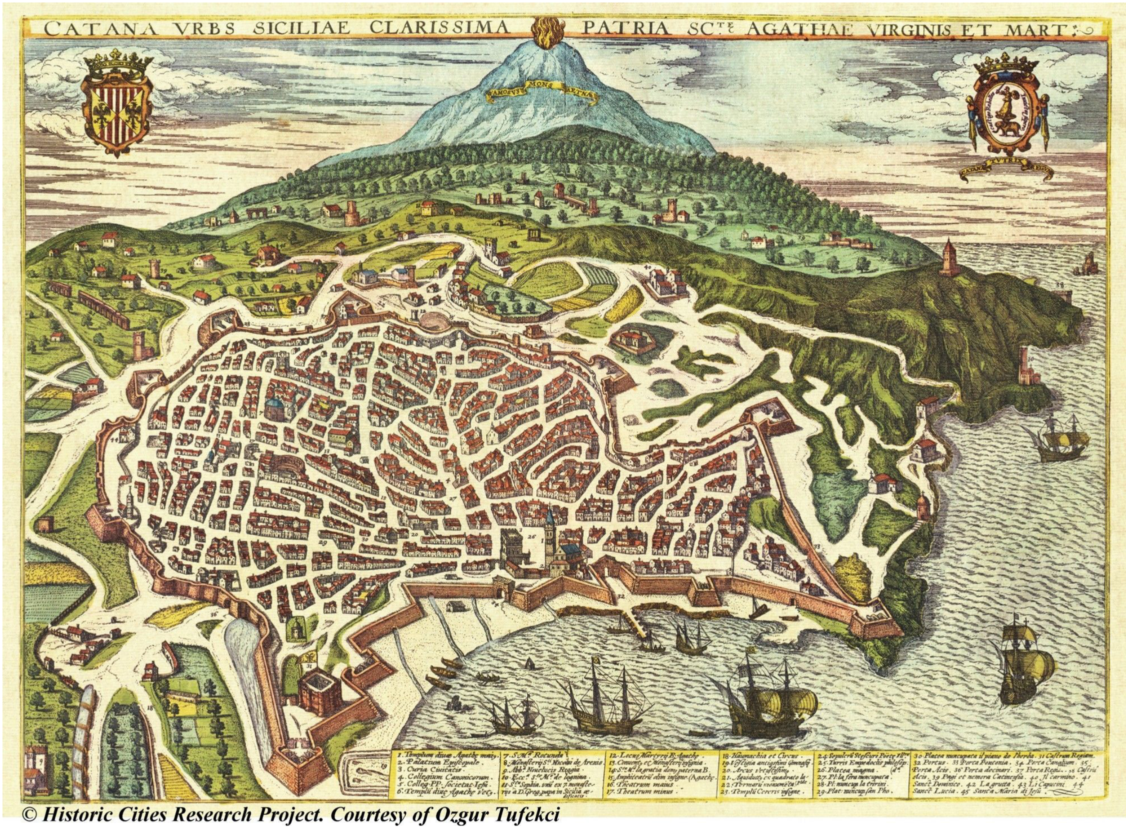


Figure 15: Master Plan of Catania (Sicily), Italy 1598
Source: Wagner & Debes

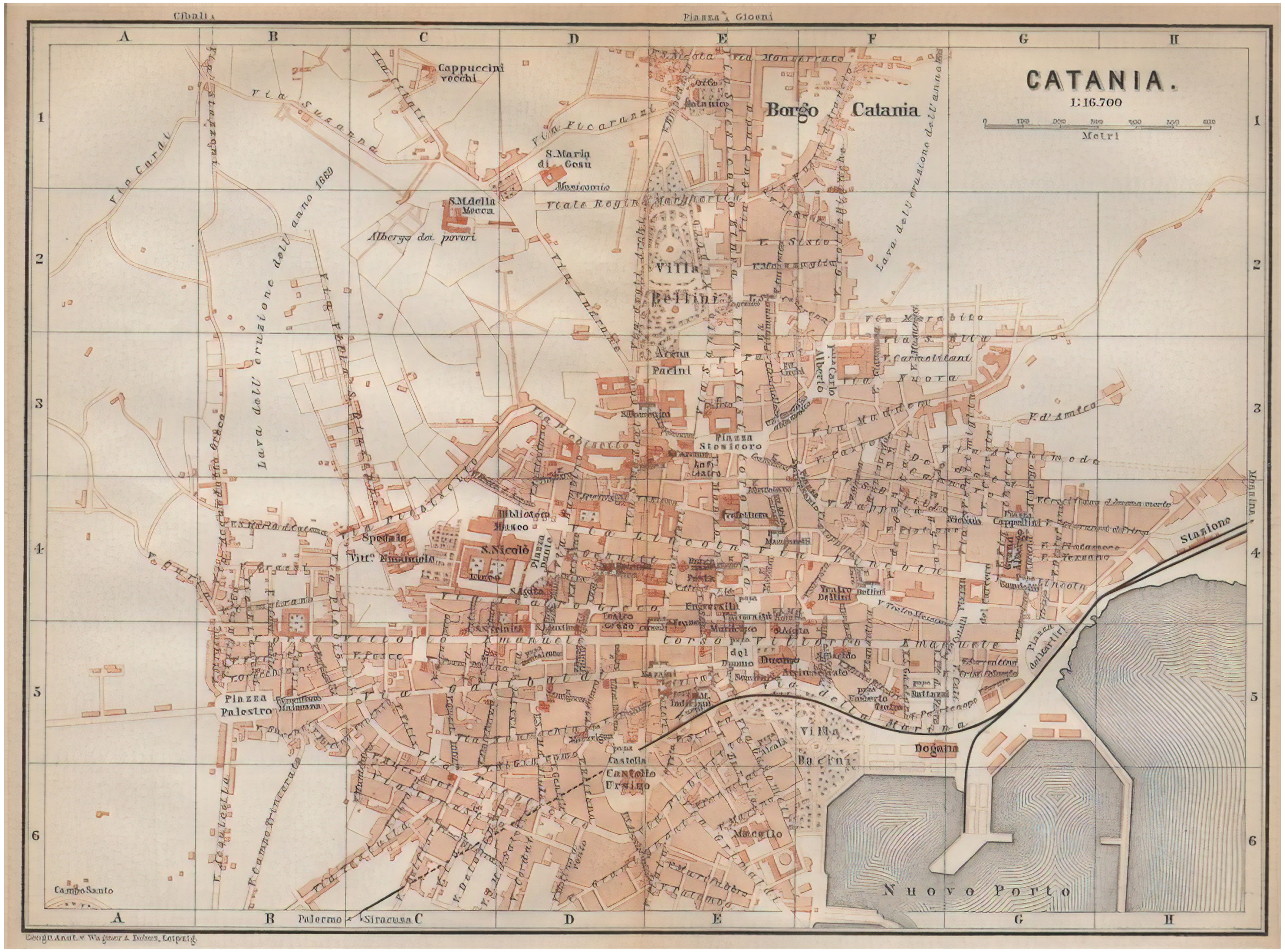


Figure 16: Master Plan of Catania (Sicily), Italy 1896
Source: Wagner & Debes

The same situation was in Lisbon, Portugal, after the earthquake and tsunami in 1755. The great Lisbon earthquake happened in 1755, 1 November. With the following secondary disasters such as fires and tsunami, and with earthquake magnitude in the range of 8,5 - 9 points, Lisbon was destroyed. (Benjamin, Walter, 1999). The epicenter was in the Atlantic Ocean about 200 km west-southwest of St. Vincent. That time the population of Lisbon was approximately 200,000 and 30,000 - 40,000 were killed during those disasters. 85% of the city was destroyed, including the palaces, libraries, and other historical and cultural places. Only one month after the engineers suggested a new master plan for Lisbon, and it took one year to reconstruct the city totally, with more full streets and avenues, connected between each other public and urban places.
(Benjamin, Walter, 1999).

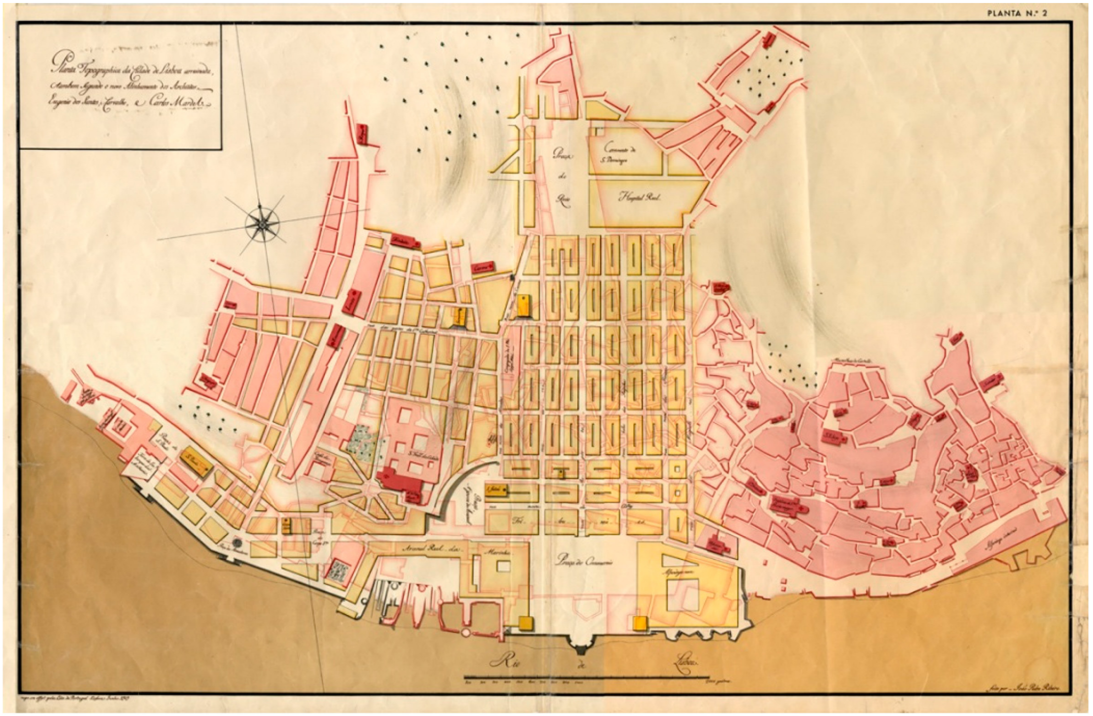


Figure 17: Master Plan of Lisbon, Portugal
Source: https://www.discusmedia.com/maps/lisbon_city_maps

The United States started the planning of the city park system in 1871. The first experience of the park system planning was in Chicago, which become the green space planning model after the fire disaster in Chicago in 1871. (Pierce, Bessie Louise, 1957). The park system is straightforward by its functionality: green spaces, parks, and roads divided the skyscrapers and high buildings and prevented the fire spread, which developed the urban planning ideas and methods, and brought new concepts of disaster prevention, such as new functions for parklands and became well working model park system of disaster prevention. Afterward, Japan used this planning model and ideas for the first Japanese systematic Green Space Planning System, which had been used for reconstruction of Kanto after the Great Kanto earthquake. (Xu, 2003 / Zhang, 2000).

Figure 18: The Jackson Park, Chicago
Source: https://www.huffingtonpost.com

Figure 19 : The Millennium Park, Chicago
Source: https://www.tripsavvy.com

3.6.2. Japanese disaster prevention park systems

Xu (2003) defined characteristics of Japanese park prevention system:

1. Small parks with their scale should configure the infrastructure of urban or public green areas and should be the main body according to their functionality and service.

2. The main advantage of small parks is their better accessibility and wide distribution around the city. It is providing a better and secure service to dwellers. Small parks are low cost, and the planning more small parks can form the high density of urban green spaces.

3. The green density will motivate residents more often use green areas or corridors, at the same time, improve the utilization and reduce the traffic.

4. Small parks have a significant role in evacuation and other ecological benefits.

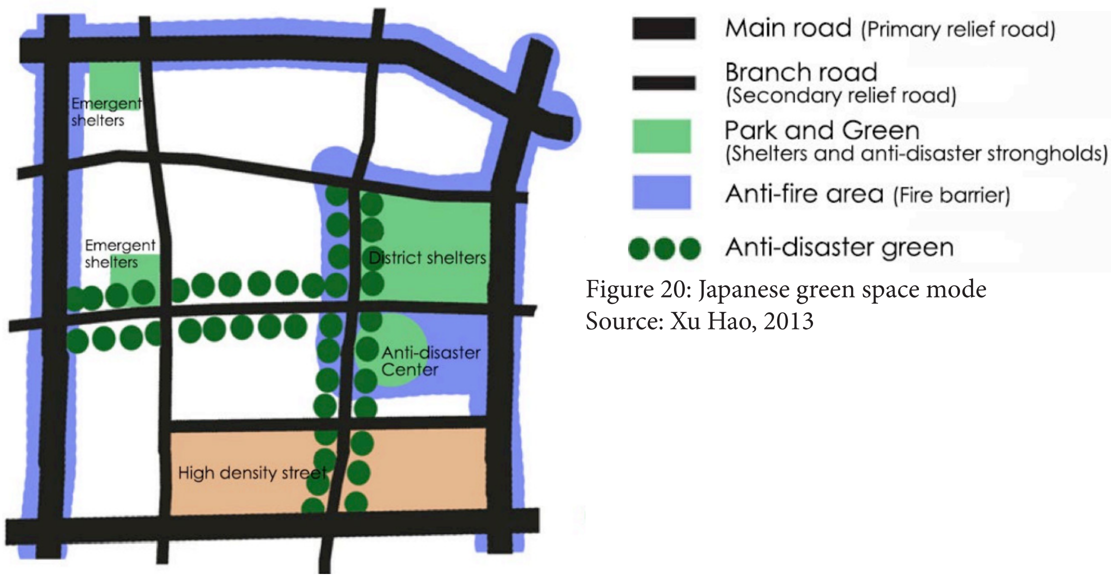


Figure 20: Japanese green space mode
Source: Xu Hao, 2013

5. Setting up water supply facilities in the park and park streets to protect the freshwater supply interruption caused by damage to channel infrastructure.
The main idea of the Japanese green space model that the streets or avenues should be full and straight and should have an anti-fire function (Xu Hao, 2013). Main roads and high-density buildings should be connected with significant open space. Emergency refuges should be settled depending on the safety radius.
(Xu Hao, 2013)

In 1998 the Japanese Ministry of Construction presented the guidelines of Disaster prevention park planning, and all information such as definition, features, ISO, standards, etc. have been explained very detailed. Japanese Ministry of Construction(1998) defined five categories of disaster prevention parks:

1. Parks and green zones more than 50 hectares can be the evacuation place for first aid, also urban regeneration, and other disaster reduction actions during the earthquake and secondary fire disaster.

2. Parks more than 10 hectares, should be zone or point for neighborhood residents.

3. City parks more than 1 hectare should be for emergency shelters for the neighborhood dwellers or can be a transit point to the more extensive area.

