Disaster Reduction in Developing Countries

- Urban Poverty and Earthquake Vulnerability in Slums

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Printed in Sweden
Media-Tryck
Biblioteksdirektionen
Lunds universitet
Lund 2012

Abstract

The urban population in developing countries was, in 2005, more than 2.3 billion people, which forms an increase by 7 times comparing to the situation in 1950. This is expected to increase even more, until it reaches 3.9 billion by 2030. A parallel urban growth results in high density cities and informal settlements and the creation of urban slums. Naturally, it is the urban poor who are not able to afford formal settlements, and consequently they are forced to settle in the peripheries of cities or in densely built areas where they are abandoned by the authorities and suffer from the lack of basic services. The United Nations have achieved some progress with their eight Millennium Development Goals (MDGs) that were adopted in September 2000 but still there is a lot of work to be done.

The rapid growth of cities has been contributing to the global warming and in turn, the increase of natural disasters – the catastrophic disasters. The chronic disasters due to poor housing, lack of basic services and infrastructure, etc., are associated with the catastrophic to make the urban slums even more vulnerable for natural disasters, particularly earthquakes since a big proportion of the world's population is living in seismically active areas. Earthquakes are the least predictable of all natural hazards, the interval between threat and occurrence is also very short which puts them on the top of the list of natural disasters as they cause immediate mortality and destruction of built environment.

It is impossible to make a building completely earthquake-resistant, even well-planned buildings are badly affected when a strong earthquake strikes. However, we are able to list the main objectives while designing an earthquake-resistant building to reduce the damages, both human and economic ones. These objectives are avoiding collapse or serious damages in a situation of unusual ground shaking, mitigating construction damages and minimizing non-structural damages in a light ground shaking. Simplicity, symmetric plan, low density materials, short scope, low height and uniform floor heights are preferable when designing such buildings.

This thesis has concluded that disaster management is crucial for saving the lives of the urban poor in slums around the world. Generally, the disaster management tends to have some common goals for all types of natural disasters; to reduce or avoid losses from hazards, to assure rapid assistance to victims and to achieve an effective recovery. Risk reducing actions can be divided into five phases; the pre-disaster mitigation and preparedness and post-disaster response, recovery and reconstruction. Each of these phases includes integrated actions like strategies and policy-making to reduce the

likelihood of the disaster occurrence as well as reconstruction approaches. One of the most essential goals is the action of providing safe shelters and housing units.

Keywords: developing countries, vulnerability, hazard, earthquake, disaster management.

Sammanfattning

Den urbana befolkningen i utvecklingsländerna bestod av 2,3 miljarder människor 2005, vilket motsvarade en ökning på sju gånger sedan 1950. Detta förväntas öka ännu mer tills det når 3,9 miljarder 2030. Samtidigt bidrar denna urbana ökning till kompakta städer och informella bosättningar och fler slumområden. Naturligtvis är det de fattiga som inte har råd med formella bostäder som hamnar i städernas utkanter eller i tättbebyggda områden där de blir övergivna av myndigheterna och drabbas av brist på nödvändiga tjänster. Förenta nationerna har genom sin Millennium Development Declaration uppnått några resultat med de åtta Millennium Development Goals som sammanfattades i September, 2000, men endast långsamma framsteg har tagits.

Den snabba stadstillväxten har bidragit till den globala uppvärmningen vilken i sin tur ökat naturkatastroferna. De katastrofala naturkatastroferna samverkar med de kroniska katastroferna som är orsakade av bristfälliga byggnader, brist på nödvändiga vardagliga tjänster och infrastruktur, etc. Dessa medverkar tillsammans för att skapa en kritisk situation för slumområden och gör dem ännu mer utsatta för naturkatastrofer, speciellt för jordbävningar då en stor del av världsbefolkningen befinner sig i seismiskt aktiva områden. Jordbävningar är de minst förutsägbara av alla naturkatastrofer och intervallet mellan hotet och olyckan är väldigt kort vilket gör dem till de mest förödande när det gäller omedelbar dödlighet och förstörelse av den byggda miljön.

Det är nästan omöjligt att göra en byggnad helt jordbävningsresistent eftersom även de mest välplanerade byggnaderna påverkas svårt under en stark jordbävning. Däremot kan vi lista de viktigaste målsättningarna när vi designar en jordbävningsresistent byggnad för att minska både mänskliga och materiella skador. Dessa mål är att undvika ras eller allvarliga skador under en ovanlig markskakning, att minska konstruktionsskador samt att minimera icke-strukturella skador vid lättare markskakning. Enkelhet, symmetrisk plan, låg densitet och enhetlig bjälklagshöjd är exempel på egenskaper som måste beaktas vid design av sådana byggnader.

Den här uppsatsen har kommit fram till att katastrofhanteringen är avgörande för räddandet av miljotals liv i urbana slumområden runtom i världen. I allmänhet har alla hanteringar av naturkatastrofer ganska gemensamma mål; att minska eller undvika förlusterna, att försäkra en snabb hjälp till offren och att uppnå en effektiv återhämtning. Riskreducerings åtaganden kan uppdelas i fem faser; två faser ligger före katastrofen och de är minskning av risker och skapandet av beredskap och tre faser ligger efter katastrofen och de är respons, återhämtning och återuppbyggnad. I var och en av dessa faser ingår

integrerade åtgärder som strategier och beslutsfattande för att minska sannolikheten av katastrofhändelsen samt återuppbyggnadsmetoder. En av de mest väsentliga målen är åtgärder för att tillhandlahålla skydd och trygga bostäder.

Nyckelord: utvecklingsländer, sårbarhet, risk, jordbävning, katastrofhantering.

Foreword

This thesis, written in the beginning of 2012, corresponds to 22.5 ETC and is the final assignment of my bachelor degree in civil engineering with architecture at Lund University. The idea grew in February 2011, when I studied a course on International Sustainable Development; all the work that my lecturers Erik Johansson, Laura Liuke and Maria Rasmussen at Housing Development and Management (HDM) had accomplished in developing countries in different parts of the world and the interesting issues which were brought up in the course changed my view of the future and my ambition to study more in this field and take advantage from the knowledge I gain in order to give, when possible, a helping hand to the millions who are suffering all over the world.

I would foremost like to thank my supervisor, the architect and lecturer at Lund University, Mrs. Laura Liuke, for her support and advice throughout the project and most of all for her availability that facilitated my work. Special thanks to my examiner Erik Johansson who helped me to define the subject since the interest in the beginning was for urban housing in developing countries which is a very wide subject. Thanks to Laura and Erik also for all the literature they lent me so I could get started with my study.

List of contents

List of Abbreviations

CRS	Catholic Relief Services
DM	Disaster Management
DRC	Democratic Republic of Congo
DRM	Disaster Risk Management
ERC	Emergency Relief Coordinator
FRC	Federal Relief Commission in Pakistan
GCMA	Greater Cairo Metropolitan Area
GDACS	Global Disaster Alert and Coordination System
GNP	Gross National Product
H	Hazard
HDFC	Housing Development Finance Company of the Indian government
HDM	Housing Development and Management, Lund University
HFHP	Habitat for Humanity Pakistan
IASC	Inter-Agency Standing Committee
ICRC	International Committee of the Red Cross
IDB	Inter-American Development Bank
IDNDR	International Decade for Natural Disaster Reduction
IFRC	International Federation of Red Cross, Red Crescent Societies
IMF	International Monetary Fund
INSARAG	International Search and Rescue Advisory Groups
IRC	International Rescue Committee
LDCs	Least Developed Countries
MDGs	Millennium Development Goals
MHADA	Maharashtra Housing and Area Development Authority
MINU-STAH	United Nations Stabilization Mission in Haiti
MMS	Modified Mercalli Intensity Scale
NGOs	Non-Governmental Organizations
NHP	National Housing Program in Egypt
OCHA	Coordination of Humanitarian Affairs
OECD	Organization for Economic Co-operation Development
PAR	Pressure and Release
R	Risk
RRF	Rapid Response Fund
RRM	Rapid Response Mechanism
SAARC	South Asian Association for Regional Cooperation
SIDA	Swedish International Development Cooperation Agency
SRSA	Swedish Rescue Service Agency
UMP	Urban Management Program
UN-	United Nations Human Settlement Program

HABITAT
UNDAC United Nations Disaster Assessment and Coordination
UNDP United Nations Development Program
UNFPA United Nations Population Fund
UNGA United Nations General Assembly
UNHRD United Nations Humanitarian Response Depot
UNICEF United Nations Children Fund
UNOCHA United Nations Coordination of Humanitarian Affairs
USAR Urban Search and Rescue
V Vulnerability
WFP World Food Program
WHO World Health Organization

1 Introduction

1.1 Background – Earthquakes as Disasters

It's seldom that people, when any natural catastrophe takes place, feel so helpless like they do when an earthquake strikes. Earthquakes cause that everything around starts shaking, buildings collapsing and the earth fractures. Even people inside buildings feel the same fear for being killed, fastened or prisoned." (Brandsjö, 1996)[1]

The most devastating of all natural hazards are earthquakes since they occur without any warning. In less than one minute, the number of mortalities, injured and homeless get very high compared with other natural hazards. The whole infrastructure might be affected due to the following damages, fires, damaged water supplies, sewage and gas lines as well as transportation and communication systems.

In 1989 an earthquake in San Francisco caused the death of 63 people while the earthquake in Haiti, 21 years later, caused the death of about 20 000 people. What does the huge difference in losses of life depend on?

Natural hazards have mainly a major impact on people living in poverty. It is not the earthquake itself that is mortal, but the collapsing buildings especially when insecure methods and materials are used to reduce the construction costs. Besides, the economic effects of earthquakes are different for people living in poverty; structures that collapse very easily when an earthquake strikes the city cause an increasing number of mortalities and a harder life for the survivors.

Disasters are brought about by the lack of communication between the key authorities such as emergency service, politicians, scientists, etc. and the population. Sometimes, the risks are ignored by the government to avoid economic disruption concerning foreign investors. Otherwise, even when the information is official, it seldom reaches the key actors because of the poor communication.

At municipal level, it is the authorities' responsibility to control the construction standards but at the same time they find obstacles for the implementation of them. The situation looks even worse in many cities that have lack of professional staff. Consequently, the lack of human and financial resources at both city and municipal level and also institutions, where

[1] "*Knappast vid någon annan typ av katastrof känner sig människor så hjälplösa och oförmögna att rädda sig själva, som då allt omkring dem skakar, byggnader rasar och marken rämnar. De som är inomhus upplever skräcken av att kunna bli dödade, fastklämda eller instängda."*

corruption is dominating, are the main reasons for the insufficient vulnerable constructions in poor urban areas (Pelling, 2003). Apart from the destruction caused by earthquakes, whole countries are influenced by the governments' weakness and failure to resist the consequences and the deteriorated economic situation caused by that.

The technical methods for avoiding earthquake consequences have always existed but technology management and economic efforts need to be implemented.

1.2 Problem Discussion

Natural disasters have significantly increased over the past decades. With starting-point from the examples above, the main reason that leads any natural phenomena to change to a hazard in developing countries is often governmental corruption and uncontrolled and illegal financial management at the national level that leads to abandoned districts and absence of basic services and infrastructure. In turn, these problems, in addition to informal settlements as a result of increased urbanization, make the post-disaster situation very hard to handle. Therefore, some sorts of urbanization management and sustainable development lead by international organizations with the help of engineers, architects and planners, must exist to enhance the capacity of governmental and local community to improve the living conditions of the urban poor. Accordingly, disaster management needs to be possible to implement in order to reduce the disaster risk and the vulnerability of the exposed population.

1.3 Objective

The purpose of this thesis is to study the effects of earthquakes on buildings in developing countries and the aspects that contribute to more losses than in more developed countries; the interaction between poverty and urbanization. This will include some descriptions of construction methods that might reduce the losses and thus, be a way to stimulate and develop the solutions through well-planned and responsible projects. Most importantly, the thesis will deal with the issue of disaster management frameworks by addressing the challenges of hazards in order to improve the situation in developing countries, taking into account the responsibilities and efforts of international organizations, the international community and the affected population itself.

1.4 Method

This is a desk study based on literature and academic reports, articles printed and published on the internet, in addition to scientific videos.

I started by collecting interesting articles, literature and reports both in English and Swedish to read and build a background about earthquakes in urbanized developing countries and to list some main points that should be studied in order to organize the project. While reading, I found many interesting topics and terms that I never encountered with before such as the difference between hazard and disaster, the disaster management cycle and methods to measure an earthquake. Each one of these topics required very much reading and I had to be careful and choose the latest available data so that the information should not get mixed.

When I studied different earthquake-resistant design concepts, I chose solutions that might be relevant in slums instead of highly technological and expensive solutions in order to make them possible to implement. Therefore, I used available literature describing traditional principles.

1.5 Definitions

- **Hazard:** a dangerous event that causes human and material damages.

- **Vulnerability:** a combination of weakness, danger, disadvantage and risk of a society to be affected by hazard.

- **Disaster:** a result from a combination of hazard, vulnerability and the lack of capacity to reduce the risks.

- **Urbanization:** a process in which the population living in cities increases as a result of people's movement from rural to urban areas.

- **Population density:** the population per unit area.

- **Urban Sprawl:** uncontrolled expansion of cities and suburbs that reach the rural areas.

- **Spatial:** existing in space.

- **Seismic activity:** the frequency and size of an earthquake over a period of time.

- **Richter Scale:** measures the size of earthquakes, indicated in magnitude that gives 10 times stronger shaking and 32 times more energy for every unit increase.

- **Modified Mercalli Intensity Scale:** measures affectivity and intensity of earthquakes.

- **Tsunami:** flood waves caused by undersea earthquakes.

- **Condensation (or liquefaction):** the soil grains become water-saturated and soil loses its strength.

2 Urbanization, Poverty and Vulnerability in Developing Countries

Despite the economic progress in urban and rural parts of the developing countries, the slums are still expanding and are simply the most exposed to different types of risks. The question is what is preventing the development of security in these areas. Serious actions must be taken by developing countries and development professionals to address the main issues that make their vulnerability of greater concern, not just for development, but also for survival.

2.1 Urbanization and Slums

The urban population in developing countries was, in 2005, more than 2.3 billion people which correspond to 7 times more than in 1950. This is expected to increase even more, until it reaches 3.9 billion by 2030. This can be compared with only one billion increase during 1950-2030 in developed parts of the world. This means that almost all the growth of the world's urban population 2005-2030 is going to take place in developing countries (Enhancing urban safety and security, 2007).

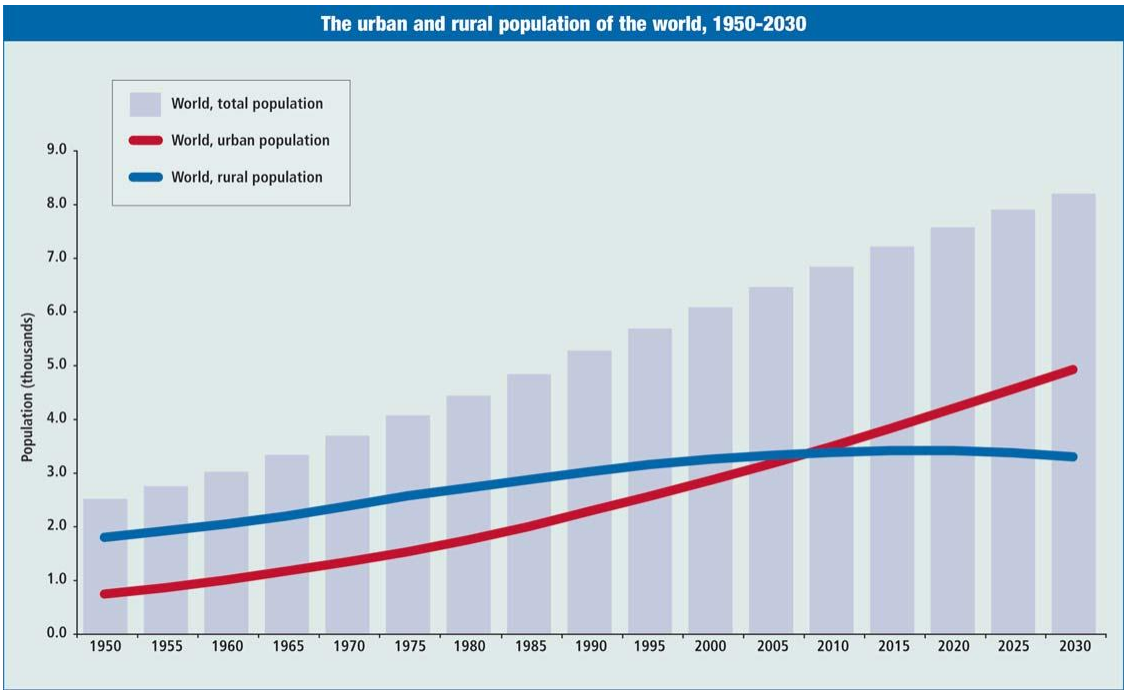


Figure 2.1 *The estimated urban and rural population of the world, 1950-2030* (UN, 2005).

Slums began first to grow in the middle of 1950s outside big towns (Buckley & Kalarickal, 2006). The informal settlements usually start with one family building a shack or making a tent on a piece of land and living in it. Thereby the transition starts gradually. When the basic elements are built, the occupants start asking for basic services from the government and once they

get infrastructure service and the ownership to the land, the community gets larger (Fay, 2005).

Dar es Salaam	60 %
Lagos	58 %
Mumbai	57 %
Mexico City	40 %
Calcutta	40 %
Nairobi	34 %
Sao Paulo	32 %

One billion people in the world live in slums and informal settlements; the table shows the percentage of informal settlements in different urban cities in developing countries.

Table 2.1 *Urban slum population in some cities in developing countries* (Kreimer, 2003).

In 2009, the United Nations, Department of Economic and Social Affairs, Population Division has published a revision called World Urbanization Prospect, which included some expectations concerning the period 2009-2050:

- During the period, the world's population is expected to increase by 2.3 billion. Thus, the urbanization level is going to increase globally from 50 to 69 %.
- The biggest part of the urban population growth is going to be concentrated in cities in developing countries; 1.7 billion in Asia, 0.8 billion in Africa and 0.2 in Latin America and the Caribbean.
- The rural population is expected to increase to a maximum of 3.5 billion in 2020 and then reduce to 2.9 billion by 2050.

2.1.1 Urbanization Management

The management of the rapid urban growth in developing countries is a complex issue and to achieve a sustainable urban development requires a long process where critical issues should be observed (Tannerfeldt & Ljung, 2006);

1. A developed and enhanced urban control and management.
2. Creating a municipality system to decentralize the responsibilities and move them to the local level.
3. Adapting rules that include the poor's right to a safe settlement.
4. Education and health service.
5. Protection against violence.
6. A plan that provides accessible and buildable land for new housing.
7. Reduction of water and air pollution and development of a recycling system.
8. Using the resources for the local development in the private and public sector, for instance through a developed municipal finance of housing and infrastructure.

Many stakeholders with different power levels might be taking part in the management work and since the poor do not have any power at all, they will not be able to play any role in the planning process or in the decisions taken. Therefore, the urban development is considered to be a political issue rather than a social which demands a democratic management that takes the social, economic and the environmental sustainability into account. In fact, the planning ability in developing countries is very limited because different national authorities are responsible for different areas; one for water supply, one for energy and one for distribution networks whereas the municipality is responsible for sewage and local roads (Tannerfeldt & Ljung, 2006).

The Urban Management Program (UMP) of UN-Habitat has, with the help of some external agencies in addition to UN-Habitat and United Nations Development Program (UNDP), supported economic growth, social development and decreasing poverty. It has also, since 1986, been contributing to urban management work by working with urban governance, urban poverty reduction, urban environmental management and even HIV/AIDS. Most importantly, UMP focuses on improving the living conditions for the urban poor. The UMP has implemented City Development Strategies in several cities such as cities in Lake Victoria Region and South American cities to empower the municipal authorities to be able to make participatory management mechanisms (Enhancing urban safety and security, 2007). It has also developed new strategies, based on the conditions in the developing countries, to reach some important goals and to involve all the interests so that the overall decisions will be taken more considerably, a long-term development cooperation program. The program aimed to support cities to contribute to sustainable urban development by

- Poverty reduction: employments, service and social integration.
- Urban environmental management: planning and infrastructure.
- Promotion of the urban governance: decentralization, municipal finance and real estate. (Liberher, 2004)

2.1.2 Housing Policies; Cases of Cairo and Mumbai

Upgrading the informal and squatter settlements in big urban poor cities around the world is of significance. Some countries have initiated the urban management in order to reduce the vulnerability of the urban poor. Reducing the slums requires years of planning and work by national governments and local authorities. It could be done by using the resources more effectively and adopting housing policies to address the problems. Cairo and Mumbai are two of the world's most urbanized cities where the majority of the population is facing high vulnerability because of hard living conditions. The two cities are

taken as examples to cast light on existing as well as ongoing housing policies in developing countries.