4. Street parks more than 500m2 can be points for prevention actions for the average day.

5. The greenways or green buffers which is more than 10 meters should have the function of refuge and evacuation.

3.7. Human behavior during disaster evacuation

John Leach (1994) defined three phases of disaster: before, during, and after, and human behavior is different for each stage.

The phase ***before*** is the stage when people know about the upcoming effect, but they are trying to ignore the facts, trying to avoid the feelings of danger and show apathetic behavior with respect to the real threat.

During the stage when the information processing of the existing situation is hampered and confused, emotional systems are out of control, and the behavior is at the reflexive level.

During the stages ***after***, people are informed about damages of the disaster but try to suppress realities, express strong and irrational emotions and develop emotional disorders.

Human behavior is physiological and psychological changes prompt by environmental or other factors. Taking account the difference between people, place, time and conditions, actions can be different. Because of unpredicted disasters and very extreme transitions between disaster phases from before to after, it's tough to take any mental preparation actions, and even for the people who understand the situation is still too frightened and trying to take proper and right steps. The lack of calm, and disability to control the behavior during a disaster will lead to making improper decisions, which is the primary behavior during the disaster. (Liu, 2001)

3.8 Route choise

Psychologically, people won't evacuate to the shelters or listen to advise or some instruction until the danger is still approaching. Wang (2005) defined 9 characteristics of the evacuation route:
1.Homing ability: Evacuate from the entering path ;
2. Daily dynamic linearity: Evacuate from frequent use or familiar access or entrance direction;
3. Phototropism: Evacuate to the bright course;
4. Opening: Similar to phototropism, the more open, the more possibility of Evacuation;
5. Visual pathway selectivity: Evacuate to the pathway or the stairs first and most comfortable to be seen;
6. Closest distance selectivity: Choose the nearest stair to evacuate;
7. Substantivity: Choose the straight stair or pathway to evacuate;
8. Instinctive avoidance of danger: Stay away from dangerous situations and evacuate to safe places;
9. Conformity: Follow the direction of the majority evacuation.
Human behavior is an indivisible and an essential part of disaster prevention system planning. According to Lv (2004), people flow during an evacuation is 1.4 - 2 people /m2 with 0.85 - 1.2 m/s speed.

Consequently, taking to account the prediction of the number of evacuated people, it is possible to design the necessary space of the evacuation zone, come up with logical evacuation route vision, and design the evacuation route by requiring properties of disaster prevention space.
He (1999) defines four characteristics of how people choosing which evacuation plan to use after an urban disaster.
1. Close to the home so that it is easy to deal with relief aid and property matters;
2. Open and secure place; a
3. A familiar environment with a sense of belonging, people know each other and take care of each other;
4. Complete facilities and management, good public security.

3.9 Blind convergence phenomena

Blind convergence is appearing during sudden disasters; people psychologically disoriented, and disoriented thoughts have an impact on the nervous system; as a result, there is no normal behavior signal which will control human behavior. (Zhou, 2001).This phenomenon is one of the reasons that caused significant human and property losses. Zhou (2001) defined Three characteristics of psychological evacuation conditions:

1. Human psychology has a positive correlation with the dangerous situation level, the more dangers, the more nervous people would be;

2. People who experienced difficult evacuation before will probably have more dangerous stress levels. While the more extended time delay, people would feel the more intense;

3. Crowded conditions will increase victims’ tension degree.

3.10 Conclusion

The literature review and the research about the disaster prevention park system will be as a guideline for designing and developing a new strategy for the case study and proposal in Spitak, Armenia. Ideas, years of experience and research of Japan, America, and Europe will be as a reference for designing new green spaces, building pattern, road, and evacuation infrastructure. According to this study, will be emphasized the importance of night spatial cognition, which was just neglected. The study about human behavior during disasters, protected evacuation routes, and place will be designed with more accuracy.

4. Methodology

4.1. Introduction of design area

Spitak city locates 96 km north from the capital of Armenia, Yerevan, in the Lori province. The biggest city of Lori province Vanadzor locates 22 km east from Spitak. The approximate population of Spitak by 2016 is 11,000 people. During the Soviet Union, Spitak was one of the leading industrial cities of Soviet Armenia. Spitak was destroyed during the 1988 earthquake. Nearly 130,000 people were injured, and 25,000 - 50,000 people died. (www.Spitak.am)

4.2. Why Spitak ?

As Robert (1995) defined, the leading criterion should be to maximize what we can learn. The earthquake of Spitak is one of the darkest points in Armenian history, which effects still existing. A huge number of people are homeless, but now due to the velvet revolution in 2018, there are possibilities to make new city plan and try to build a much more safety city. That is the main reason for choosing Spitak, to try to have my engagement in the new history of Spitak.

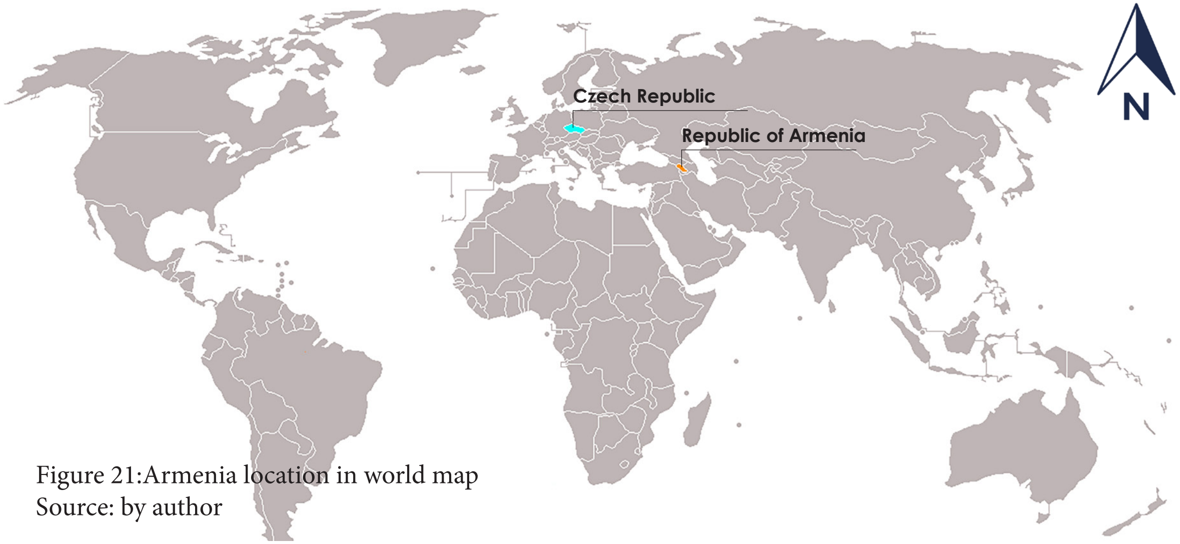


Figure 21:Armenia location in world map
Source: by author

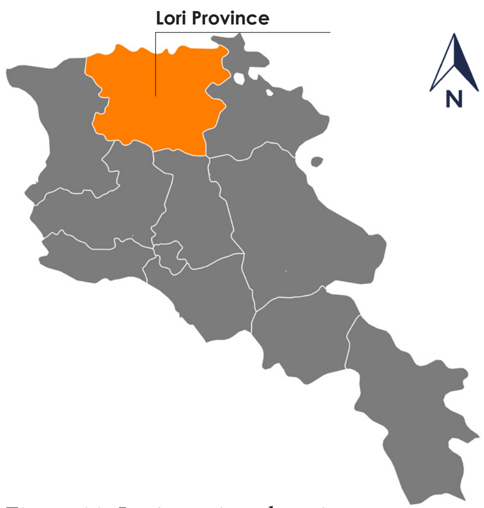


Figure 22: Lori province location
Source: by author

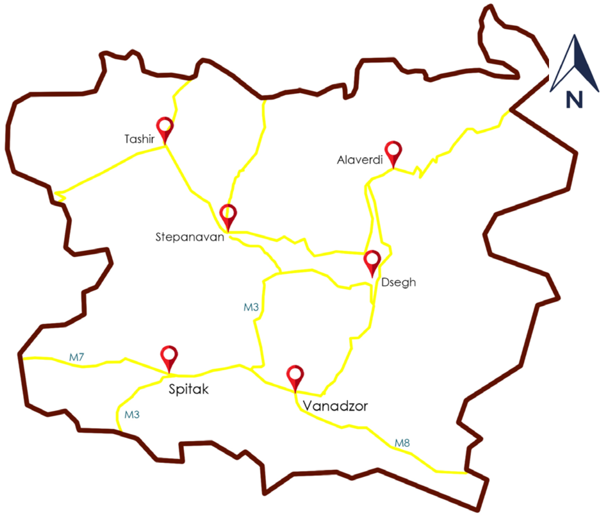


Figure 23: Main cities of Lori province
Source: by author

4.3 History

The area of Spitak was probably occupied by ancient settlements located on the surrounding hills since the fourth millennium BC. Many remnants dated back to the Bronze Age, have been found on the Sardar hill. Later, during the 7th century BC, the region was included in the Kingdom of Urartu.(Yegian, M, 1994). The region was part of Orontid Armenia between the 4th and 2nd centuries BC, followed by the Artaxaid ruled in 189 BC. It has been a member of the Tashir province, the 13th district of Greater Armenia, in the former Gugark region. The invading Seljuks ruled the whole country, including Tashir, in a brief Byzantine rule over Armenia from 1045 to 1064. The establishment, however, under the Georgian protectorate of the Zakarid Principality of Armenia in 1201 resulted in significant growth in Eastern Armenia, including Gugark. Following the capture of Ani by the Mongols in 1236, Tashir became a Mongol protectorate of Ikhanate, and the Zakarids were the Mongols ' vassals.

The Zakaria Princes reigned over Tashir, after the collapse of the Ilkhanate in the mid-14th century, until they succumbed to the conquering Turkish tribe in 1360.
In 1501, Safavid Persia conquered most of eastern Armenia, including Tashir. The small town of Hamamlu was established in the historical region of Tashir during the mid-17th century within Erivan Khanate's newer administrative territories under Iran's Afsharid Dynasty. Armenian migrants from the Iranian city of Khoy were the first residents in the village. In 1937, dairy products firm was the first commercial venture in the Soviet Union to be established in Hamamlu, in 1947, with the sugar factory. Hamamlu was renamed Spitak in 1949, granted town status in 1960, and became a region for political subordination in 1971.In 1965 architect A.Harutyunyan introduced the first city development plan. The second plan composed of architects K.Harutyanyan was in 1974. Several major factories, mostly for knitwear and milk products, operated in Spitak.

The city's new sports center was opened in 1983, and a new urban plan was approved in 1980. Spitak was destroyed during the 1988 earthquake(Figure 24,25,26,27). With the support of many nations, including Uzbekistan, Sweden, Turkey, Russia, Austria, Finland, Denmark, Italy, the Czech Republic, Estonia, and the United Kingdom, after the breakup of the U.S. Soviet Union Spitak, was gradually restored by the State and Armenian Diasporas ' actions.

Figure 24: Commeercial buidling after disaster
Source: newizv.ru

Figure 25: Residential buidling after disaster
Source: newizv.ru

Figure 26: Residential buidling after disaster
Source: newizv.ru

Figure 27: Residential buidling after disaster
Source: newizv.ru

4.4 Geography

Spitak city cover around 57.6 km2 area and located on the shores of the Pambak river at the height of 1600m. The city surrounded by mountains from all four sides, but mostly it dominated from the north by Bazum mountain with the highest point Qarajayr (Rock) 2084m, and from the south by Pambak mountain with the highest point Njuyg (Horse) 2469m. (www.Spitak.am)

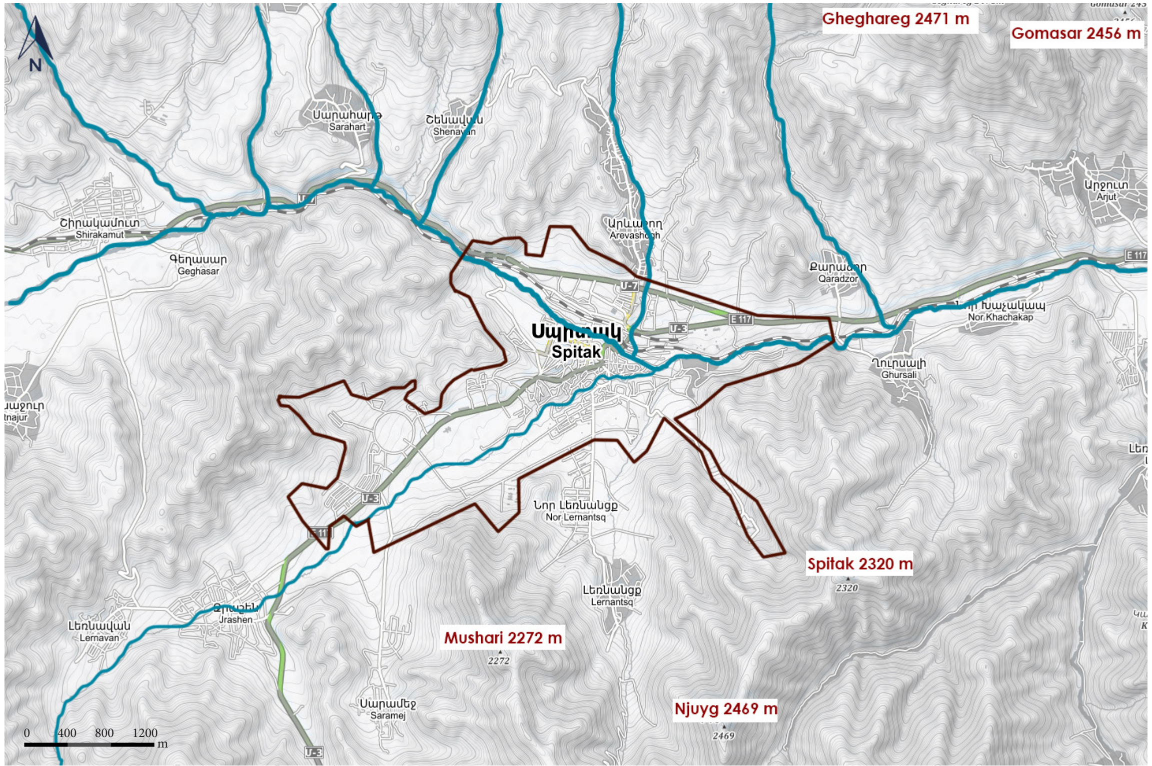


Figure 28: Spitak city topography.
Source: by author

4.5. Existing External Transportation

M3 is classified as an intergovernmental road that links Armenia's road network with the other state's highway network. The road is 183.7 km long. It's linking Yerevan and Tbilisi, crosses through Spitak and making the city one of the primary gateways to Armenia, and making its a key element of external transportation infrastructure. M-6 highway is the second by its importance, it's connecting Spitak and Tbilisi crossing through Vanadzor city. (www.Spitak.am)