Cairo is one of the most densely populated areas in the world with nearly 40.000 inhabitants per square kilometer. Over the past four decades, The Greater Cairo Metropolitan Area (GCMA) went through rapid urban growth and the population more than tripled at an annual average growth of 2.5 %. In Egypt, the informal settlements are the same both in rural and urban areas. The Ministry of Local Development reported in 2001 around 1,105 squatter and informal settlements in Egypt that were housing 15.7 million inhabitants which is 23 % of the country's population.

Figure 2.2 *Densely built houses in Cairo, 2009* (By the author).

The formal housing sector has not been able to make progress in housing solutions. Moreover, nearly 81 % of the informal settlements are privately owned agriculture lands which are strategically located in the urban space. However, in 2005 the government launched the National Housing Program (NHP) to, by 2011, provide 500,000 units to improve the housing conditions. The government has shown some improvements like:

- developing a housing finance system;
- improving law for property tax;
- land and property registration system;
- unified building code;
- new rental law.

In 2008, the urban upgrading was one of the most important issues in the policy agenda and aimed at developing the urban poverty and livelihoods, bringing forth the local economic growth and most importantly, preventing the formation of informal settlements (Slum Upgrading Up Close: Experiences of Six Cities, 2008).

In Mumbai, the slums can be found everywhere; along railways, in forests, on hills and even on pavements. As mentioned in the previous chapter, this makes

it much more complex and difficult for the people to have access to basic services and since they often earn money by informal economic activities, they also do not have any access to housing finance. Today, 48 % of the population lives in urban slum dwellings.

In 2007, the Indian government declared the first housing policy which included the following objectives:

- making a better access to housing in rural and urban areas;
- working more effectively on slum upgrading;
- adapting the housing sector so that the private and public sector can easily take part in constructing houses for the poor;
- developing rental housing system.

The housing policy was concluded in 2008 but still, an action plan to implement the policy was under preparation. The government is responsible to provide affordable houses for the urban poor through The Maharashtra Housing and Area Development Authority (MHADA) which is the main agency for supplying public houses, especially for the lower and middle-income groups (Slum Upgrading Up Close: Experiences of Six Cities, 2008).

The Housing Development Finance Company (HDFC) of the Indian government finances different systems, also for site and service systems and for housing where they reserve most of the constructed houses for the low-income people. Another organization in India, Birla Home Finance, aims to help poor urban households gaining less than 135 USD monthly (Tannerfeldt & Ljung, 2006).

2.2 Urban Poverty

The urbanization is very closely related to the economic development. It is even required for the economic development. The most urbanized countries are those with higher gross national product, GNP[2] and higher income per capita. A good and reasonable explanation for these phenomena is that the economic development also contributes to the urbanization; the growing countries create opportunities for the economic development. However, that success does not benefit everyone since it also increases the poverty. The most significant aspect is the dependence of the income for survival comparing to the rural life where money almost does not exist (Tannerfeldt & Ljung, 2006). The Global Report on Human Settlements 1996, *An Urbanizing World* showed that cities create more negative effects than positive. Sometimes, the rapid population growth has overpowered the authorities' capacity to act at the municipal level.

[2] The value of all products and services produced in a country in one year.

The reduction of urban poverty must start at a municipal level by improving houses and basic service like water, sanitation, drainage and also basic health care and transportation. Employment and increasing of the income play a major role in the development process as well. But the local governments have, in most cases, a number of obstacles like:

- The distribution of functions is influenced by the central government and therefore, the financial transfers are also controlled by the central government;
- The policy framework for addressing the urban poverty is very difficult since the powers and responsibilities are inadequately organized to contribute to an effective municipal management;
- The key actors are often not included and for example NGOs are never in position where they are able to deal with the long-term planning;
- When dealing with urban land, infrastructure, shelter and services in developing countries, the support programs have not reached the urban poor groups who were the main target.

Therefore, some points should be observed in order to overcome those obstacles, such as:

- Defining the responsibilities and allocating the resources concerning land use management, housing finance, municipal infrastructure and services, urban agriculture etc.
- By mobilizing the resources of the municipality, the transfers within the municipalities will be done effectively which means that the resources are used more efficiently;
- The internal institutional and intergovernmental arrangements should be more efficient so that the urban services will be obtained;
- Using the human resources in order to create a more sufficient municipal staff and at the same time make more employment possibilities for the population.

Accordingly, directing enhanced resources to the municipalities or local governments is very important if the local government bears the responsibility of significant expenditures like primary health, education, housing subsidies and social services (Vandersheuren et.al, 1996).

2.2.1 Millenium Development Goals

In September 2000, the United Nations Millennium Declaration was adopted by 189 countries and was briefed in eight Millennium Development Goals (MDGs) to be achieved by 2015.

Figure 2.3 *The Millennium Development Goals* (UN).

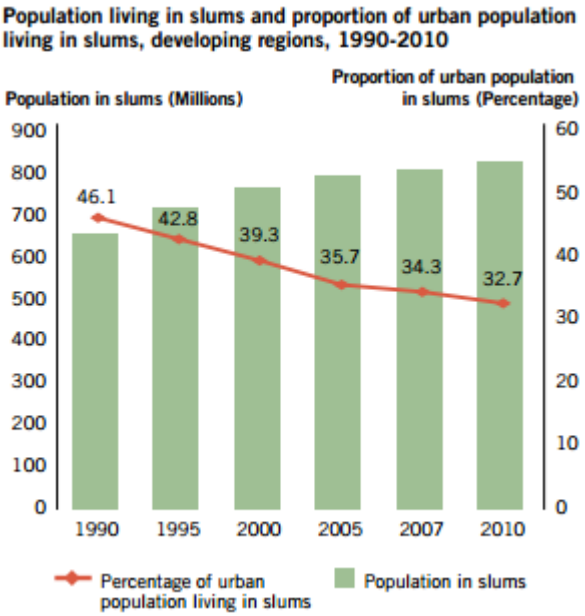
The success or failure in achieving these goals depends very much on how much is done within the urban communities. Reviewing these goals today, the situation is as follows;

Goal		Approach
1	▪ Halve the proportion of people whose income is less than $1 a day and the people who suffer from hunger between 1990 and 2015. ▪ Achieve full and productive employment and decent work for all, including women and young people.	Many countries and regions show a decrease in poverty. It is now estimated that by 2015 the global poverty rate will be less than 15 %.
2	Ensure that all children will be able to complete primary schooling by 2015.	Some LDCs like Samoa, Sao Tome and Principe and Togo in addition to other poor countries, are very closely achieving the universal primary education goal. Sub Saharan Africa is a region that made the most noticeable improvement.

3	Eliminate gender disparity in primary and secondary education by 2005 and in all education levels by 2015.	There has been progress in gender parity in developing regions; for every 100 boys, there are 96 girls enrolled in primary and secondary education in 2009. However, the progress did not reach all regions, only three regions achieved gender parity in primary education; Latin America and the Caribbean, South-Eastern Asia and Central Asia. Concerning secondary education, progress was shown in Central Asia, Northern Africa and South-Eastern Asia.
4	By 2015, reduce the rate of mortality of children under five years old by 2/3.	The progress is unequal; children younger than five years suffering from malnutrition have, according to the World Health Organization (WHO), decreased from 1990 to 2007. The number of deaths of children has fallen from 12.4 million in 1990 to 8.1 million in 2009 which means 12,000 fewer children are dying each day.
5	▪ Between 1990 and 2015, reduce the maternal mortality ratio by ¾. ▪ By 2015, achieve universal access to reproductive health.	Maternal mortality remains a problem in developing countries. Even though the ratio has been reduced by 34 % between 1990 and 2008, the MDG target is still far to reach.
6	▪ To be stopped by 2015 and beginning to reverse the spread of HIV/AIDS. ▪ Achieve, by 2010, universal access to treatment of HIV/AIDS for all infected. ▪ Have halted the malaria by 2015 and begun to reverse it and other major diseases.	Because of increased funding and expansion of major programs in the sub-Saharan Africa, the number of people who were recently infected with HIV declined with 21 % in 2009 comparing to 1997. After receiving different kinds of therapies, the number of deaths caused by AIDS was reduced by 19 % in this period.

7	▪ Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources. ▪ By 2015, halve the proportion of population without safe drinking water and basic sanitation. ▪ By 2020, achieve a significant improvement in the lives of at least 100 million slum dwellers.	In 1997-2008, around 1.1 billion people living in urban areas and 723 million in rural areas could get access to safe drinking water which is an increase with 17 %. Continuing on this rate of progress, the target of drinking water will be achieved by 2015. Yearly sanitation conferences are held to guarantee that sanitation remains on the political agenda but still, the world is far from reaching the target. Assessing at the current progress rate, it will take until 2049 to ensure 77 % of the global population with sanitation service. As shown in figure 2.4, the situation is critical. Therefore, intensified efforts will be needed to improve the lives for the poor in urban cities in developing countries. Beyond the MDGs, the Governing Council of the United Nations Human Settlements Program encouraged in 2011, the countries to make national, regional and local goals to improve the life conditions in slum dwellers mainly in housing, basic service and infrastructure.
8	▪ Address the special needs for the LDCs.	Enquiries show that donors plan to increase the aid to the LDCs until 2013.

Table 2.2 *The MDGs approaches, reported by the UN* (The Millennium Development Goals Report, 2011).



Sub-Saharan Africa	62 %
Southern Asia	35 %
South-Eastern Asia	31 %

Figure 2.4 *The proportion of slums in urban developing regions* (The Millennium Development Goals Report, 2011).

As shown in the table above, despite all progress, it has been hard to reach the most vulnerable since there still are distinctions in the progress between the rural and urban areas. To deal with the situation, world leaders were gathered at a High-level Plenary Meeting of the General Assembly on the MDGs in 2010 to confirm their engagement to the MDGs and agreed about enhancing their actions and expanding the successful achievements (The Millennium Development Goals Report, 2011).

2.3 Sustainable Urban Housing

The characteristic of a major city lies on its importance for the economic strength and quality of life in a region. Major cities are the centers of cultural development, learning, housing, social services and resources and financial support. What connects all those aspect together, in order to create a balanced environment, are the existing buildings and infrastructure which are the elements that increase the vulnerability (J. Logario, 1990).

2.3.1 High Density Urban Development

Sustainability in the growth of cities in developing countries demands high-density development, but sometimes it is seen as irrelevant since the cities in developing countries are already overcrowded, which makes the development model extremely difficult to implement (Dave, 2010). The compactness of some developing cities has a big impact on life conditions and the increase in class distinctions. There are many aspects explaining the higher density in developing countries (Jenks & Burgess, 2000);

- The rapidly growing urban population;
- Increasing number of dwellings and informal settlements in urban areas because of people moving into the city close to livelihoods since they are not able to afford transportation costs;
- High-rise apartment buildings;
- Huge number of vehicles;
- Insufficient and even absent building codes in addition to tolerant regulations;
- On-going plans, which mean further extreme increase of the land-use.

Jenks & Burgess (2000) explain that these aspects might be the reason for the unsustainability in urban developing cities. Referring to Drakakis-Smith (1996b), he said that the opposite is also convincing; the capacity of these cities when preserving the huge and growing population can be seen as sustainability and that the known definition of it is just the global view. In the context of hazards, densely built settlements in compact cities have, as mentioned above, more negative effects than positive; they are more liable for disasters and their consequences. That is why the attributes of sustainability should be studied by defining and explaining the concept of compactness and also its relationship to sustainable urban development. Firstly, according to Jenks & Burgess (2000), the spatial basis is the main factor to be studied; it might be the whole city, region, the urban system or urban sub-centers, inner city, suburb or urban and regional transport corridors. He also questions whether the compaction efforts should be concentrated on the development of new settlements or modifying the existing ones. Since it is critical to know the relationship between spatial centralization and decentralization forces in cities, the contemporary compact city approaches are to be defined (Jenks & Burgess, 2000):

- *Densification - Increase built area and residential population density;*
- *Improve urban economic, social and cultural activities;*
- *Manipulate urban size, form and structure;*
- *Settlements system to achieve environmental, social and global sustainability.*

The density levels and growth rate are hardly measured in developing countries because of lack of data. That makes it very complex to assess the densification policies for the cities; it is also difficult to make a general assessment because of the considerable variation in urban densities in those countries. Beyond the economic and social developments which are the most important factors, there is also the cultural factor that influences the social scene of neighborhood and space consumption. Additionally, the environmental factor has, since human existence, been influencing the urban densities; absence of urban land, limited availability of water and amount of surplus agriculture. High demographic growth, poor economic development

and small urban budgets with lack of environmental infrastructure, shelter and basic services have all negative effects on densification policies. Furthermore, some other factors also play major roles in the densification policies such as land capacity, infrastructure, transport and land use.

Achieving sustainability through urban form manipulation in developing countries is limited because of changed planning forms, especially the change from physical to socio-economic planning and the change from urban professional practice to restructuring in neighborhood level. In some cases, restructuring has had an effect on the urban form such as Curitiba that turned its circular forms into linear. These changes are highly preferable in South Africa and East South Asia but the high costs in addition to limited resources to build the urban forms contribute to the absence of them. Concerning the urban size manipulation, lack of action might depend on different arguments about the relationship between urban sustainability issues and city size, some development strategies claim that the size is not a problem and that the key policy is intensifying the urban productivity and efficiency by determining the spatial dynamic.

Urban policy has to be adapted to the issues of globalization and global environmental change through globally adapted statement of environmental, architectural and planning and design practices working in all spatial levels (Jenks & Burgess, 2000).

2.3.2 Urban Sprawl

The fastest growth of cities occur on their peripheries and creates low-density urban sprawl; a very complex issue when dealing with environment problems and sustainable development. As mentioned previously, the urban poor move into the cities and settle in their peripheries which results in uncontrolled illegal squatter settlements.

2.3.3 Housing Strategies

In the late 1970s, the public housing agencies in many developing countries offered costly housing which was not widely available. The World Bank wanted, through slum-upgrading projects, to prove that it is possible for the public sector to offer budget-houses with good standard for the low income by producing fundamental housing design with basic services (Buckley & Kalarickal, 2006). The policy-makers and other participators were helped by the World Bank to establish strategies to manage urban upgrading and housing projects locally (Imparato, 2003). The strategies included engaging the population itself for development of urban poor settlements but it should be kept in mind that complications might emerge since there basically is, for the urban poor, an already slow on-going project lead by themselves which means

constantly demanding the authorities to improve the conditions. The future expectations and hopes need to be well-organized and the project leaders should help them to understand the process and the meaning of the project and to be more tolerant. Accordingly, the community participation in slum housing upgrading is vital for the sustainability for many reasons (Imparato, 2003):

- By communicating with the local population and defining their needs and economic capability in addition to getting local knowledge, the project becomes significantly more effective and facilitated;
- Showing receptivity and responsibility when dealing with facilities that concern the population and insure local ownership of the project in order to *strengthen the effect and sustainability of the project*;
- Constituting local capability to cooperate with the authorities and faciliating the participation, even in decision-making which has a lifetime influence on them; all those aspects help to reach goals like *poverty reduction, better governance and democracy*.

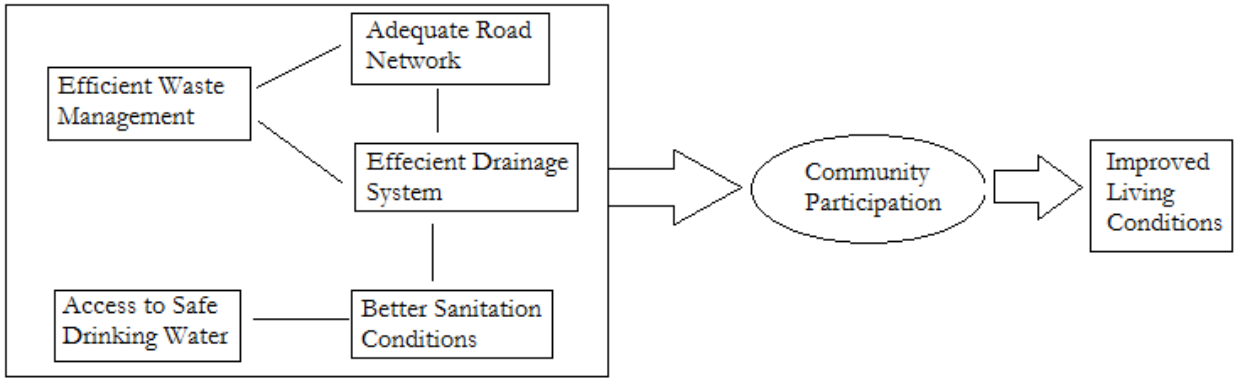


Figure 2.5 *Factors improving living conditions in urban informal settlements* (Spaliviero, 2006).

As shown in figure 2.5, the linked factors are significant for reducing the vulnerability and they improve sustainable living conditions in informal settlements. Adequate waste collection decreases the risk of accumulation of domestic garbage in the drainage channels which prevents the water flow and create sanitation risks. The road network, clearly, faciliates the transit of vehicles and also the waste management operations, and most significanlty the vehicle access in case evacuation is needed. Moreover, safe drinking water reduces the vulnerability of the population related to disease transmission through poor sanitation. Reducing the vulnerability through slum-upgrading framework can best be done when involving the community in all planned activities and, thus, make sure that social equity is achieved (Spaliviero, 2006).

3 Natural Disasters

The majority of the developing countries are characterized by their location on lower latitudes and with a higher average temperature than developed countries. Moreover, differences in climate types might be shown between the countries; warm-humid, hot-dry, tropical highland and monsoon.

3.1 The Increase of Natural Disasters

Natural disasters have been increasing over the past decades and the humanity and environment are suffering more and more. There is a series of factors causing that; high population growth and density, unplanned urbanization and migration in addition to the environmental degradation and global climate change (G.R.I.D. ARENDAL).

The number of major disasters has increased from 100 in 1975 to 550 in 2000. The economic losses have also increased by 14 times since 1950 (Enhancing urban safety and security, 2007). According to the International Monetary Fund (IMF), the material losses have been estimated to 625 billion USD throughout the 90s. In total, 4.1 billion people suffered from disasters between 1984 and 2003, when the number of victims had increased along with the increased population density. In 2004-2006, the number of natural disasters caused huge human losses; 220,000 people died and 1.5 million became homeless after the tsunami in December 2004 and the earthquake in Pakistan in October 2005. 98 % of the 211 million who suffered from those natural disasters around the world lived in developing countries.

3.1.1 Climate Change

The climate change as a result of the global warming, rising sea temperature and the resulting weather pattern, have contributed to 50 % of the increase of the extreme weather patterns during 1950-1990. In turn, that increase has obviously caused the hurricane Mitch in Honduras and Nicaragua 1998; the flooding in Guatemala 2005 and the Caribbean hurricane 2002-2005 that affected the whole region of Cuba, Haiti, Jamaica and Yucatan in the Mexican Peninsula (Guha-Sapir et.al. 2004). Accordingly, particularly affected are cities located along the world's coastlines because of increased extreme weather events such as flooding, heat waves and tropical cyclones. Around 40 % of the world's population lives today in areas with less than 100 kilometers distance from the coastlines.

Climate change has a direct impact on cities. In sub-Saharan Africa, the climatic variation has been contributing to urban migration and resulted in

rapid and uncontrolled urban growth which has also been followed by spread of informal and hazardous settlements. On the other hand, cities are not only affected by the climate change; they are also the key contributors to the global warming since they produce high carbon emissions levels that cause climate change (Enhancing urban safety and security, 2007).

3.2 Natural Hazards

A natural hazard is a dangerous event that has a potential for causing human or material damages. Thus, it interacts directly with vulnerability to create a risk situation for people's lives and properties. The occurrence of a hazard in a vulnerable context causes an emergency situation. Hazards are grouped in natural and manmade but only the natural will be illustrated here. As shown in the table below, hazards are also classified in different types: geological, water & climate, biological and environmental hazards.

Type	Hazard
Geological	Earthquake, tsunami, volcanic eruption, landslide, dam burst, mine fire.
Water & Climate	Tropical cyclone, hurricane, floods, draught, hailstorm, cloudburst, landslide, heat & cold wave, snow avalanche, sea erosion.
Biological	Human/animal epidemic, pest attacks, food poisoning, weapons of mass destruction.
Environmental	Environmental pollutions, deforestation, desertification, pest infection.

Table 3.1 *Disaster* types (*Natural Hazards and Disaster Management,* 2006).