Approximate distance and duration:

Yerevan to Spitak:

Car - 95,4 km \ 1,30 h
Train - 202,9 km \ 3,50 h
Bus - 95,4 km \ 2,00 h

Tbilisi to Spitak

Car - 191 km \ 4,15 h (by M6)
Car - 183 km \ 3,50 h (by M3)
Train - 178,1 km \ 4,50 h

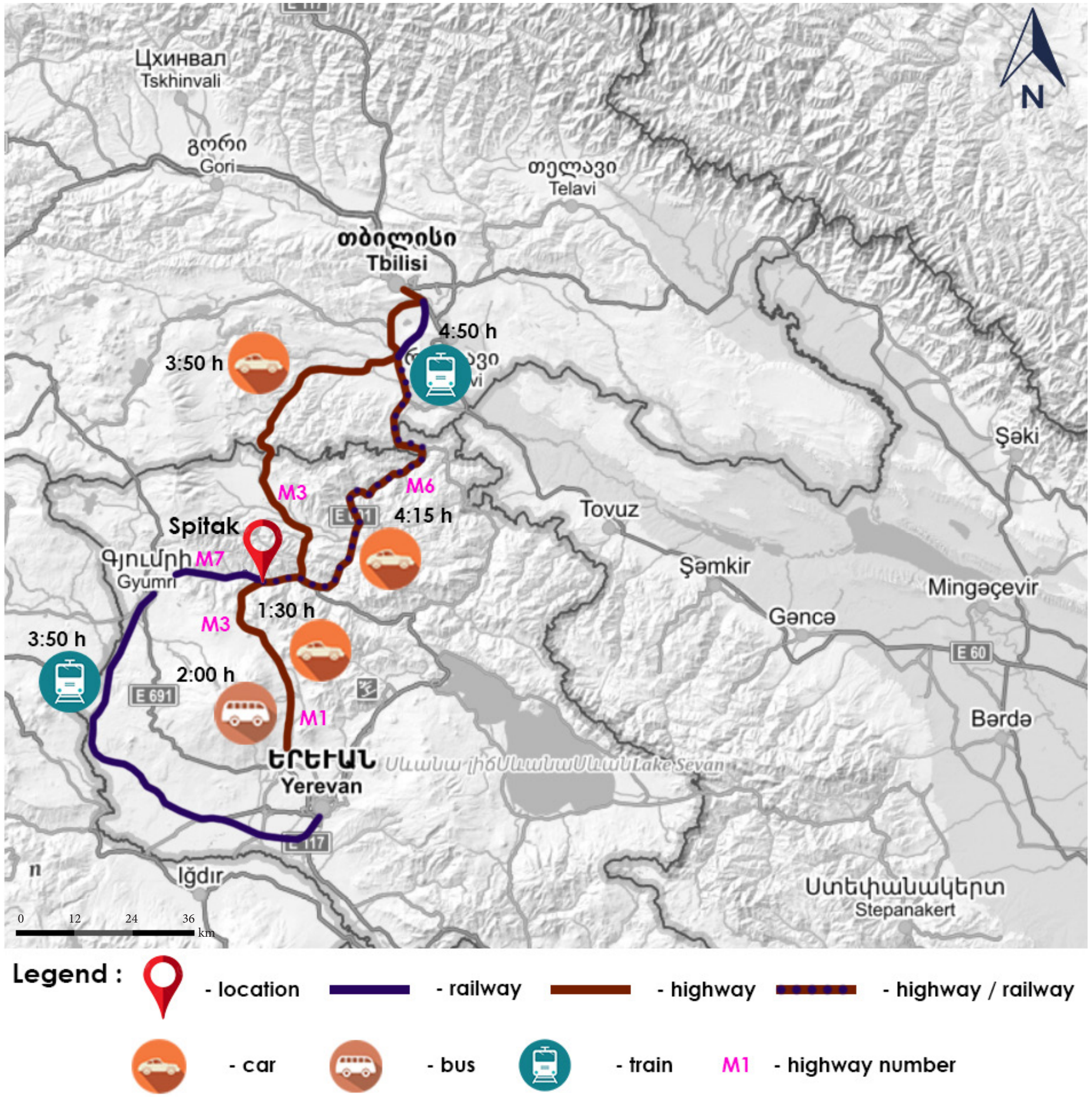


Figure 29 :Existing External Transportation
Source: by author

4.6. Existing Internal Transportation

The main roads consisted of the M3 intergovernmental highway, which is connecting both sides of the river, and it crosses the city from south to north. It has good potential to be an anti-disaster road because it is willed straight relatively. The M 7 highway is on the north side of the city. It is connecting with the M3 highway on the north side of the river and playing the role of the city border, and because it is straight and full, it will also be the main mitigation road in disasters. The red lines show the primary road. The importance of the secondary roads is the connection with neighbor villages in north and south. As shown in the map, there are only a few primary roads, but the most significant issues are secondary and branch roads. The current secondary and branch roads are intricated. Even for the residents, it is a problem to have a clear road map of their city because many roads are stopped after the disaster happened, and many of them still are not recovered. In conclusion, all secondary and branch roads should be built according to the needs and building functions of the public to conclude the

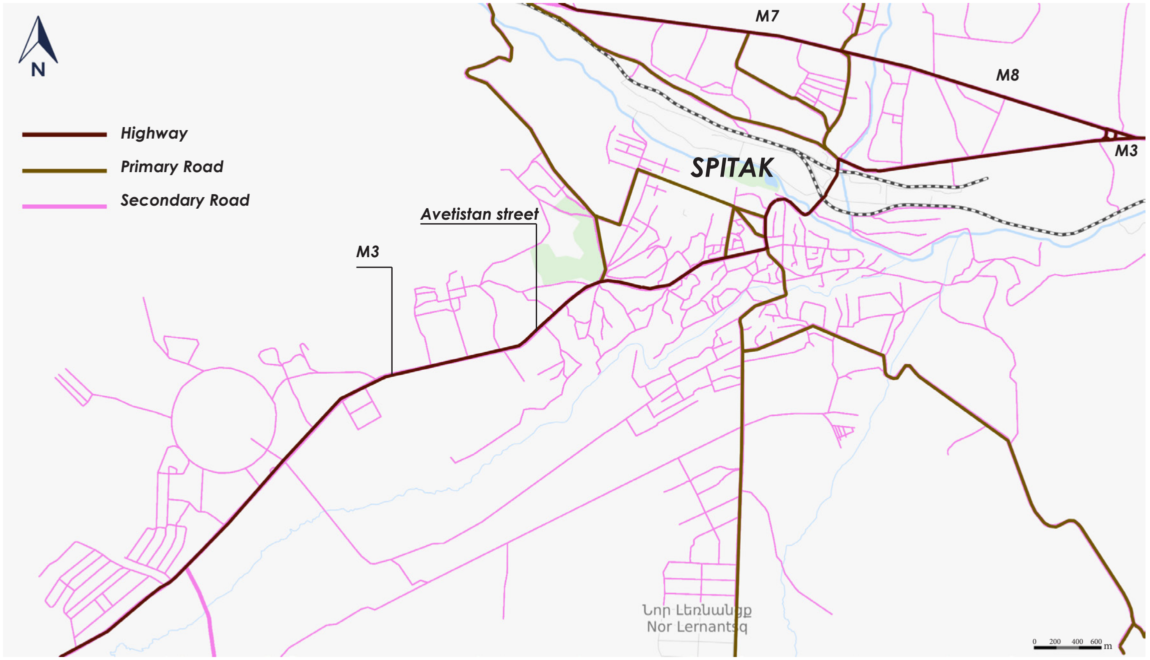


Figure 30 : Existing Internal Transportation
Source: by author

current road network except for the highways and the primary road. The the connection should be smooth and clever designed for daily uses and during the disaster mitigation.

4.7. Building analysis

The building's pattern of the city is typical Soviet Union city buildings pattern. Because of the mountains, there is a limitation of the flat area. Therefore there is a high density of the buildings in the central region. The residential buildings are located in the center of the city and surrounded mostly by family houses and agricultural lands. As it mentioned upper, most of the roads are disoriented without a transparent road infrastructure. Because of the poor quality of construction and corrupt anti-disaster systems, during the disaster, many residential buildings collapsed and became the reason for so many deaths. It is noticeable that the structures fir carrying the lateral loads are either masonry or reinforced concrete. Also, noteworthy is the RC frames or slabs that nowadays are only used for important buildings. Additional detail is the relation between buildings types and the number of stores, which us due to central planning of the Soviet Union building industry, optimization considerations for housing projects, and story limitation imposed by the Antiseismin Code. the vertical structures and number of stories are also shown, along with variations in the horizontal structure. In the following sections, the structural characteristics for each of these buildings' typologies will be discussed along with their performance during the earthquake. The discussion is divided between load-bearing and reinforced concrete buildings.

Figure 31 : Residential buidling after disaster
Source: newizv.ru

4.8. City planning
(why so much destruction)

The risk that many of these buildings would collapse would be much less if the concentration of buildings of the same design avoided in one location. This is because the spatial variability of soil motions and subtle differences in foundations continues to modify the reaction of these same buildings of architecture in a community. This could work the other way around since the collapse of all structures in one location had been stopped because of site-specific movements and circumstances. Leading some to fail in the whole area. Nonetheless, in contrast with the events of Mexico 1985 and the Armenia 1988 earthquakes, it is a prudent decision to distribute the same style structures across the area. The cookies cutter city planning has been speculated to be a possible factor in damage caused by this earthquake.

4.9. Functional Zones Analysis

There is no digital map showing the functional zoning of the city before the earthquake; this section will consist of information gathered from city residents, from peoples and companies who participated in the rescue work and form various archives of Armenian architectural and urban agencies. The residential area is the biggest one, consisted mainly of family houses and farms. Most of the residential buildings were located in the center of the city. The next is the industrial zones, and as it was mentioned in the history section that Spitak was one of the most critical manufacturing centers of Soviet Armenia. Therefore, mixed-used zones were taking most of the area, that the reason for the difficulty to make a clear map of functional zoning, and one of the issue is, that mix-used blocks are suitable for people daily use but considered the anti-disaster planning aspect, the building usage should be more coherently designed. A lot of different functional buildings aggregate together will result in a higher dangerous potential.

The key green areas are natural green (mountain) and agricultural land. While the green space in the inner city is little, it is not enough in quantity and scale to protect oneself during disasters.
Green areas, such as city parks and district parks, should be included in the city. Instead of waste, space should be used. Therefore, a green fire belt, such as the green boulevard, should be planned.
The Spitak city has good natural anti-disaster conditions, such as mountains surrounded by the city anda river goes through the city. They are natural barriers to prevent disasters if used in a correct way. Otherwise, they can alsobecome relief barriers for people. Combined with the theoretical study, many problems can be found in current city, in theaspect of road system, green space and so on.

5. Design proposal

5.1 Design Concept

Upon learning from research and site analysis, I summarize the complaint and purpose of the current quote, then I develop a brief master plan for Spitak City. New city planning should solve these problems and improve the anti-disaster potential of the city in both disasters and after disaster.

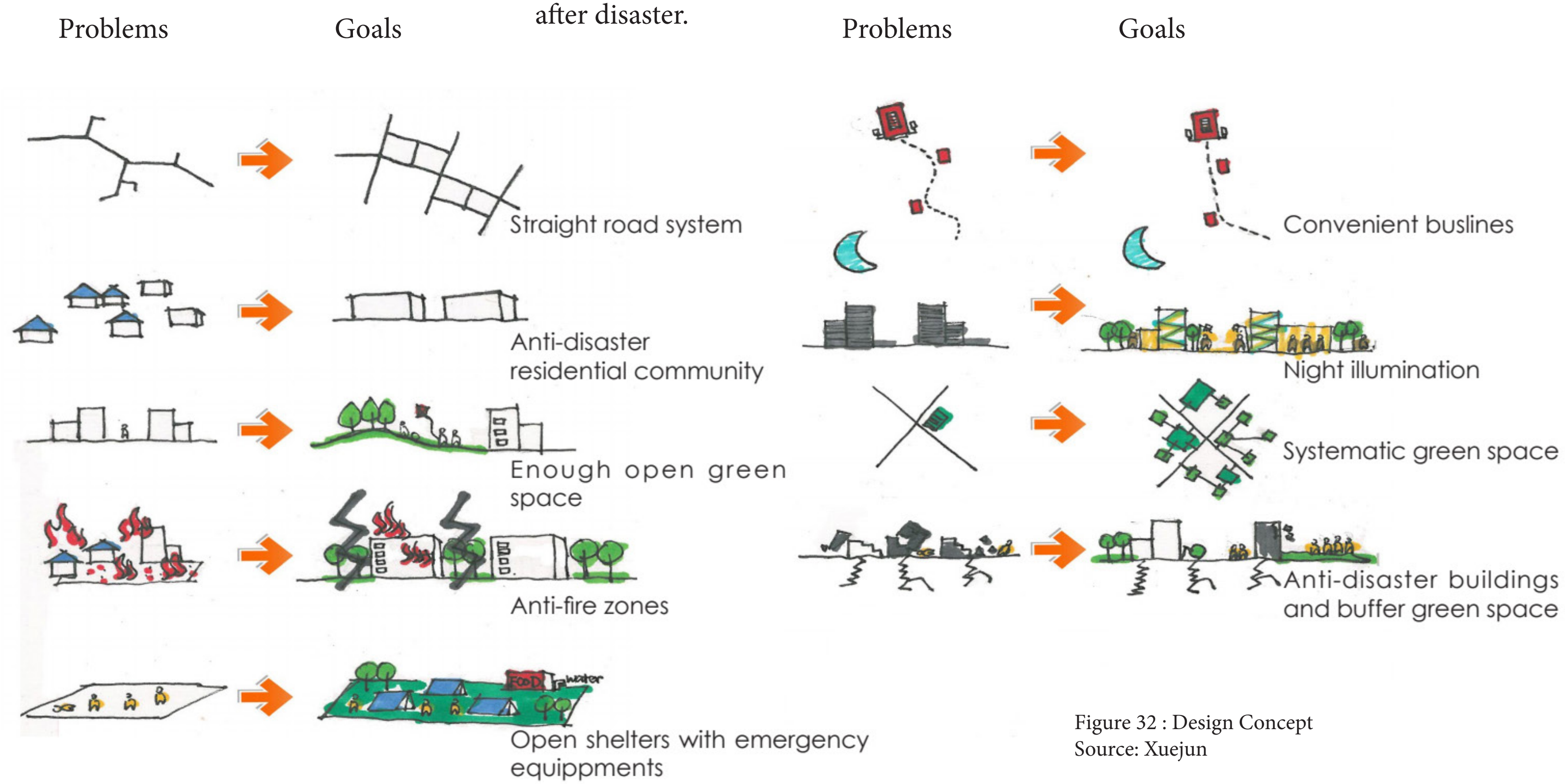


Figure 32 : Design Concept
Source: Xuejun

5.2 Idea

I summarize the advantages and disadvantages of the current city and then make a brief master plan for the principal of Spitak city taking into account case study analysis and literature review. The new master plan will be able to solve the spatial and anti-disaster problems of the city. The figure 31 illustrates all objections and objectives which should be improved, started from road infrastructure until anti-disaster buildings design scheme and green zones buffers.

5.3 Master plan

First I keep the highway and most of the main roads because they are the main axis of the city. Especially the highway which is classified as an intergovernmental road has a very well communicated with the capital Yerevan and other neighbor cities. Then the second step was to redesign the functional zones of the city. Figure 32 illustrates the new function zone map of Spitak city, and as it is shown, there will be three main zones:

1. Commerial / Industrial zone
2. Residential zone
3.Green

As it is shown in the map (figure 32), the industrial/commercial zones occupy huge territory in the north side of the city, because Spitak was an important industrial city in Soviet Armenia, the main idea of new functional zoning is to keep this meaning of the city and to reborn Spitak as a new industrial center of new Armenia.

There are two types of residential zones: new and old. The biggest new residential area is located in the south-east part which is connected with the old part by the highway and by the main road. The other two smaller residential areas are located in the north and south part of the old one, and both of them are connected by main roads.
The dominant is the green zone, which is working as a buffer between residential - residential and residential - commercial/ industrial zones. However, the green zone has an essential role during evacuation and first aid emergencies during the disaster.

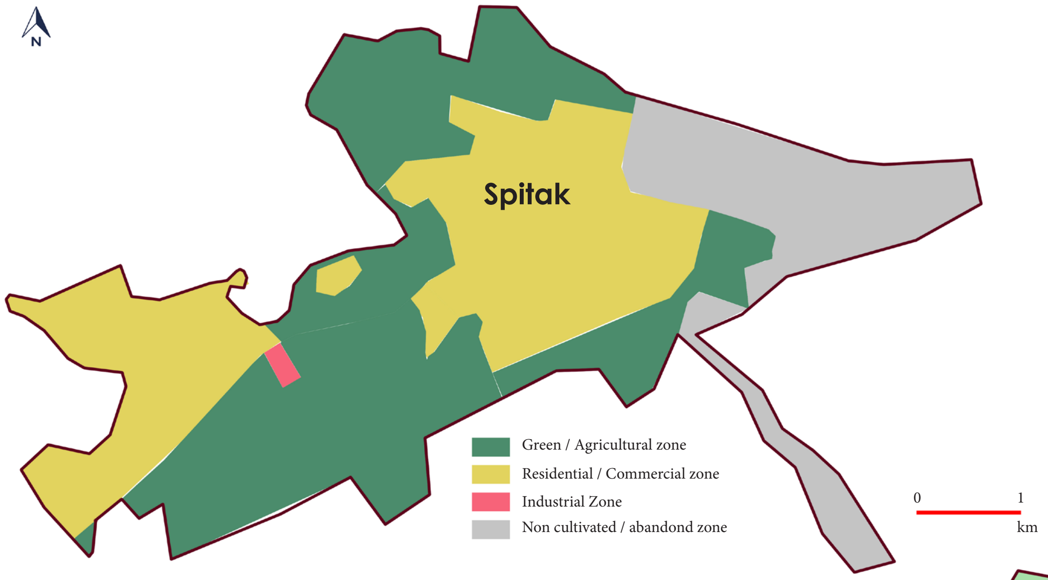


Figure 33 : Existing Land Use map
Source: by author

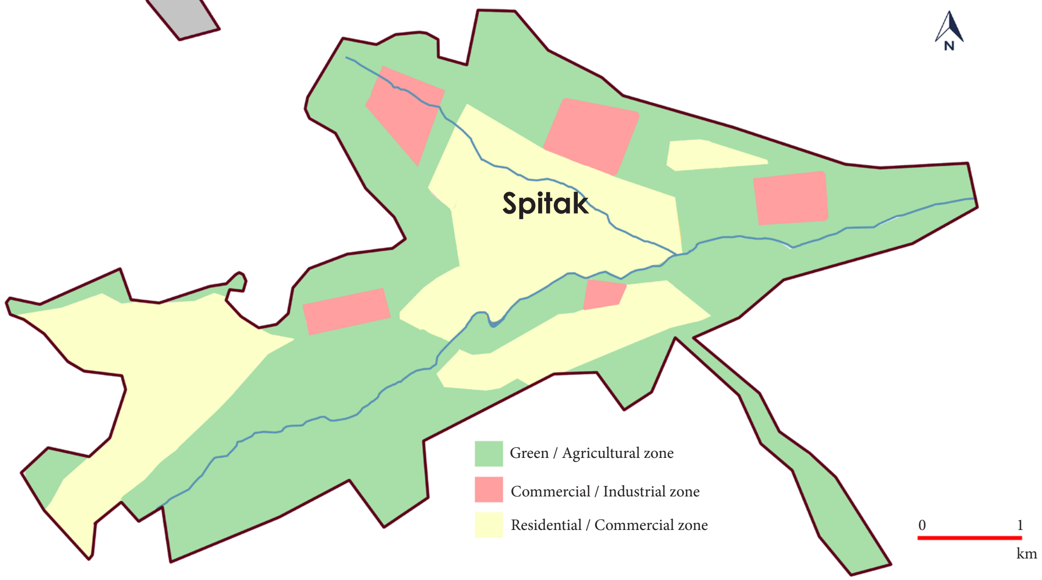


Figure 34 : New Land Use map
Source: by author

5.4 New Road system

The quality of the existing road system is not meeting the standards of nowadays high-level road infrastructure. It relates to all types of roads: highways, main roads, etc. However, as it was mention, the highway and main roads are the axes of the city. Therefore, the idea is to keep the main road system, but develop the connection and road quality, safety, and accessibility. The first step is to make roads more straight by taking into account the topography of the area. I keep the main shape of the M3 highway, but now it's straighter without any additional curves. However, primary roads have undergone serious changes. Now, there is a clear connection between new and old residential areas. They are more straight and wide which will guarantee easier and faster evacuation and emergency (Figure 34,35). There is a new road near to the riverbank, and people can easily evacuate to the river during fire disaster.

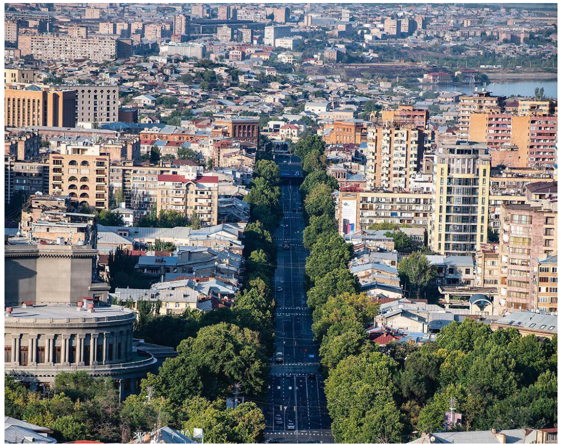


Figure 35 : Primary road in Yerevan / Armenia
Source: flickr.com

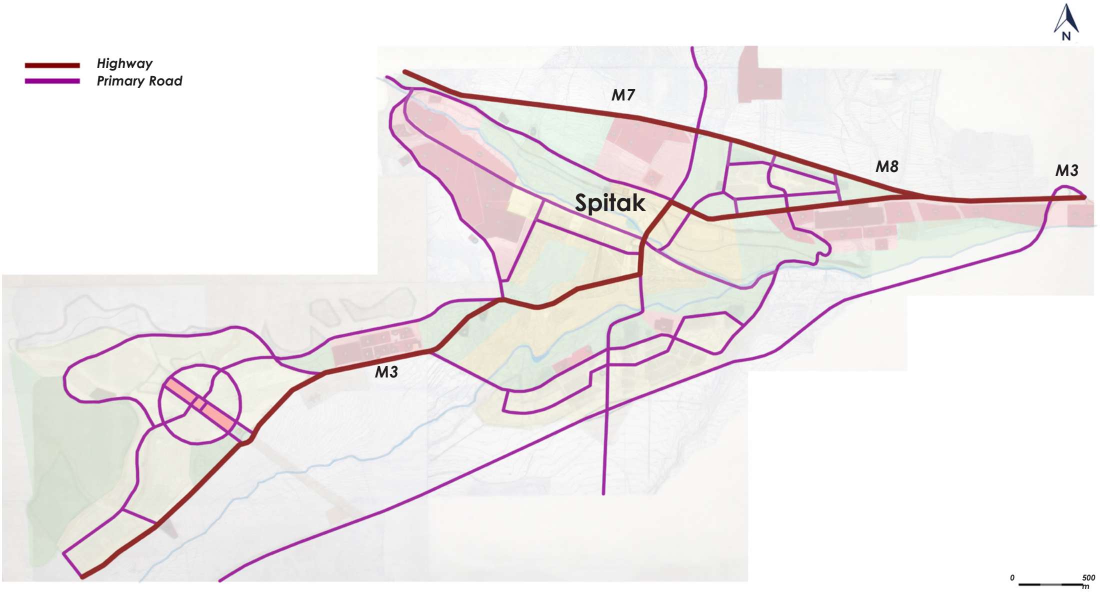


Figure 37 : New road map
Source: by author

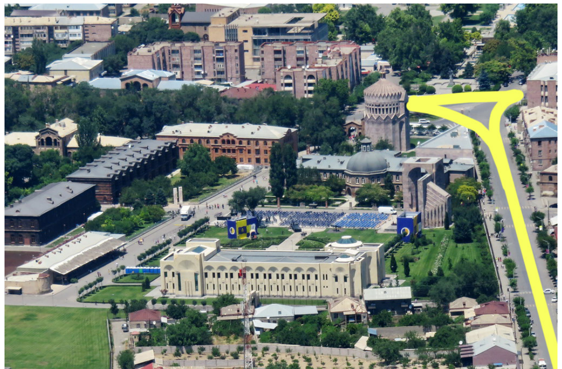


Figure 36 : Primary road in Vagharshapat / Armenia
Source: flickr.com

Various kinds of green streets can build the tasteful inclination and intriguing quality of the urban scene. The different mixes of hostile to fire trees, asphalt, bike line, and vehicle lines will let individuals appreciate in the city strolling and driving on an enemy of calamity level.
As per the various elements of the side of the road structures, the asphalt and ranch types can be extraordinary. For instance, the asphalt in the over two pictures is more extensive than beneath on the grounds that the structures is an open capacity with the goal that individuals can sit on the seat, looking to the structures, taking pictures, or hanging tight for their companions, etc.
The principle of Green Space Planning in Spitak is shown in Figure 38. Between the tree zones are emergency shelters. The trees planted on the ground up and down will prevent damage to the shelters due to fire, poison gas and other pollutants. The shelters are on the ground floor and near the water, making the lives of victims safer and more comfortable. Water can support the live basics, but can also avoid fire and poison gas.

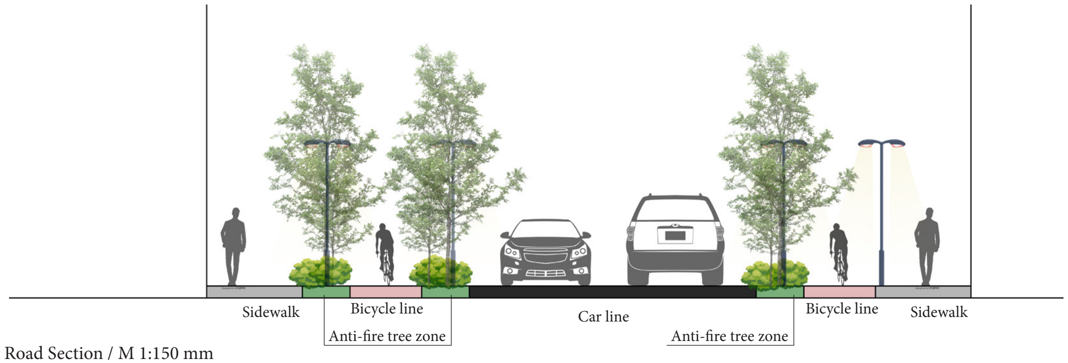


Figure 38 : Road Section / M 1:150 mm
Source: by author

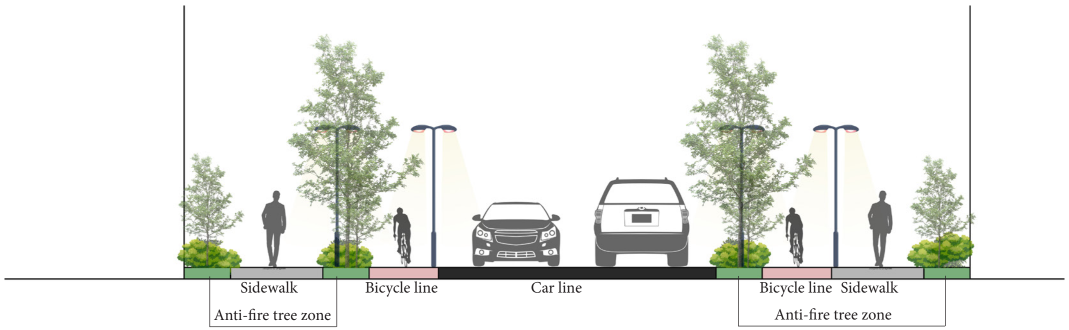


Figure 39 : Road Section / M 1:150 mm
Source: by author

6. Detailed city planning

6.1 Master plan

The principal concept is characterized by its symbolism and extravagance. This illustrated the design of the city in the shape of a circle with shopping facilities and administrative buildings at the center of the city. From the middle to the housing estates, three roads will lead to outwards. Originally, this circle was to take the form of a hand that entered the globe, symbolizes universal help, solidarity, sun, and light. This was why the initiative was renamed Heliopolis: Sun City. The Sun City idea is well known from different backgrounds. Heliopolis was, for example, an ancient Egyptian town, but it redefines the original designs of 1948 for Novokuznetsk or the original designs of Stalingrad of 1945, which also had a circular center and street light from the circle. The sun is precisely the star on which the eyes are centered and Louis XIV was called the King of the sun.
All analogies point to a high degree of importance for the project, on the verge of utopia.