3.3 The Impact of Urbanization in Developing Countries

Urbanization has a strong impact on the natural environment; the rapid growth increases urban air pollution, worsens the ecological balance of surrounding seas, destroys drinking water resources and overloads soil filtration. The relation between natural disasters and urbanization can be described as equal; the effect of the urbanization on natural disasters is just as strong as the natural disasters' effects on urbanization (Hamza & Zetter, 1998).

3.3.1 The Vulnerability of Slums

Apart from natural disasters which are sometimes called *catastrophic disasters,* there are *chronic disasters* which refer to "everyday, less visible hazards". In developing countries, those are long-term disasters such as poor housing, sanitation and polluted air and they are also connected to catastrophic disasters; the chronic disasters are the main reason and are imposing factors

for catastrophic disasters. Thus, the majority of the losses of lives caused by natural disasters do not come from direct impacts but from everyday health risks caused by lack of urban planning which in turn causes limited access to satisfying the daily needs followed by the disaster (Pelling, 2003).

The direct impact that causes damages on the infrastructure networks have, however, the biggest effects on the urban economy especially in the global south[3] where the poorly built infrastructure can result in areas of the city being isolated for some weeks before any type of help or service reaches them. The natural disasters are followed by two types of economic losses; *indirect losses* and *systemic impacts*. The indirect losses are referred to the non-completed or lost production and services because of the disaster occurrence which means higher expenses for alternative distribution etc. The personal income losses because of the livelihood or production loss also belong to this category. Systemic impacts are on the other hand found in the macro-economy[4], the GDP, indebtedness and reserves. The systemic impacts have mainly an influence on people who are already suffering from indirect losses. In urban contexts, systemic impacts may lead to long-lasting unemployment and livelihood disruption; a factor that in turn plays a major role in operational work such as water and sanitation systems which breed different kinds of diseases (Pelling, 2003).

The explanation of a disaster, more substantially, needs a search for a progression that connects the impact of a hazard through several levels and factors that generates vulnerability. This is illustrated in details in the Pressure and Release model, PAR-model, below.

[3] Includes Africa, Latin and Central America and most of Asia.
[4] The change of the national economy.

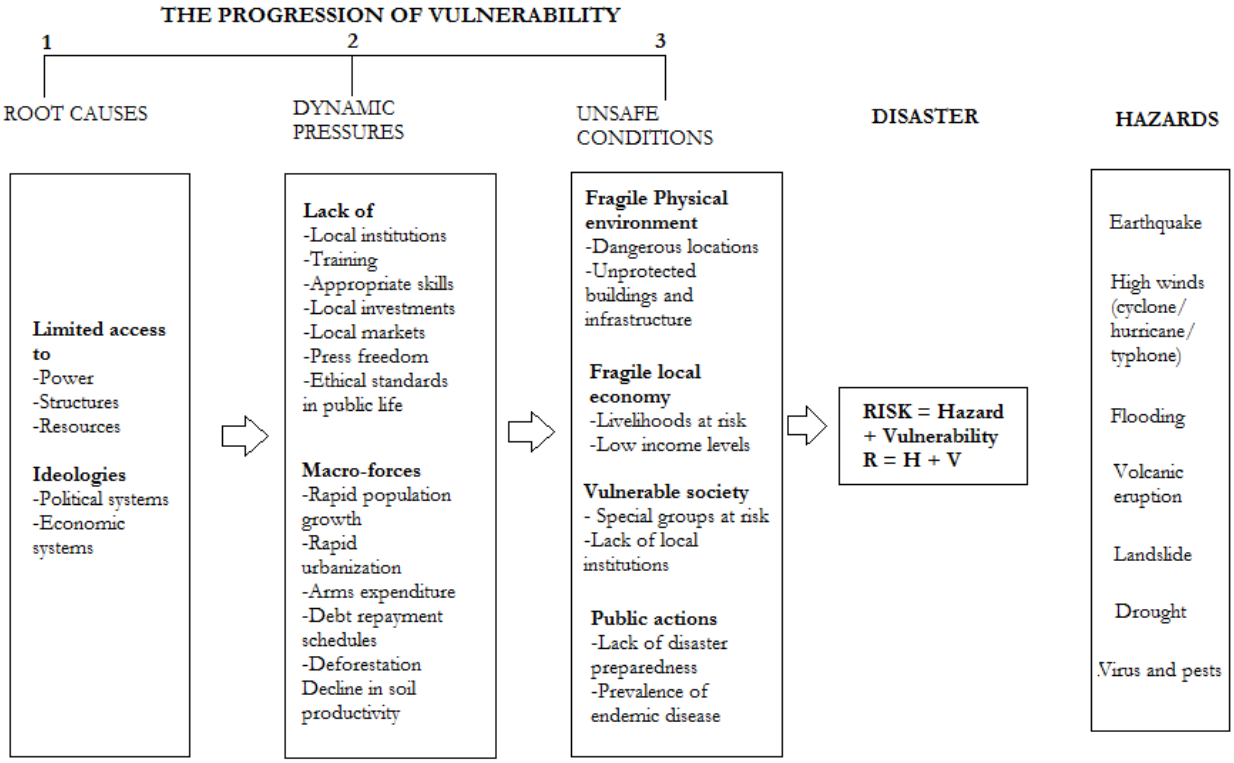


Figure 3.1 *The progression of vulnerability* (Blaike et.al, 1994).

4 Earthquakes

The crust of the earth contains 8-10 plates which all move by colliding and sliding from each other or by sliding beside each other. Some plates are damaged while new ones are formed. The production of materials takes place close to the plate margins. Afterwards, a compression of materials takes place near the collision zones, which results in damaged plates, or tension of the plate material so that new plates form. The production of materials appears through a natural phenomenon like earthquake (Svensson, 2009). The rigid materials in the plates break during the collision and the strain produced by the movements increases to a certain level and causes fractures in the crust called faults. The released pressure causes vibrations, so called seismic waves because the geological materials in the ground surface lose their strength. Through measurements of the seismic activity it is today possible to know where the plate lines are. The ground shaking is a result of either body waves or surface waves; the body waves press the body of the earth and cause fast shaking while the surface waves make the ground vibrate horizontally and vertically. These are long period waves which result in swaying buildings and water wave movements (Natural Hazards and Disaster Management, 2006).

4.1 Movements

There are different types of the plate movement:

- **Divergent**: as the plates move away from each other, new crust will be produced.
- **Convergent:** one plate moves another one by diving beneath; crust will be destroyed.
- **Transformational:** plates just split apart horizontally, that does not contribute to any changes in crust (www.ucmp.berkeley.edu).

The most affected areas in the world where plates move towards each other and cause earthquakes are North and South America's west coast, Himalaya, Turkey and Japan (SGU).

Figure 4.1 *Earthquake-prone parts of the world* (WORLD MAPS).

4.2 Measurements of Earthquake Strength

The frequencies and velocities of the earthquake variations may vary and the constancy is between a few seconds up to one minute depending on the size of the earthquake (*Natural Hazards and Disaster Management,* 2006).

There are two different ways for measuring earthquakes; one measures the size and indicates either the exact position or the magnitude and focus, the other one measures the affectivity or intensity. Using both of the methods at the same time gives much better result. The magnitude is given in *Richter scale*; an earthquake with a magnitude of 7 gives a 10 times stronger shaking and 32 times more energy than a magnitude 6 earthquake. The highest magnitude mapped was in Valparaiso in Chile 1906 and it was as high as 8.6. Figure 4.2 shows also the average number of earthquakes of larger magnitude than 6.0 during the past decades. On the other hand, to measure the effect of an earthquake, the Mercalli Intensity scale (MMS, Modified Mercalli Intensity) is used. It measures on the basis of effects on humans and buildings and classifies the earthquake in 12 classes where number 12 describes the most disastrous level according to the table below (SKB AB, 2012);

I	*Not noticeable*	**VII**	*Damages on buildings*
II	*Hardly noticeable*	**VIII**	*Destruction of buildings*
III	*Weak, partly noticeable*	**IX**	*General damages on buildings*
IV	*Largely noticeable*	**X**	*General destruction of buildings*

V	*Awakening*	**XI**	*General destruction*
VI	*Scary*	**XII**	*Changings in landscapes*

Table 4.1 *MMS Earthquake measuring* (Arya, A.S.1987).

The MMS Intensity scale also indicates different Seismic zones;
Zone A- risk for widespread collapse, corresponds to MMS IX or more
Zone B- risk for collapse and serious damages, corresponds to MMS VIII
Zone C- risk for damages, corresponds to MMS VII
Zone D- risk for small damages, corresponds to maximum MSK VI
(IAEE & Nicee, 2004)

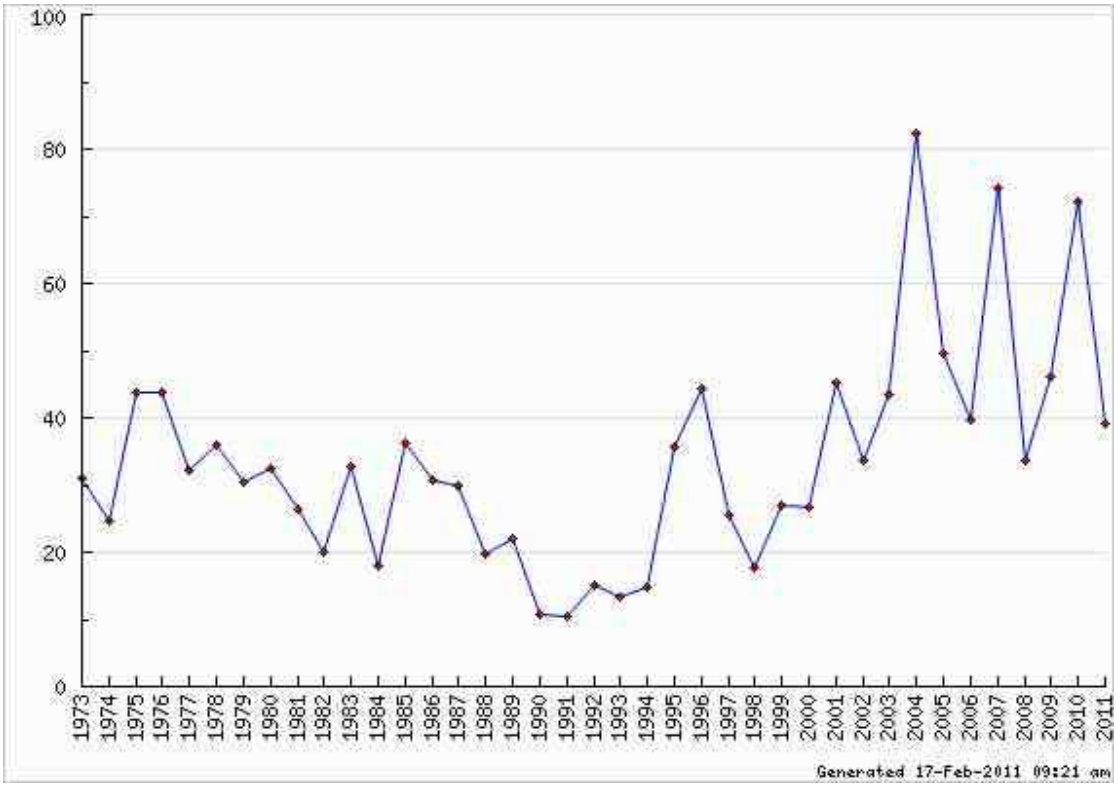


Figure 4.2 *The global average number of earthquakes of larger magnitude than 6.0 in the past century* (Worzel, 2011).