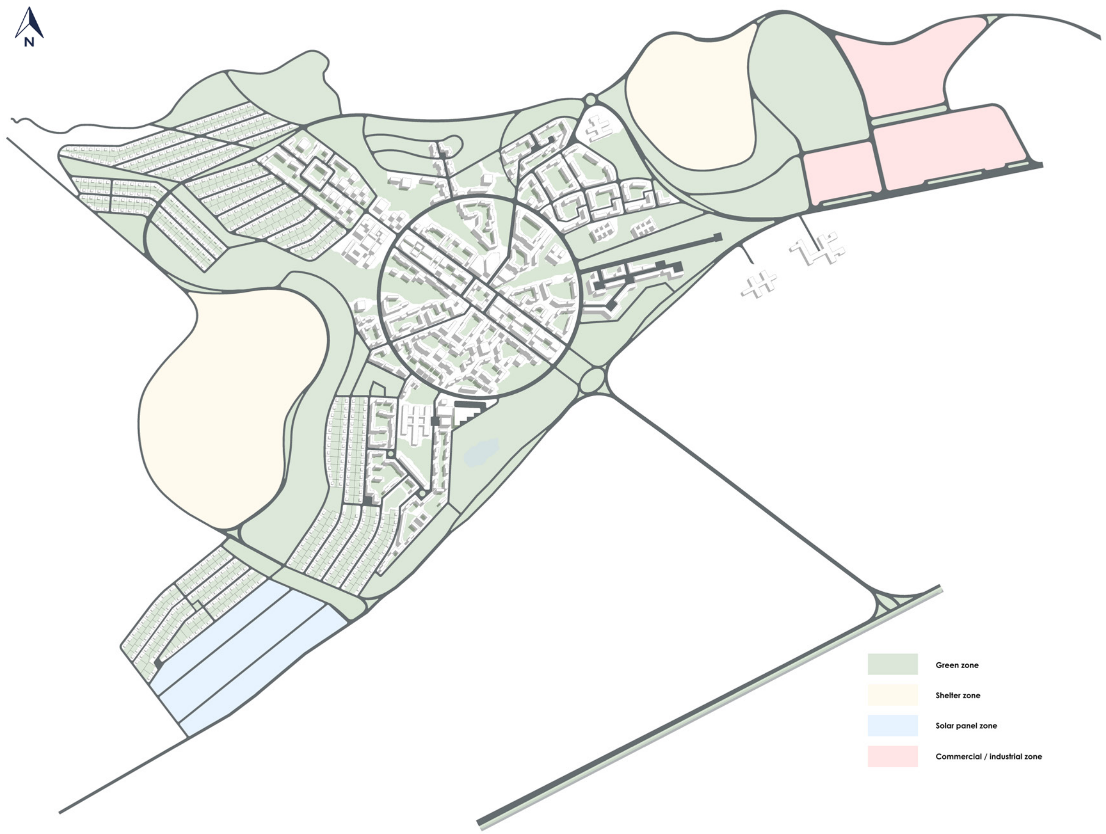


Figure 40 : Master Plan / M 1:15000
Source: by author

Ultimately, Spitak's long-term metamorphosis into the world's reference point is also a utopian concept that the circular sun figure with its endlessly far-reaching rays sought to convey, and this huge architectural undertaking.
To create good climatic conditions, the master plan outlined the harmonic and organizational integration of the new Spitak into mountain scenery. Besides efforts to create a city center closed to traffic, the dense road network within the master plan denotes a commitment to pedestrian friendliness and therefore lower emissions. Numerous parks would incorporate greenery into the city center's surroundings, creating a pleasant environment for residents. All factories were built outside the city to keep the air clean. In fact, with regards to seismicity, the concept of building design is simply a three-story building. These will stand up to an earthquake on the Armenian scale of up to 9. In addition to the fact that each new municipality, regardless of its sustainability, intrudes in nature, the ideas contained in the master plan show the need to develop a city that is organic and energy-efficient.

Figure 41 : Building analysis / 3D View
Source: by author

6.2 New Road System

The road infrastructure is totally redesigned fot this part of the city. According to topography, the city is divided into blocks, and every block has a conncetion with primary roads. When disasters happened, people can escape from every direction, the straight and clear road will help people to save time. The primary roads wide enouhg to have two or three green zone buffer with one bicycle line, and the secondary roadr equpied with one line of green buffer zone, and bicycle line will be fixed with car line.

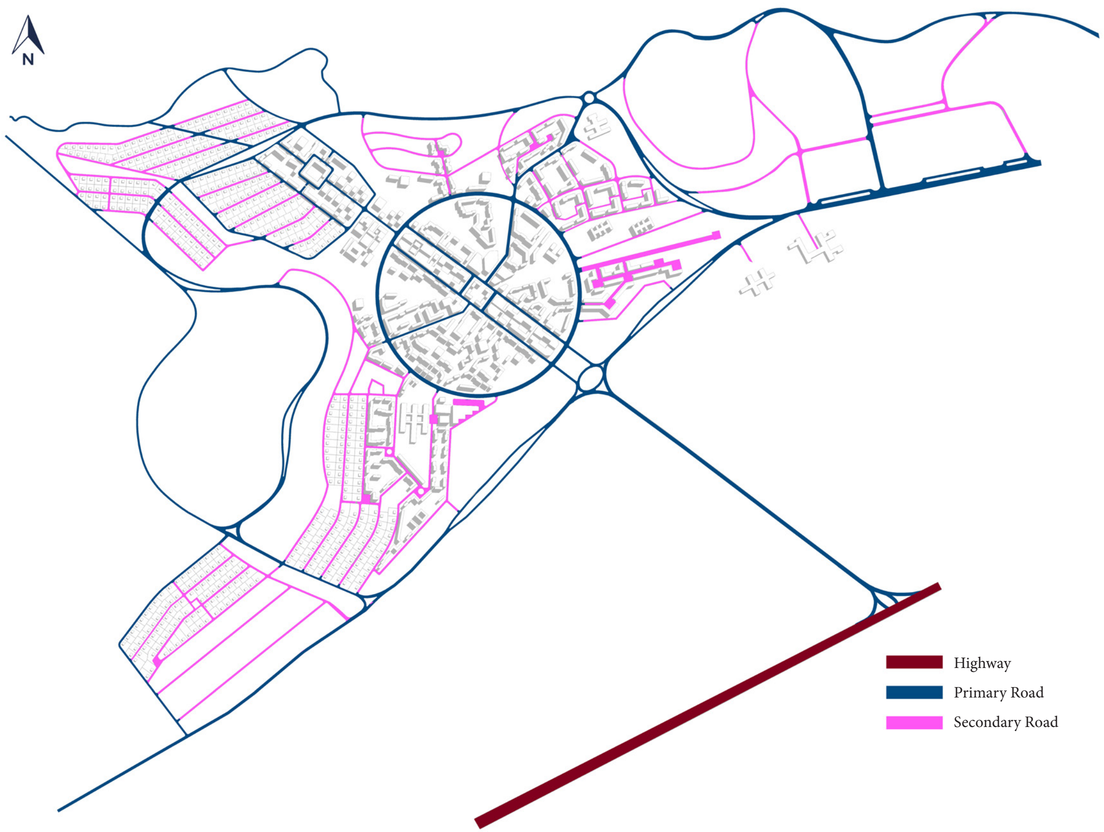


Figure 42 : Road System / M 1:15000 mm
Source: by author

6.3 Shelter and storage

The figure 42 illustrates the storage facilities and emerging shelters location. Storages are located in the school, factories and the first floor of some residential and commercial buildings. Emerging food, clothing, quilts, tents, and some other necessary disaster stuff should be stored. Also, in a certain period, this stuff will be replaced and checked to ensure its quality. Most of the emerging tent areas are also on the school playground and large green or empty ground in the factories because space should be wide and empty. Storages are always set up in these areas so that citizens can get food and supplies in good time. Hot water and some other basic supplies will also be provided in this area.

Figure 43 : Shelter and storage location / M 1:15000 mm
Source: by author

6.4 Oriented Disaster Relief Corridor

The most effective and easiest way to relief during the disaster is the road-oriented disaster relief corridor. As it has been discussed in the road infrastructure analysis chapter, all roads are meeting the standards for evacuation and have an influential disaster mitigation ability. According to the newly designed road infrastructure, there are two types of relief corridors. The relief Corridor 1 is the main relief or evacuation path. It's wide enough for escaping both by foot and car, and a large number of green spaces and shelters are on both sides of the corridor. The relief Corridor 2 is mainly along the border of the city. This is also very important because most of the factories are close to this corridor. The workers and important stuff will be rescued in this way.

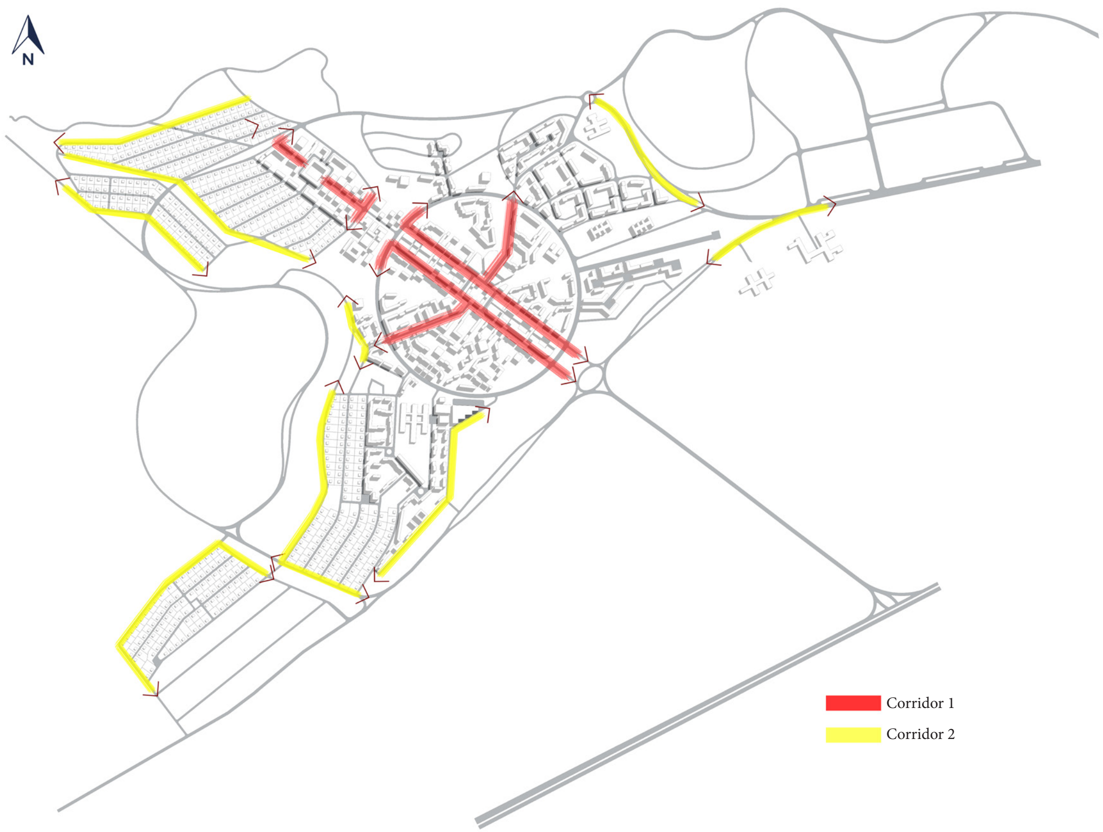


Figure 44 : Road oriented disaster relief corridor / M 1:15000 mm
Source: by author

6.5 Supplementary facilities

Emergency toilet

Earthquake accidents destroy the urban water supply and irrigation system to prevent the use of regular toilets. Emergency toilets should be placed at the convenient place of use, and easy to remove, move and control, as well as saving energy.

Signs

The disaster sign system concludes road signs and emerging shelter signs. The road signs are at the cross, so people can find where they are to go. Often, symbols can use as road signs at night.z The new shelter signs should be unique to other icons. Their functions should be easy to recognize through icons and colors like emerging clinics, tent areas, emerging landing fields, etc.

Fireproof materials

As we learn from the study, the earthquake also triggers secondary fire disasters. Therefore, the first step in building design, particularly for residential and public buildings, is the use of fireproof materials such as fireproof bricks and fireproof coatings.

Anti-seismic water supply

Anti-seismic water storage tanks allow the routine use of water for responders and firefighting. Hot water is basic infra-structure, but it is easy to ignore in urban emergency planning. Hot water source is close to new shelters and green spaces.

Temporary hospitals

Temporary hospitals and devices are also closed to the emergent shelters so that they can take the treatment and transfer of victims for the first time. Except for the temporary clinics, some anti-earthquake buildings in the disaster mitigation green area can be reformed as constant disaster hospitals.

Figure 45 : Emergency toilet
Source: by https://rdpo.net/emergency-toilet

Figure 46 : Anti-earthquake signs
Source: https://www.theguardian.com/cities/2019

7. Results

Hence my main aim in this thesis is to use the urban disaster planning method to devise a design plan for the Lori district, Spitak's central city area, to create a successful emergency shelter network, a continuous relief corridor, and modern practical architecture. This thesis contains two research questions:

Question 1. How can a relief zone contribute to disaster mitigation?

Question 2. In the case of Spitak, Lori, Armenia, how can a relief zone be designed?

The study questions can be answered through the concept proposal.
The proposed earthquake relief zone could be built by learning theories: avoidance of a secondary fire catastrophe, mitigation of this night, learning about West and Japanese parks systems, using photos of the city as a reference, experience with disaster needs, and so on. From these aspects, relief zones can play a significant role in the disasters from earthquakes.
The architectural part shows how the relief areas in Spitak are planned in a road-based system. The urban relief area covered every urban area through anti-disaster planning in this city. The new shelters can be identified in the shortest time in the relief hallway. Many lives can thus be saved in significant catastrophes. However, the most critical time can be helped by sufficient developing and full emergency resources in the relief areas.The program reflects on the world's imminent natural disasters, but thestrategy also includes specific limitations. During the disaster, the Spitak destroyed most of the roads infrastructure and buildings. In designing the road system, I change the way to be straighter, more extensive and divide the blocks in a definite order, based on the current situation. Nevertheless, they can not be bulldozed on a large scale in most cities, which also have an excellent earthquake hazard. Second, the digital drawing of Spitak is challenging to obtain. It is too expensive too buy the city maps which have done by architectural offices. Although I sent the related office and institutes email and post, they didn't answer me. Therefore, by using GoogleMap and current photos, I need to draw up the current digital basic map. The final map is right but is not exactly accurate for roads, buildings and green areas. The conceptual design is a thought, so the underlying map is not severe. But a detailed digital map of good quality is essential for us in real urban planning.
Spitak's reconstruction from the new level is only feasible once adequate plans and policies have been formulated. These are the approaches for urban renewable energies and revitalization from the cultural, social, and environmental perspectives of the recent earthquake.
The following are some of the major plans that are needed to develop:

Short term strategy:

These categories include those plans and policies which are very urgent to implement recently. These are the things to be completed within a few months, or a maximum of six months. These include the emergency till the construction phase of the transition shelter. Some major plans are as follows:

-Survey of all post-earthquake hospitals and schools and categorize them as available or not according to the case. If there are minor losses, it could be quickly repaired or it could take a long time, information, etc. This could be achieved using the sticker scheme such as green for functional, yellow for the partially affected, and red for the unusable in terms of the survey data.

-Residential houses and other structures like shopping malls and so on are also analyzed at the same time with public buildings.

-Training the architects, engineers, and other technical teams to assess and store the analysis of the damage.