There are some aspects making the earthquakes and tsunamis fairly different from other natural disasters, some of them are going to be demonstrated later in other contexts but they will be illustrated below in relation to earthquakes (Cosgrave, J. 2008):

- Destruction of the whole infrastructure reduces the communication possibilities;
- Collapsing buildings result in high mortality;
- Fractures and crush injuries increases the morbidity;
- The aftershocks make it even more devastating; upset the operations, expose the staff and the losses and damages increases even more;

- The recovery efforts begin after the earthquake; no stability after the relief phase;
- The rubble caused must be cleaned before the reconstruction starts which requires plenty of time.

There are also some buildings classified as more vulnerable and therefore, they should be made stronger than other buildings for example: schools, hospitals, communication spots, water supply facilities, police stations, cultural treasures, etc. (IAEE & Nicee, 2004).

4.3 Effects on Built Environment

The built environment plays a major role when dealing with earthquakes. The poorly built slum housing with substandard construction causes thousands more deaths than buildings with a sufficient standard. The destruction caused by earthquake vibrations does not only depend on the earthquake intensity, but also the local soil conditions and how stable the houses are, which are the premier causes of higher number of deaths in poor areas.

4.3.1 The causes of Structural Collapse

The damages of a building depend much on the strength, intensity and integrity of the building and also the rigidity of the ground in a given intensity of an earthquake movement. Built structures get affected primarily because the horizontal power in a structure struggles against vertical strains. Thus, concerning the overall shape of the building, the symmetry and regularity have a big influence on the damage since a rectangular or square shape in plan and height gives more stability than an irregular shaped building when subjected to twisting during vibrations.

When an earthquake strikes, the built structure moves from its base. However, that doesn't need to affect the roof since it has a big tendency of sticking into its original position because of the inertia. But it might be pulled by connected walls and columns. The roof's weight is therefore of a big importance for the inertia force; the heavier roof the higher inertia power. This power transmits down to the ground through the columns which experience a relative movement between their upper and lower ends and try to resist the deformations. Floors, walls, plates, columns and ground should be built so that the inertia power is able to transmit through them. Even though the walls and columns are the most critical parts concerning the transmission of the inertia power, they are usually not getting so much attention when constructing and shaping the building. The result is often thin walls produced of brittle material which are weak and are hardly able to carry horizontal earthquake's inertia power along the thickness of the material (IITK).

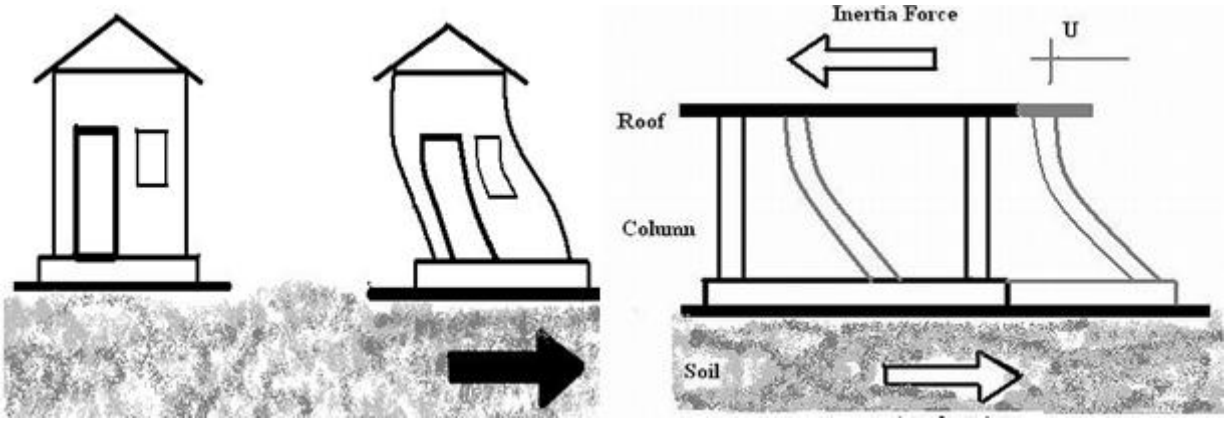


Figure 4.3 a) *The inertia effects on the base of the building,* ***b)*** *The inertia force and the relative motion within a building* (EngPedia).

Sometimes, buildings with strong structure fail because of the weak foundation, movements or even fractures. Some types of foundation can be more exposed for damages such as subsidence, for example insulated column foundations can sink, especially when the ground consists of soft or different types of soils (IAEE & Nicee, 2004).

The destruction of multi-story buildings of six to twelve stories caused by the earthquake in Mexico City 1985 and the collapse of the multi-story buildings in the Armenian earthquake in 1988 were a result of many factors such as bad design, poor locations and inadequate building technologies (Pelling, 2003). The endurance of buildings is namely a very risky factor; the authorities should therefore be stricter about the requirements regarding structural elements. In what area are the buildings most exposed for falling? What does the hazardous situation depend on? Which actions should be taken to reduce the pressure? These significant questions will be discussed to form a clearer idea of the situation and how it can be improved. Firstly, we have to study some of the basic causes of the damages, called secondary effects, which are included in an earthquake:

- Bursting comes up like visible fractures and displacements on the ground surface along a fault. These might stretch hundreds of kilometers. The ground displacements can be horizontal, vertical or both, they can also cause a big risk for built structures like bridges, power plants etc.
- Landslides may occur anywhere in the world and are another result of earthquakes and other natural disasters like hurricanes, volcanic activity, wave erosions and forest fires, which weaken the ground.

- Condensation takes place in thousands of similar saturated grain sizes with low density. The soil loses its strength and thus has an extreme impact of large structures like bridges and hanging buildings. Another word for condensation is liquefaction
- Flood waves: if earthquakes take place under the sea, a flood wave called tsunami may be produced. Flood waves can move long distances and when they reach the land, their speed comes down as their height goes up to 5-8 meters. Naturally, the most affected buildings are those located on coastal areas.
- Fire: since strong earthquakes are normally accompanied by water losses and traffic jams, it becomes very hard to extinguish fires that start when an earthquake strikes. Therefore, the damages increase even more if an earthquake brings fire. The majority of the earthquakes' victims die in fires (IAEE & Nicee, 2004). Spread of urban fires, especially in the aftermath of earthquakes, depends on structural framing and building material in addition to the number of doors, windows and ducts that contribute to the spread as well. The fire starts with a flame that produces black smoke and the lack of oxygen causes the deadly asphyxiation (Jain, 2008).
- Floods: when the water volume in a flood or a lake exceeds their capacity, floods rise. They might be a result of an earthquake damaged dam.
- Subsidence is settling of the ground over a long time. When the subsidence is uniform on the whole site if does not affect the building directly, while it might influence the access to the building. With non-uniform subsidence, the damages increase noticeably. Earthquakes, in turn, precipitates the subsidence and causes differential settlements that result in cracking building components such as walls, floors and roofs etc. (J. Lagorio, 1990).

Figure 4.4 *Port-au-Prince, Haiti, after the earthquake 2010* (Marco Dormino, 2010).

4.4 Earthquake-resistant Design

The effects of an earthquake vary but primarily, there is a connection between earthquakes and weak buildings. Proof from earlier disasters shows that many countries, particularly developing countries in seismic areas, have very dangerous built structures that are exposed to the risk of collapsing due to acute earthquakes. Sometimes these buildings might collapse on their own even without any seismic forces.

It is impossible to make a building completely earthquake-proof, even the most well-planned buildings are badly affected when a strong earthquake strikes. However, we are able to list the main objectives while designing an earthquake-resistant building to reduce the damages, both human and economic ones. These objectives are

- Avoiding collapse or serious damages in a situation of unusual ground shaking.
- Mitigating construction damages.
- Minimizing non-structural damages in a light ground shaking.

The structure and its foundations must be built to be resistant and, if the force is received from the walls, they have to be symmetrical in both directions. The walls must be strong enough to receive loads and be connected to a shape which can support loads in its weakest direction. However, if the force is

received from diagonal bracing, they must be symmetric in both directions; they should also be strong enough to receive loads from tension and compression. The lighter the building is the lesser are the loads. Therefore, the roof should rather be of light material while floor, and load bearing and interior dividing walls, should be even lighter.

There are some basic principles for designing houses to achieve the objectives above that are discussed in the following sections.

4.4.1 Location

The location must be safe for building houses based on the local land-use practice and even the classification of the risks and critical areas. A certificate must be carried out by the appropriate authority to insure that the area is safe for building and is not vulnerable for erosions or displacement. According to Philippine National Housing Authority's Manual for Land Development in Manila, the houses must be placed in relatively flat areas; they should not be placed on slopes steeper than 15 % (figure 4.5). The wind speed and the wind direction, drainage and the direction of the surface water drainage must be considered when planning the location of the house. It is important to put the drainage before starting building to avoid condensation. Moreover, measures must be done to control the soil erosion in slopes around the houses, for example through building walls or planting bamboo along the slopes (Matabang, 2009).