-Urgent consultation with experts such as professors and specialists on temporary shelters and urgent preparations for rescue plans.

-There shall be urgent activation of emergency mobile medical support and drinking water teams.

-Communication with the affected areas using loudspeakers as to the closest relief camp as best possible.

Long-term strategy:

Long-term strategies are those plans and strategies which are to be carried out immediately after the gradual collapse of the earthquake or after the six months of the earthquake. Based on the complexity of the project, the short term strategy should be executed within 5 years and long term strategy up to 20 years. Long-term a few significant ones are:

-By mass media channels, public information about the earthquake, and safety measures. Community participation is very important to create awareness. For these campaigns the local clubs, organizations must be involved.
This public meetings or discussions should be lead by architects, civil engineeries, firefighters and rescuers organizations.

-Consideration of society as a part of the vulnerability mitigation campaign. To improve the common knowledge of society. For this reason should be organized theoretical and practical training by Lori municipality.

-The obtained experience from the society could be major to express a social and cultural capital with the technological support which could be very essential for the sustainable resilience structure

-Implementation of the seismic resilient structure constructions after forming a strong building code and policies.

-The need for urban code or guideline of urban development as in defense of earthquakes and a sustainable city.
This core or guideline should be developed by architects and civil engineers by taking account the Eastern and Western countries experience, which are mentioned in this thesis, and should be provided to people by Lori municipality.

-Organize trainings for people for the earthquake-resistant structures

-Use of computer simulation applications to discover the exact location after the city is again hit by an earthquake of magnitude 8.0 or more.

-The universities should be accessed with the potential disaster and disaster preparation should be part of educational programs.

-Provision of public spaces during the earthquake as an initial and emergency shelter.

-The retrofitting of the unsafe structures, which is done partly by now.

-The strait-laced scheme of emergency exits and their provisions, like maps or signs, which should be all over the city, schools, hospital, in public spaces and etc.

-Increase the width of the roads

-Organizing the earthquake-resilient construction-related job possibilities, which should be organized by the government of Armenia.

-Readiness towards the potential future disasters, by providing above mentioned guidlelines, trainings and public meetings.

-Forbid the new constructions in seismic active zones

-Develop transportation infrastructure which is risk-sensitive, by using modern technologies of civil engineering and experience especially of Eastern countries.

-Develop abilities for emergency response by improving access to emergency transports, decreasing density (essentially in the city area), planning and classification of open area, classifying and posting escape roads, developing firefighting and search and rescue skills, and emergency response preparation.

-Utilization of better construction technologies and experience towards earthquake resilience.