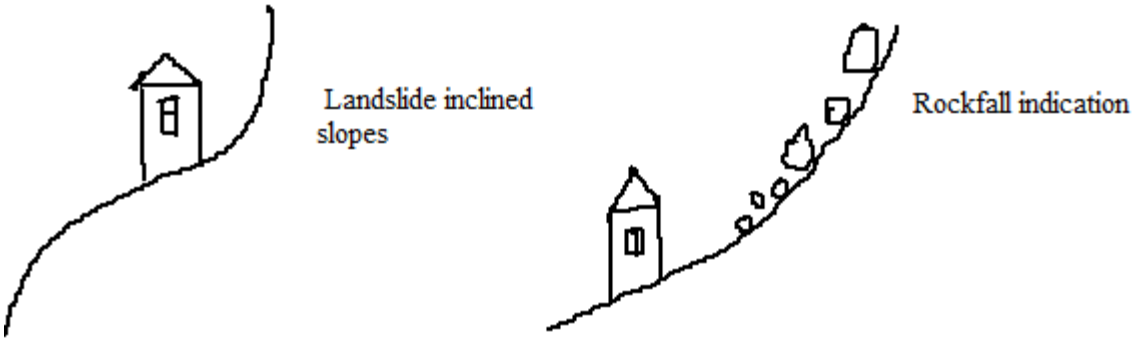


Figure 4.5 *These types of locations should preferably be avoided in earthquake-prone areas* (Jain, 2008).

4.4.2 Shape

For disaster resistance, it is recommended to use regularly-structured buildings, preferably with simple and compact design since they are the least affected by earthquakes. A square shape is particularly safe because it is well-braced against earthquakes and the wind is able to pass around. However, the most exposed shape is the L-, U- and T-shape, especially in the corners on the inside. If we have a rectangular design, the length must be maximum 3:1 (figure 4.6a) and if there is a projection of the building, the total length of the

projection should be less than 1/3 of the total buildings length (figure 4.6b). For more complicated design, the engineer has to make structural estimations to guarantee earthquake resistance.

Large buildings can easily be destroyed by strong earthquakes. During the ground-shaking high load factors, inertia and the emerged seismic shocks constitute serious danger for high buildings and once the structure weakens, the building will be unable to bear the following shocks. Therefore, height should be avoided in earthquake-prone areas. Large buildings can also be separated into various blocks so that symmetry is able to reduce or prevent damages between them (figure 4.7). The separation of about 3 cm can be composed beginning from above the plinth and should be covered with aluminum sheet that crashes during the shaking (Jain, 2008).

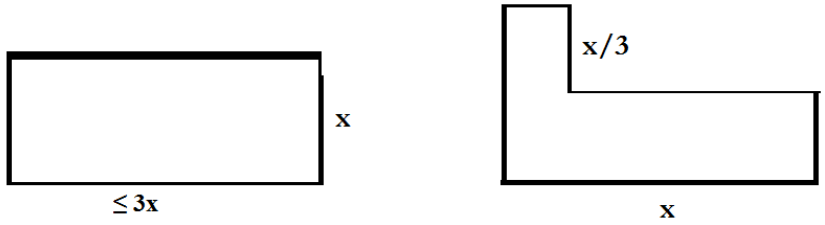


Figure 4.6 a) *Symmetry in plan on both axes is required,* ***b)*** *projections preferences.*

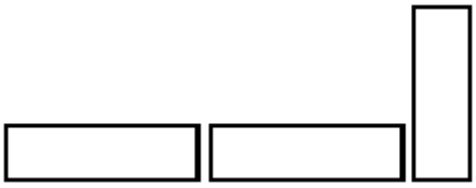


Figure 4.7 *Separation of large buildings.*

4.4.3 Foundation

For a stable building, it is important that the foundation is well-anchored in the ground otherwise the building might slide down or be turned over. To decide which foundation type the construction requires, we have to know the area's soil type and its characteristics. The soil must have good bearing ability, be compact, expansive and not water-saturated. The foundation must also be adequately deep to rest on the fixed basis. Thus, the depth is dependent on the number of floors that it is going to bear (UNNATI, 2006).

There is also a risk for condensation during an earthquake and for protection against that a level beam has to be fixed so that the walls can rest on it in order to protect the top of the building in case it is exposed (REcampus).

4.4.4 Columns

Reinforced concrete columns are often placed in the corners of the house which strengthens it against collapse and also from tilting of walls during earthquakes. A suitable reinforcement is important so that the columns are strong enough to resist buckling and bending as well. Vertical reinforcement bars go through the length of the column and horizontal reinforcement bars with smaller diameter should be bent into closed loops and placed at equidistant intervals along the column (Matabang, 2009).

4.4.5 Floor and Joists

Wood floor must consist of connected floor boards while in concrete construction the floor must be reinforced with steel. To make the floor both tight and stable so that it settles equally with the ground during a movement, it should be constructed directly after the foundation walls are done (Matabang, 2009).

4.4.6 Exterior Walls and Façade

The same principle as in floors is used for strengthening of the exterior walls against horizontal shaking; bracing in wood constructions, horizontal and vertical reinforcement in stone and concrete walls that also protection against developing fractures. The steel reinforcement should be placed both vertically and horizontally close to doors, window openings, connections and intersections (figure 4.8a). The reinforcement functions as bands to connect walls and columns and to strengthen the construction so that it moves as one object while shaking. It is also important that columns and walls are casted together to prevent sloping or collapse (Matabang, 2009).

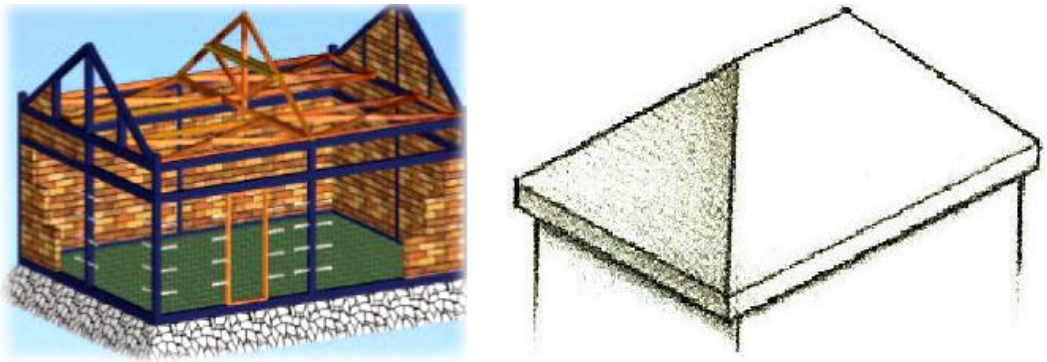


Figure 4.8 a) *Exterior walls,* ***b)*** *Hipped roof* (Handbook on Good Building Design and Construction, 2007).

4.4.7 Doors and Windows

It is known that huge openings weaken the walls and therefore, small openings are more preferable. There are some instructions for constructing openings taking into account both wall height and the distance from the openings.

Normally, the door and window-opening length in single-story house should not exceed 50 % of the wall length while it is 42 % in two-story house and 33 % in three-story house. Furthermore, doors and windows should be placed in the middle of the wall (UNNATI, 2006).

4.4.8 Roof

The roof is the most exposed construction part in an earthquake. Hipped roof is considered to be the most secure because it can resist damages very well since it takes less pressure upward. Thus, the flat roof is the most exposed one. Moreover, low walls with sloped roofs should be chosen rather than high walls with flat roofs. The recommended roof gradient is 25-40 degrees. The roof overhangs or eaves are at highest risk to be rolled down or lifted up in an earthquake. Therefore, they should be kept to the minimum and not exceed 0.40 meters overhang (Matabang, 2009).

Terrace must be covered by separately built roof so that it does not affect the rest of the building in case it comes away. The roof ridge can be affected by strong winds or shakings. However, it is possible to avoid the impact in many different ways. One alternative is to use special metal sheets in corners, flanges or metal bands. In addition, diagonal bracing is required to strengthen the roof to connect the roof and walls, and to strengthen the whole structure. To connect the roof and walls together, the eaves of the roof should be fastened with the wall or column by a metal band. Another alternative is to eject the column reinforcement from the top so that it can fasten around the eaves (Matabang, 2009).

Figure 4.9 *The roof eaves must be connected to the wall columns by metal band* (Handbook on Good Building and Design and Construction, 2007)

4.4.9 Preferable Features for Proper Earthquake Design

Briefly, the earthquake-proof design should be based on these points:

- Symmetric plan;
- Low density materials;
- Short scope;

- Low height;
- Separate buildings for different functions;
- Simplicity;
- Unifrom floor heights (Jain, 2008).

4.5 Structural Materials

The structure has the biggest impact on a buildings' durability. Actually, there are some significant facts about different material choices when constructing earthquake-resistant buildings. Typically dangerous characteristics are (Jain, 2008):

- Concrete without reinforcement;
- Pre-cast concrete composite buildings or old precast constructions;
- Inadequate strength in the ground floor;
- Pre-stressed concrete elements or post-tensioned concrete slabs in a building;
- Concrete or steel frame with masonry walls without reinforcement;
- Masonry walls without reinforcement and with pre-cast concrete or wood floor;
- Inadequately anchored glazed exteriors;
- Large and poorly structured wood-frames.

Wood	Timber and wood are often considered to be the best and cheapest for constructing small houses when they are accessible. Wood has high seismic resistance and with its light weight the earthquake's forces on the structure will be much less than for brick or stone. However, the resistance may weaken because of inadequate connection to the foundation and walls. Therefore, to resist the lateral forces in wood constructions, bracing in all levels are required to give strength and keep the building connected in order for it to not collapse laterally. Buildings constructed of wood resist the most devastating earthquakes. Experiences and analyses have been done to prove that even multi-story buildings survive big earthquakes with very small damages. These buildings can resist earthquakes with the magnitude 8.2 or even higher. Studies done at Canterbury University showed that if the Haitian presidential palace had been constructed with wood it would not have collapsed. Unfortunately, it was actually built with reinforced concrete. Wooden constructions are expected to best resist the most destroying earthquakes when comparing to other construction methods (NZ Wood).

Reinforced concrete	In the same way as for wooden structures, badly designed concrete structures tend to behave like un-reinforced masonry buildings which are exposed because of the weak connection between walls and foundation and, therefore, they cannot sustain any damages. However, concrete resists compression forces while steel resists tension; that makes the reinforced concrete a sustainable frame when aiming at an earthquake proof construction. The flexibility of the steel combined with the stiffness of the concrete increases the capacity for the building and gives an adequate strength to resist the seismic forces (PCA). An example is shown in figure 4.10.
Steel	Steel is known for its flexibility and ductility which is beneficial when it comes to earthquakes.
Earth	This type of structure is basically not able to resist different weather conditions, which makes it even more vulnerable during the occurrence of movements because of earthquakes. It normally gets fractures in walls and separations in corners and even collapses (Jain, 2008).
Brick	The bearing of brick buildings depends much on the type of mortar that has been used, type of roof and quality of the strength construction (Jain, 2008).
Stone masonry	The collapse of the whole building during an earthquake makes the stone masonry the most catastrophic frame type (Jain, 2008).