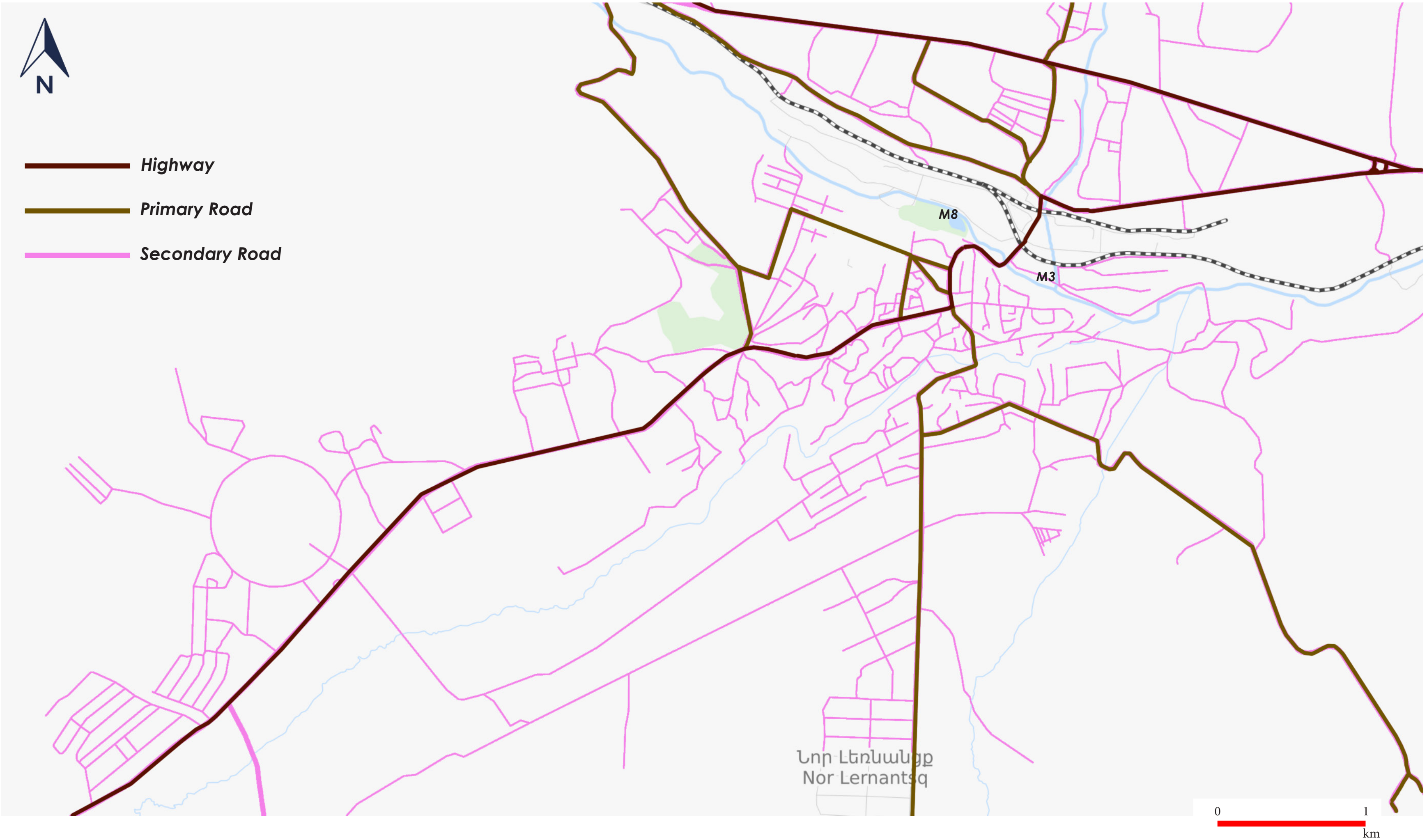


Figure 30 : Existing Transportation System
Source: by author

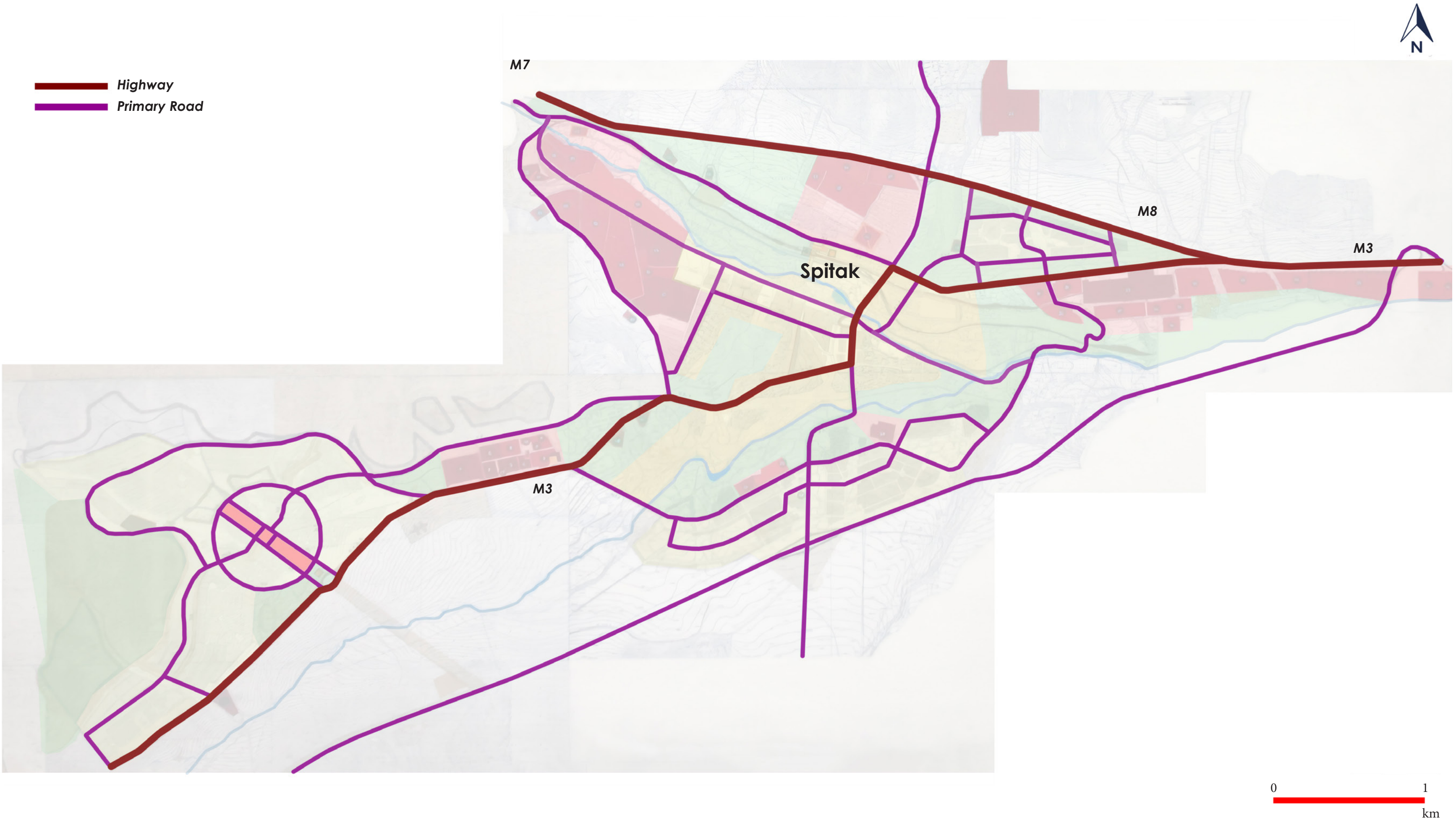


Figure 33 : New Internal Transportation System
Source: by author

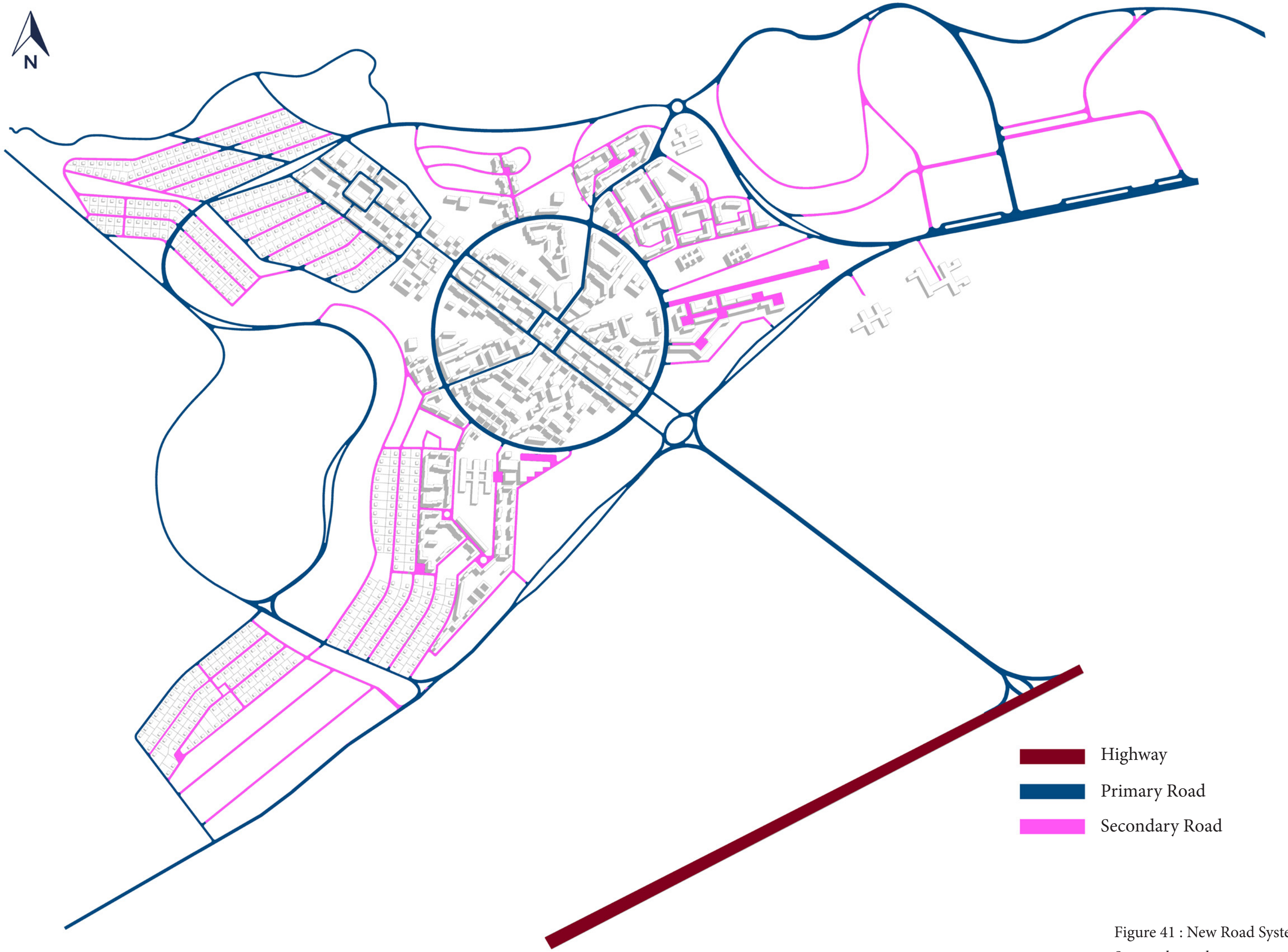


Figure 41 : New Road System / M 1:15000 mm
Source: by author

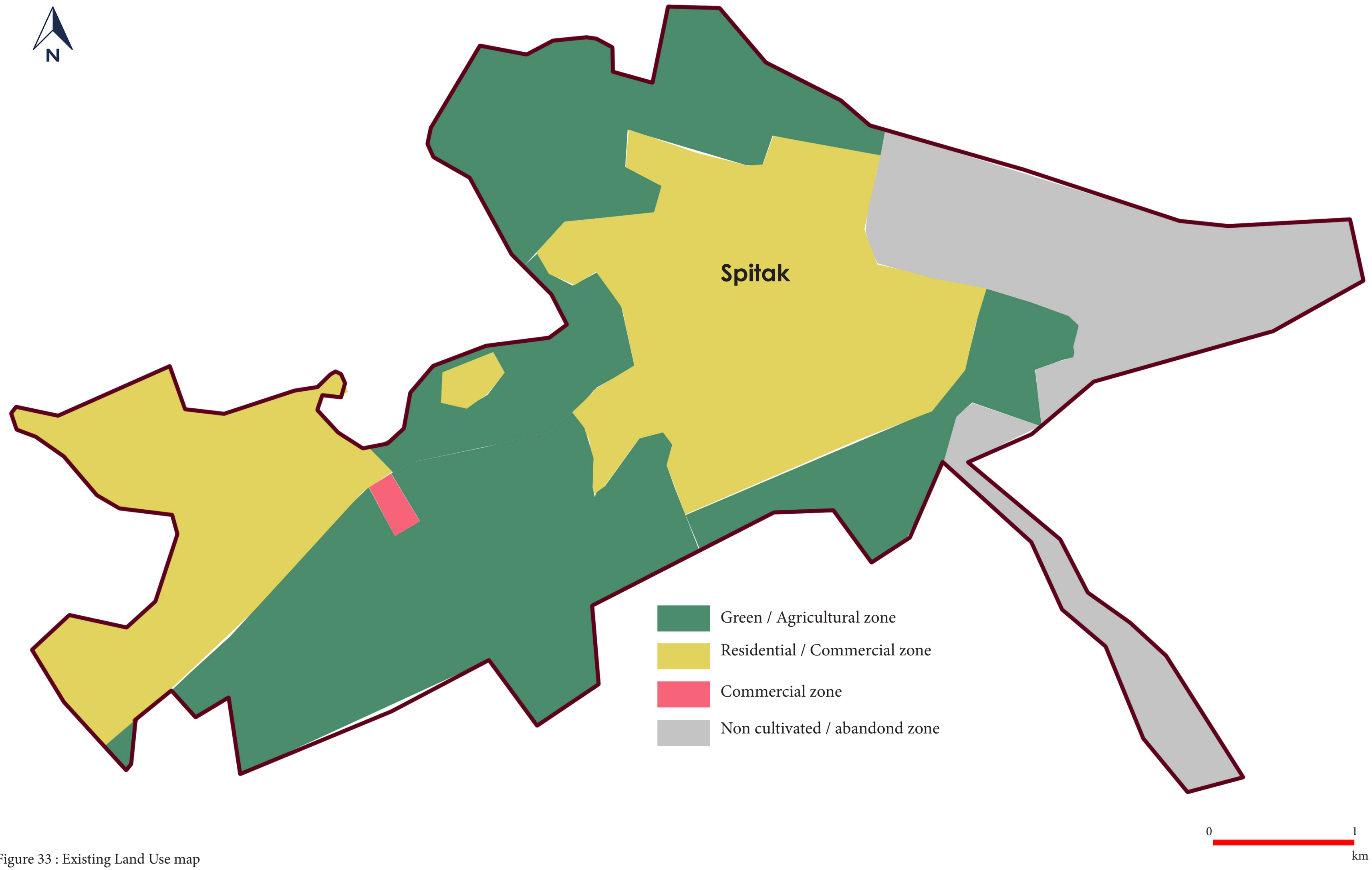


Figure 33 : Existing Land Use map
Source: by author

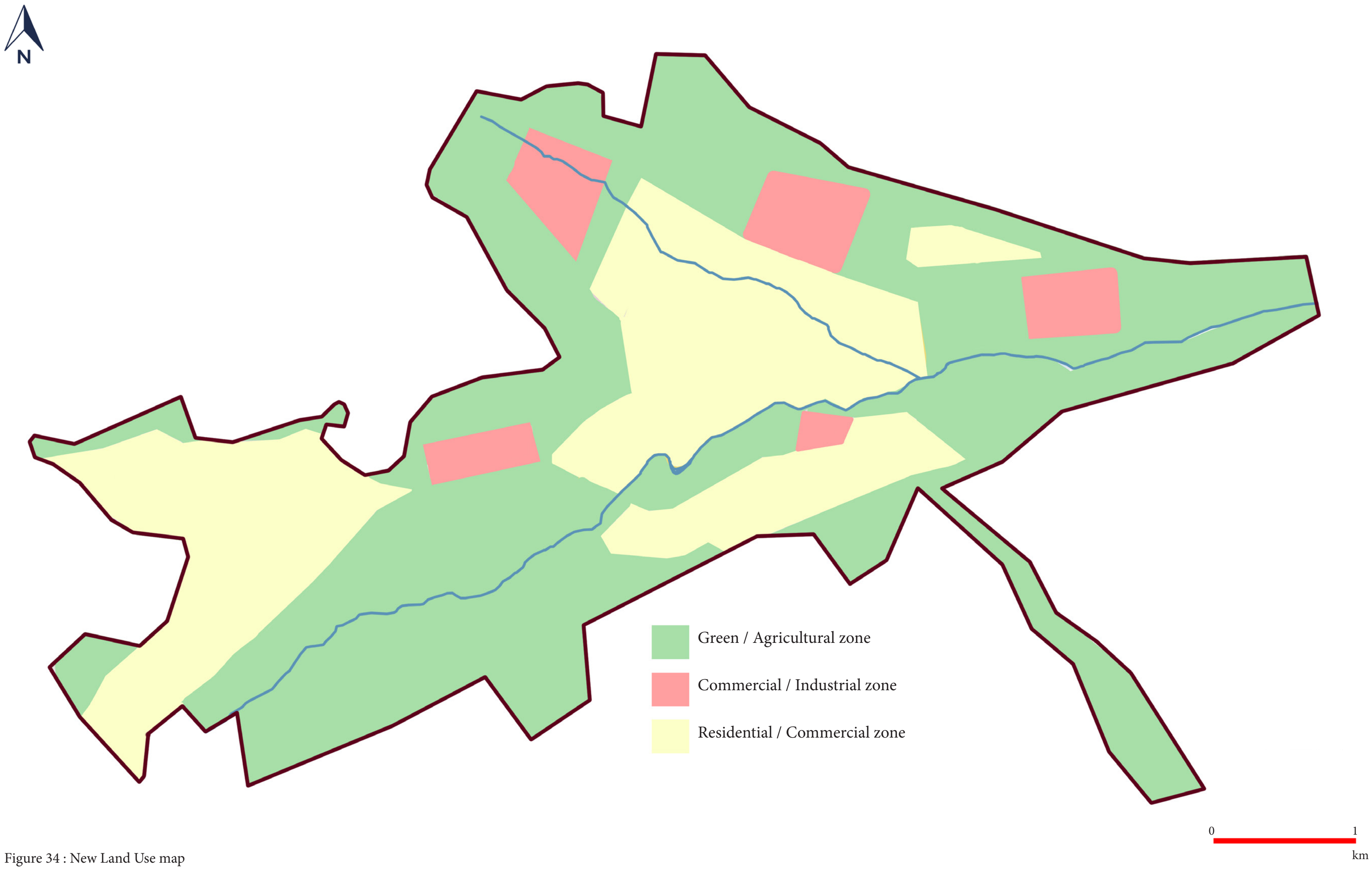


Figure 34 : New Land Use map
Source: by author

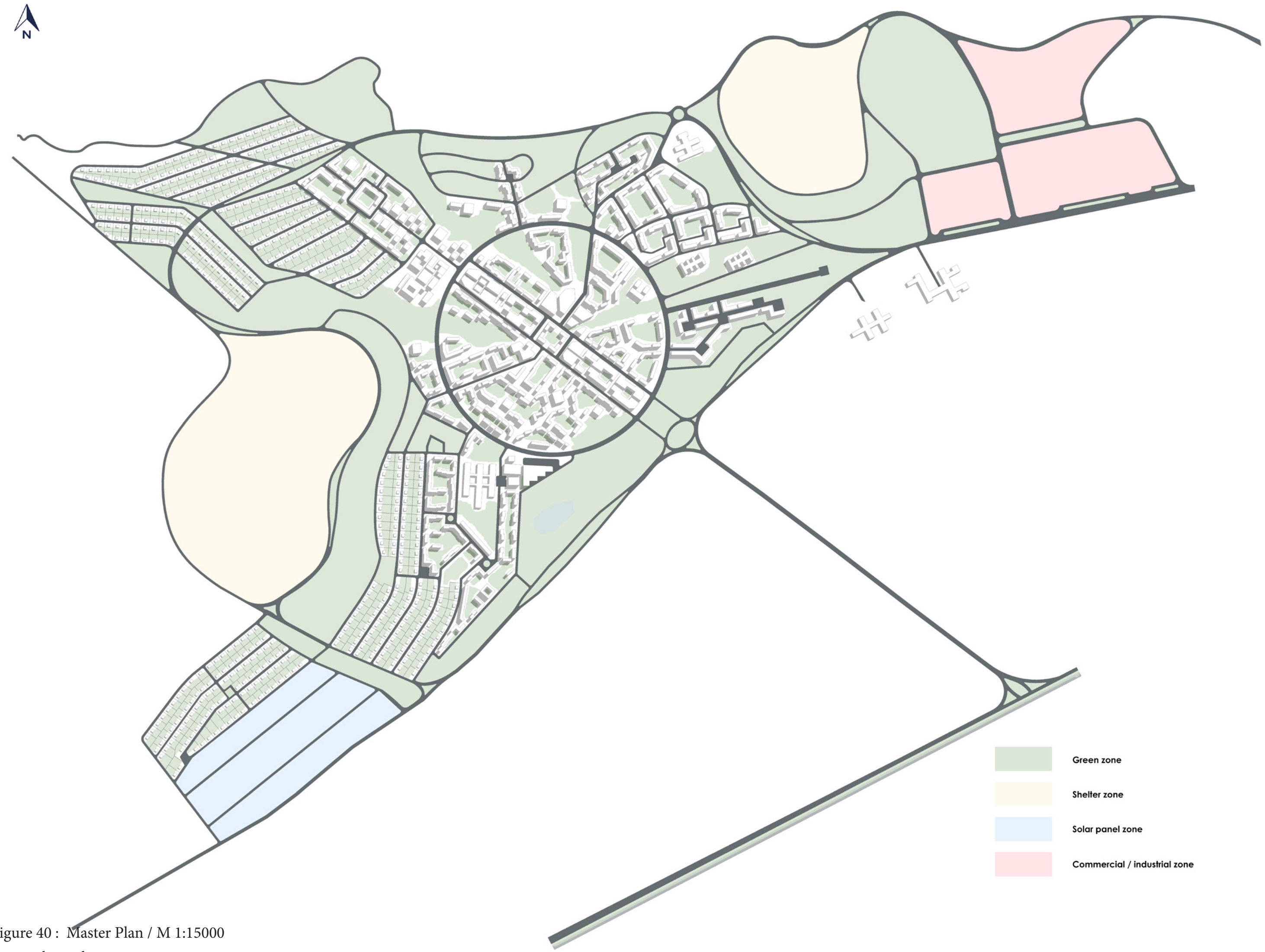


Figure 40 : Master Plan / M 1:15000
Source: by author

Figure 43 : Shelter and storage location / M 1:15000 mm
Source: by author

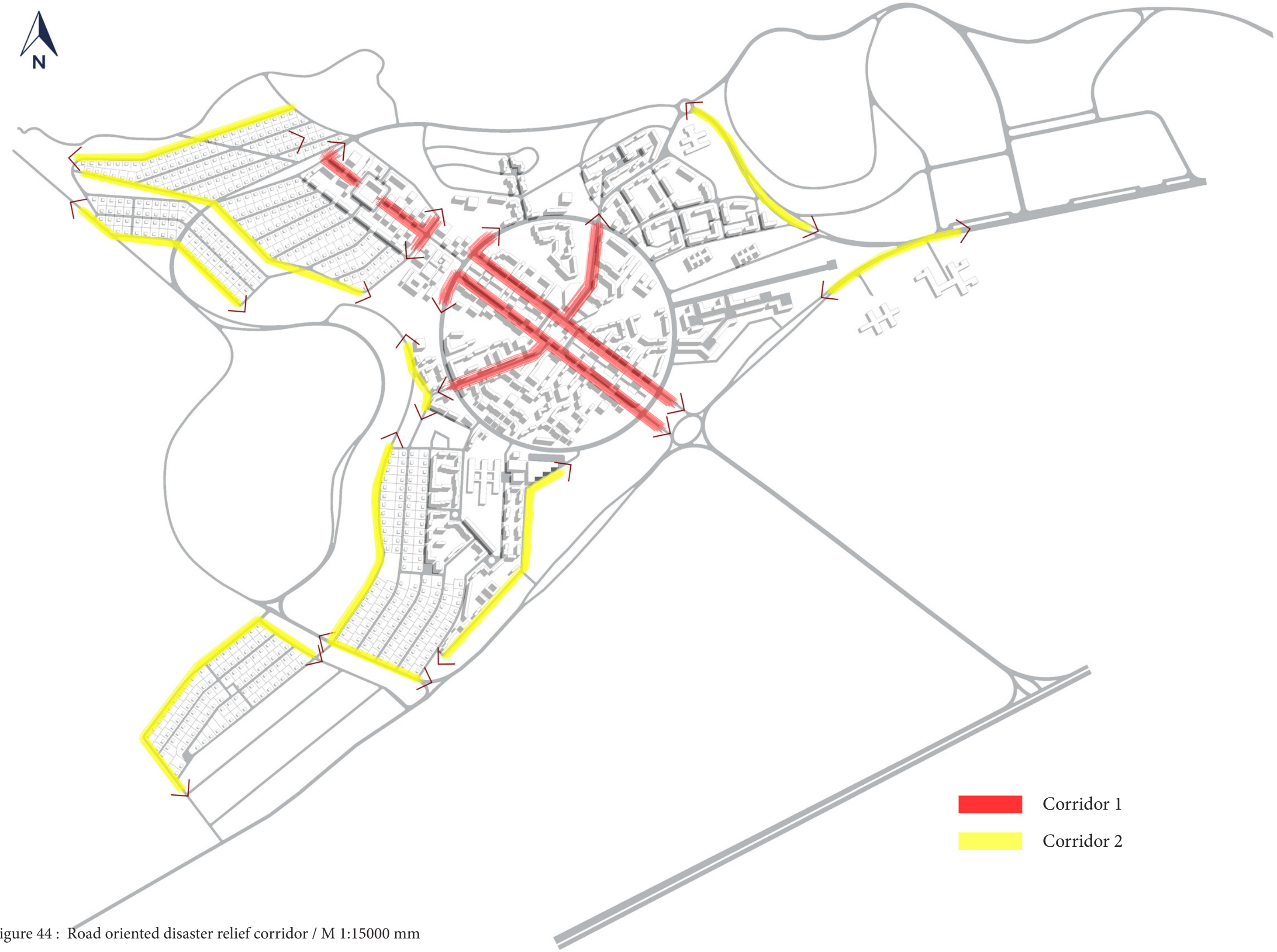


Figure 44 : Road oriented disaster relief corridor / M 1:15000 mm
Source: by author

8. Future Research

The purpose of this thesis to open opportunities for future research in urban redevelopment after and before the earthquake disaster. There is a and demand, and legal requirement for urban codes or policies in every city. The code is essentially required in the urban space which is more significant in terms of story and culture and also maintains urbanization. The development of urban code for Spitak is one of the planned study options founded after this thesis. The research concerning the original knowledge in terms of sustainability and resilience is also exciting for further investigation along with the recent scientist technological intervention. The business expansion and recovery for the post-disaster urban zone is also another impressive study for further research which is behind the limit of this analysis. The spatial analysis of the plan and the proper land-use plan including the risk-sensitive land management is another valuable analysis for the future.

Another significant vision for future study is to determine a suitable design of cities like Spitak which are on the edge of disaster. This model could be the one suggesting specific plans, strategies, and policies taking attention of socio-cultural-economic and environmental viewpoints of sustainability. There are numerous cities around the world which are unprotected in terms of some natural disasters in the form of earthquake, tsunamis, fire. This design consists of the possible preparation before the disaster and security during the disaster and rehabilitation after the disaster. One such model is formed it can be used as a model in the developing and unprotected cities of similar geological and socio-economic conditions.

9. Discussion

While this preparation focuses on the world's urgent natural disasters today, some shortcomings remain in this proposal. Spitak was heavily damaged in the great earthquake, most of the roads and buildings have been demolished, and I can examine and make the preparation learned from the literature and experiences. Once I build the road network, I adjust the road to be straighter, broader, and divided the blocks in a single order, based on the current situation. However, they cannot be bulldozed on a large scale to most cities, which also have a substantial earthquake risk.

Second, it is hard to get any digital map of Spitak. The Digital map of cities in Armenia is offered at a high price to architecture institutes. While I sent emails andmessages to the appropriate office and institutes, they gave me no reply. For this reason, based on Google Maps, Mapy.cz current images, I need to draw the latest digital basic map. The final map displays the roads, buildings, and green spaces accurately, but it is not completely precise. Thinking this is a conceptual design. Therefore the simple map is not extreme. However, precise and useful- a digital map is essential for us in real urban planning.

Third, this subject applies to several subjects, such as Geography, Disaster Science, Systematic Disaster Science, Disaster Engineering, etc. Despite the lack of engineering research, some non-engineering considerations are included in the design, such as anti-fire wall painting, hot water supply, etc. However, some technical studies such as the seismic reserve capacity coefficient and the degree of damage to the buildings are not discussed in the design, either of the hot water channel settlement. It should be updated in the future, and further research should be undertaken.

Since the study object of this thesis is the region, there are several different types of cities, so just choosing Spitak since case study can be a limitation. Actually, in the aspect of different topography, scale and other characters, whatever city to be chosen have its limit. Therefore, I think it is essential to tailor the steps to local circumstances. When we do have more work in various case studies, it will be more useful.

Further earthquake disaster relief corridor studies are still underway, beginning from a deeper stage. That is, we need to do a systematic and more in-depth analysis of the theory and practice of Armenian planning in the related fields, summarize the experience of predecessors and get inspiration and reference. At the same time, we need scientific integration of the latest foreign science, objectively evaluating and summing up the advanced research system, realistic experience and exemplary case in Western countries, Japan and China, in order to avoid detours and accelerate the cycle of relevant study in our country, direct anti-disaster preparation and development.

In addition, reinforcing work on plant species mitigation and planting methods, using unique features of garden plants, taking scientific planting methods are the next challenges in supporting urban green space performing stronger disaster functions. Also, some quantitative studies need to be considered, such as the width and size of planting and plantation plants.

10. Conclusion

Spitak city is one of the biggest tragedies in the modern history of Armenia, and even after the velvet revolution, the new government is not able to heal these wounds. The main reason for this tragedy is the lack of preparedness against earthquakes, poor construction systems, and luck of anti-disaster policies and strategies. Another perspective might be the lack of proper techniques to record the earthquake and the damages.
The population change and the migration destination for the maximum internal displaced population are also the addition of the urbanization. Despite the remarkable past, Spitak seems to be incapable of the urban transformation as the transformation is beyond the planning and is haphazard. This combines vulnerability to the disaster. Many investigations regarding the vulnerability estimation of Spitak suggest the actuality of a threat concerning the high loss of human beings and infrastructural losses.
Information from the interview regarding cultural and social capitals are as follows:

-Society still is not with enough earthquake-resilient knowledge.

-There are small social groups in the communities of the Spitak which is very helpful for the delivery of local knowledge and other activities to be accomplished at the community level.

-There are various associations working for several ideas like for the maintenance of churches, operating the schools, etc.

-A community organization with adequate knowledge and financial resource with the harmony to the existing management system is inevitable for resilience governance.

The disaster is always against the development. If we face some disasters than this is indispensable it costs us time and money to rebuild although the exact resurrection is impossible. This is very important for the sustainable redevelopment of Spitak after Earthquake 1988 support the limited and poor societies as they are the most prone to a disaster like an earthquake and other. Usually, they are lacking the appropriate housing and employment which ultimately leads them to more vulnerable. This is positive that the capacity can nullify the vulnerability and this is possible using the cultural and social capital through the community-based organization's involvement in cooperation with national and international organizations.

The formulations of strategies and methods which are very severe in implementation extending the city flexibility and developing sustainability of Spitak. Beginning from the urban code which is very essential. The plans involving the local community are very important to implement sooner rather than later which could be beneficial immediately. The short term plans are to be immediately into action as the last earthquake of The people living in the city is still out of the proper help from the government. However, the people are already adapted to this disaster effect and accepted this as a natural fate. The people are without any hope from the government as the government lacks to gain the faith of the people.

11.Bibliography

"20 Years of Disaster Risk Reduction in Latin America and the Caribbean | European Civil Protection and Humanitarian Aid Operations." https://ec.europa.eu

" Communities Association of Armenia." https://www.caa.am

Albala-Bertrand, J M. 2003. "Urban Disasters and Globalization." In Building Safer Cities, , 75–82. http://elibrary.worldbank.org

Alexander, David C. 2017. Natural Disasters Natural Disasters.
Alshenqeeti, Hamza. 2014. "Interviewing as a Data Collection Method: A Critical Review." English Linguistics Research 3(1): 39–45. http://www.sciedu.ca

Aprile, Luca, and Civil Engineering. 2016. "Cara, Selma."
"Armenia Earthquake Anniversary – 2 0 3 0 – Medium." https://medium.com

Azatutyun. 2018. "Still Recovering: Armenia's Catastrophic Earthquake, 30 Years Later." https://www.rferl.org

Bakun, William H. 2005. "Magnitude and Location of Historical Earthquakes in Japan and Implications for the 1855 Ansei Edo Earthquake." Journal of Geophysical Research: Solid Earth 110(B2). http://doi.wiley.com

Balassanian, Sergey Y. et al. 1995. "Retrospective Analysis of the Spitak Earthquake." Annali di Geofisica 38(3–4): 345–372.
Bronson, William. 1959. The Earth Shook, the Sky Burned. Doubleday.

CRED, UCL, USAID, and UNISDR. 2015. "The Human Cost of Natural Disasters." : 1–55.

DFID. 2009. "Disaster Risk Reduction in Urban Areas (Evidence and Lessons from Latin America)." : 1–5.

District, Yucheng. "Planning and Design of Earthquake Disaster Relief Corridor in Stricken Cities."

Doose, Katja. "Spitak : The Last Petrified Soviet Utopia."

Dust, Combustible. "Understanding the Hazard Combustible Dust." : 1–4.Edited by Murat Özyavuz.

ELLA. 2017. Urban Disaster Risk Management in Latin American Cities. http://ella.practicalaction.org

EM-DAT. 2016. "Database | EM-DAT." EM-DAT. https://www.emdat.be

Engineering, Earthquake. 2007. "Comparison of Italian Seismic Codes.Pdf."

Evacuation Planning HANDBOOK 4 Australian Disaster Resilience Handbook Collection. https://www.ncoss.org.au

French, Emily L. 2017. “Designing Public Open Space to Support Seismic Resilience : A Systematic Review by The University of Guelph for the Degree of Master of Landscape Architecture.”

Gilbert, Grove Karl, Richard Lewis Humphrey, John Stephen Sewell, and Frank Soule. 1907. The San Francisco Earthquake And Fire of April 18th, 1906 And Their Effects On Structures And Structural Materials. Washington: Government Printing Office. https://books.google.com

Glenday, Craig, and publisher. Guinness World Records Limited. 2013. Guinness World Records 2014.

Goenjian, A K et al. 1994. “Posttraumatic Stress Disorder in Elderly and Younger Adults after the 1988 Earthquake in Armenia.” The American journal of psychiatry 151(6): 895–901. http://www.ncbi.nlm.

Gough, D E, I F Hammerton, T R Bridle, and C K Hertle. 1991. Proceedings 14th AWWA Federal Convention, Perth, Australia Demonstration of the Oil-from-Sludge Technology at the Malabar Sewage Treatment Plant.

Greely, Adolphus W. 1906. Earthquake In California, April 18, 1906. Special Report On The Relief Operations Conducted By The Military Authorities. Washington: Government Printing Office. https://books.google.com

Hari, Johann. 2011. “The Myth of the Panicking Disaster Victim.” Huffington Post. http://www.huffingtonpost.com

Jordan, David Starr et al. 1907. The California Earthquake of 1906. San Francisco: A. M. Robertson. https://books.google.com/

Kawata, Yoshiaki. 1991. “Urban Natural Disasters-Doc5801.Pdf.” http://cidbimena.desastres.hn/pdf/eng/doc5801/doc5801.pdf.

Kobayashi, Reiji, and Kazuki Koketsu. 2005. “Source Process of the 1923 Kanto Earthquake Inferred from Historical Geodetic, Teleseismic, and Strong Motion Data.” Earth, Planets and Space 57(4): 261–70. http://earth-planets-space.springeropen.com

Kopić, Miloš, and N K Folić. 2011. “Principles of the Design of Urban Space That Support Rail Systems from the Aspect of Urban Elements and Elements of the Relief.” Geodetski Vestnik 55(4): 726–49. www.funini.com

Lee, Eun-gyong. 2015. “The Great Kantō Earthquake and ‘Life-Rationalization’ by Modern Japanese Women.” Asian Journal of Women’s Studies 21(1): 2–18. https://www.tandfonline.com

Manual, D E E P TM. Disaster Emergency Evacuation Preparedness. https://www.azdhs.gov/documents/licensing/childcare-facilities/training/deep-manual.pdf

MOROI, Takafumi, and Masayuki TAKEMURA. 2004. "Mortality Estimation by Causes of Death Due to the 1923 Kanto Earthquake." Journal of JAEE 4(4): 21–45. https://www.jstage.jst.

Most Destructive Earthquakes. U.S. Geological Survey. https://earthquake.usgs.gov

Noboru MASUDA. 2014. "Disaster Refuge and Relief Urban Park System in Japan." 2(4).

Nyst, M., T. Nishimura, F. F. Pollitz, and W. Thatcher. 2006. "The 1923 Kanto Earthquake Reevaluated Using a Newly Augmented Geodetic Data Set." Journal of Geophysical Research: Solid Earth 111(B11): n/a-n/a. http://doi.wiley.com

Proulx, Guylene, and Curt Mcqueen. 1994. I*I Council Canada de Recherches Canada Construction Construction June IWC-CIUC Evacuation Timing in Apartment Buildings Evacuation Timing in Apartment Buildings. www.funini.com

Rule, Basic, and Demonstrating Intent. 1974. Performing arts UC Riverside.

Scawthorn, Charles. et al. 2005. Fire Following Earthquake. Reston, Virginia: American Society of Civil Engineers. http://www.asce.org

Scawthorn, Charles. Fire Following Earthquake. https://www.iafss.org

Schorlemmer, Danijel, Stefan Wiemer, and Max Wyss. 2005. "Variations in Earthquake-Size Distribution across Different Stress Regimes." Nature 437(7058): 539–42. http://www.ncbi.nlm.

Segall, P, and M Lisowski. 1990. "Surface Displacements in the 1906 San Francisco and 1989 Loma Prieta Earthquakes." Science (New York, N.Y.) 250(4985): 1241–44. http://www.ncbi.nlm

Sela. Disaster Risk Reduction in Latin America and the Caribbean: A Guide for Strengthening Public-Private Partnerships: Economic and Technical Cooperation. http://www.sela.org

Siodla, James. 2017. "Clean Slate: Land-Use Changes in San Francisco after the 1906 Disaster." Explorations in Economic History 65: 1–16. https://linkinghub.elsevier.com

Smolka, A. 1988. "[Natural Disasters]." Naturwissenschaften 75(7): 327–33. http://www.ncbi.nlm.nih.gov

Song, S. G., G. C. Beroza, and P. Segall. 2008. "A Unified Source Model for the 1906 San Francisco Earthquake." Bulletin of the Seismological Society of America 98(2): 823–31. https://pubs.geoscienceworld.org

"Spitak." https://armeniadiscovery.com/en/city/spitak (March 9, 2020).

"The Great Kanto Earthquake of 1923." library.brown.edu. http://library.brown.edu/cds/kanto/ksmith.html (February 16, 2019).

The San Francisco Earthquake And Fire: A Presentation of Facts And Resulting. 1906. New York: The Roebling Construction Company. https://books.google.com

Unit, Development, and Statistical Divisions. 2002. "E CONOMIC C OMMISSION FOR L ATIN A MERICA AND THE C ARIBBEAN (ECLAC) Recent Policy Statements." (May): 2002–3.
Urban Natural Disasters-Doc5801.Pdf.

Vorst, Harrie C M. 2010. "First International Conference on Evacuation Modeling and Management Evacuation Models and Disaster Psychology." www.sciencedirect.com

Wald, David J., Hiroo Kanamori, Donald V. Helmberger, and Thomas H. Heaton. 1993. "Source Study of the 1906 San Francisco Earthquake." Bulletin of the Seismological Society of America 83(4): 981–1019. http://pasadena.wr.usgs.gov

Wang, Jing-ai et al. 2008. "The Regionalization of Urban Natural Disasters in China." Natural Hazards 44(44): 169–79. http://link.springer.com

Wyss, Max. 1979. "Estimating Maximum Expectable Earthquake from Fault Dimension." Geology 7(of M): 336–40. https://pubs.geoscienceworld.org

Yin, Robert K. "Yin Case Study."

Zhong, Jiangrong, Zhendong Zhao, and YU Shizhou. 2008. "Study on the Secondary Fire of Earthquake." The 14th World Conference on Earthquake Engineering (MMI).

12.List of figures

13.List of appendixes

Appendix 1: Existing Internal Transportation System
Appendix 2: New Internal Transportation System
Appendix 3 : New Road System
Appendix 4 : Existing Land Use Map
Appendix 5 : New Land Use Map
Appendix 6 : New Master Plan
Appendix 7 : Shelter & Storage location
Appendix 8 : Road oriented disaster relief corridor
Appendix 9 : 3D View