Table 4.2 *Various frames and earthquake resistance*

4.5.1 Load Bearing Structures

For adequate earthquake performance, all components of the construction should be properly bounded together to increase the cohesiveness.

There are two framing alternatives that withstand seismic loads; load-bearing wall construction and framed construction. The second can either have light parts which need diagonal bracings or infill walls against lateral loads, or substantial stiff jointed beams and columns that resist the lateral loads (Jain, 2008).

4.6 Existing Buildings

The main reason for the remaining vulnerability of major cities in developing countries is that the majority of the existing buildings were constructed before seismic technologies were developed. Moreover, there are many types of building structures and building classes with various construction materials and ages. Based on these conditions, the buildings will be shaking at different

rates, depending on the mass, size and class of construction. The earthquake in Mexico City 1985 caused damage in 42 % of the city's buildings, where 40 % of the damaged buildings were corner buildings. In overpopulated, high-density urban centers, the risk is increased by adjacent buildings with different heights since the adjacency of a tall and flexible building next to a short and rigid one result in destruction of one of them or both. This condition interacting with the long-duration ground shaking was the reason for the destruction of 42 % of the buildings in Mexico City (J. Lagorio, 1990).

Buildings with no structural framing and with an upper floor and roof built on masonry walls might lose the strength and collapse in case the walls shake. What can be done is strengthening of each room on four sides round the floor and up to the wall corners and, clearly, the roof as well. These frames must be of steel or reinforced concrete. Besides, in concrete framing, the amount of materials used should be taken into account since every material has its significant function; not enough steel leads to poor reinforcement and the result will be bending failure and not enough cement in the concrete result in crumbling caused by loads.

It is not uncommon either to find buildings with floors resting loosely on frames, which lead to a complete structural failure because of seismic shakes. For example, timber joists resting on walls or cross beams can cause fall of the floor and then, the floor below will not be able to tolerate the weight of it. To avoid such destruction, the adjacent floors can be tied together so that they do not separate from the sides of the supports.
In some poor countries, like Haiti, properly built buildings might get extended in height over the years; additional floors are built because of increase in family size. Obviously, this height increase is not just dangerous; it also weakens the original structure. Removal of the additional storeys and strengthening like described above, of every floor, may be the best solution (REIDsteel).

5 Earthquake Exposure in Developing Countries

More than 50 % of the world's population lives today in urban areas. 22 cities in the world have 10-25 million inhabitants, 14 of them are in the developing countries, and eleven of those 14 cities are in risk zones. 13 of the 22 cities are exposed to big risks and 7 are located in a high seismic zone (Blaikie et.al, 1994). Asia and Africa are the most rapidly urbanizing regions in the world and as the world's most growing cities are in the global south, this area shows an increasing exposure to environmental and geological disasters (Pelling, 2003). As the rapid and unplanned urbanization in developing countries grows, more lives get exposed to big risks. The urbanization process increases the pressure on the land since people migrate to already overcrowded cities and settle on weak ground when no alternative is possible.

In developing countries, more than 86 % of the population is exposed to some major natural hazard because of deficient quality of construction, large slums, air pollution, violence, poor health and education services and damaged infrastructure (Janhevich, D. et.al). Thus, urbanization is a significant factor for increasing vulnerability, especially for the low-income population. Today, according to Sida, the Swedish International Development Cooperation Agency, billions of people who are moving in to the cities every year to improve their life conditions live constantly in danger because they end up living in slums in the peripheries of the cities. The yearly rate of urban population growth in the peripheries of mega-cities reaches about 10-20%; 1.6 million in Rio de Janeiro settle on slopes, garbage and flood-exposed lands, and on 400 areas in Sao Paulo 75,000 people are at risk of whom 25,000 are exposed to high landslide risks (Pelling, 2003).

Studies show that the urban poor suffer more from serious diseases and have much higher mortality though the big cities are known for having the best hospitals. In fact, the situation looks different within the same city; the reason being densely populated slums without healthy drinking water or sanitation which is a real breeding ground for diseases. The illegal settlements are unacknowledged by the authorities and therefore, the population is not presented in the statistics and has no access to public service. Mathre Valley in central Nairobi with more than 200.000 inhabitants has existed in 50 years and was still unacknowledged by the authorities in 2006, which results in inadequate health and education services (Tannerfeldt & Ljung, 2006). Another example is Quito in Ecuador where, despite the strong earthquake in 1949, the population continued to increase from 500.000 to be more than 1.5 million. According to Swedish Rescue Service Agency (SRSA) 1997, many have settled on steep slopes and even ravines have become too full for the sewers to pass by (Blaikie et.al., 1994). In this way, the vulnerability has also

been increasing. To eliminate the negative effects of the urbanization, some actions from the authorities and other organizations need to be taken.

5.1 Earthquake Vulnerability

Earthquakes are the least predictable of all natural hazards, the interval between threat and occurrence is also very short which puts it on the top of the list of natural disasters when it comes to immediate mortality and destruction of built environment. The most significant risk factors are:

- Population density
- Intensity of the seismic activity
- Structural fragility
- Time for occurrence

When comparing the past two decades of the 20th century, it is noticeable that the number of earthquakes with the magnitude 7.5 and higher have increased from 1980s to 1990s. The increase has then continued until it reached its maximum in 00s and in turn, the number of victims. Mortality in earthquakes has risen significantly and also varies in different countries because of the difference between building types and the density of settlements (Guha-Sapir et.al., 2004).

Vulnerability is best described as the situation where numbers of people risk to be affected by the disaster either by losses of lives or property, damages or even economic difficulties. This may explain the connection between poverty and the influence of natural disasters since the most significant factor is the population's vulnerability when a disaster strikes.

The most significant factors that increase a society's vulnerability are:

- **Physical:** the population is exposed to a potential disaster which means that it is living in a dangerous area, for example in a seismically active area.
- **Social:** the population growth, conflicts that create insecurity, discrimination of all kinds, lack of access to social security or even the population's capacity to cope the disaster (Guha-Sapir, D. et.al, 2004).
- **Economic:** the globalization of the world's economy has been worsening the situation in developing countries, the population's or the country's dependence on agricultural resources, the lack of the existence of insurances, loans and financial access, debts and even access to basic infrastructure as communication networks, water supply, electricity, health and education service, etc. (Guha-Sapir, D. et.al, 2004). The disaster losses may also vary within a city where economic development and disaster preparedness are unequally distributed. The

urban economy decides who bears the biggest burden of the disaster (Enhancing urban safety and security, 2007).

- **Environmental:** ground damages and erosion, chemical and biological pollution in addition to the access to water (Guha-Sapir et.al, 2004). The climate change and the influence on the environment are global issues and their consequences affect both poor and rich. However, those issues have still stronger impact on developing countries since they do not have enough resources to mitigate such threats. Despite the attempts to discourage climate change, the world's countries have not made any progress in arguing about reducing the emission of greenhouse gases. That makes it a challenge for the poor countries to adapt themselves to the climate changes (Regeringskansliet).

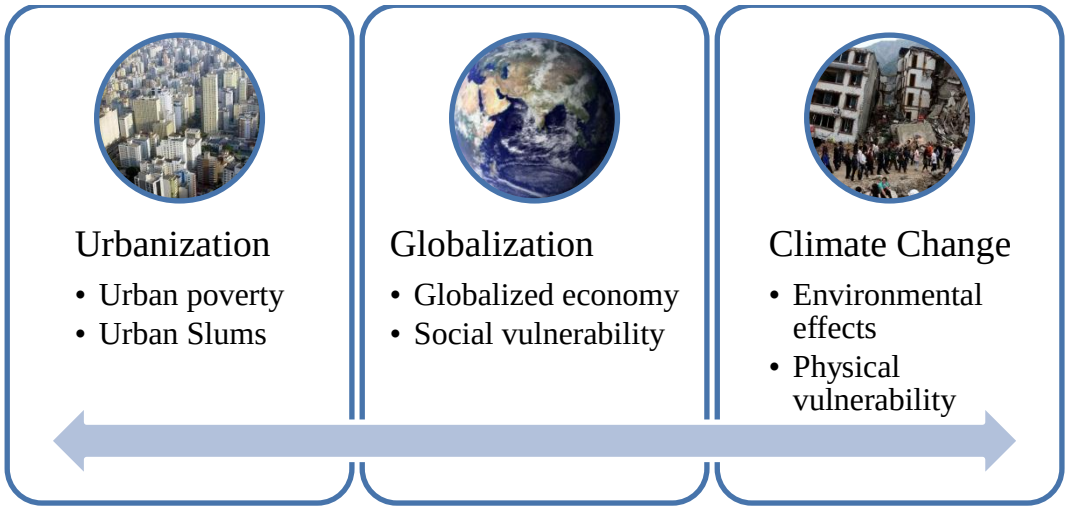


Figure 5.1 *Vulnerability parameters and their relation* (By the author).

The aspects above interact with each other, they are together able to increase the risk of vulnerability and in turn increase the risk of an occurrence of a disaster.

The biggest risk for loss of lives in an earthquake occurs in the collision of urbanization and poverty. The least developed countries (LDCs)[5] are exposed to high risks of natural disasters; at least six of them have during the past 15 years been affected by 2-8 different disasters a year. Those were followed by long-term damages that affected the human development. Despite the report of 1991 that showed that 50 % of all disasters occur in countries with less economic and human development, about two-thirds of all victims were from countries with low human development while only 2 % were from highly developed countries (G.R.I.D. ARENDAL). According to Hardoy et.al. (2001), the lower-income groups are those who bear the most of the post-

[5] See Appendix A.

disaster consequences such as diseases and premature mortalities. The reason is their inability to afford safe housing with basic services close to their jobs.

The 7.5 Richter scale earthquake that struck Guatemala in 1976 and was followed by a large aftershock two days later, caused the loss of 22.000 lives and 75.000 injuries, and resulted in about 1,000,000 homeless. The majority of the deaths and injuries were reported in the low-income and slum areas of the city (Olson, 1977). The landslide in Venezuela and the storm in France in December 1999 caused damages of around 3 billion dollars each; the French buildings are of course highly valued comparing to the Venezuelan. However, the losses of life in Venezuela were estimated to be 50,000 persons while in France only 123 persons lost their lives. A study that was done by the Organization for Economic Co-operation Development (OECD) showed that less than 10 % of the losses are financed and covered by donations in the post-disaster phase which means that the disaster can be considered as a permanent barrier to development (Enhancing urban safety and security, 2007).

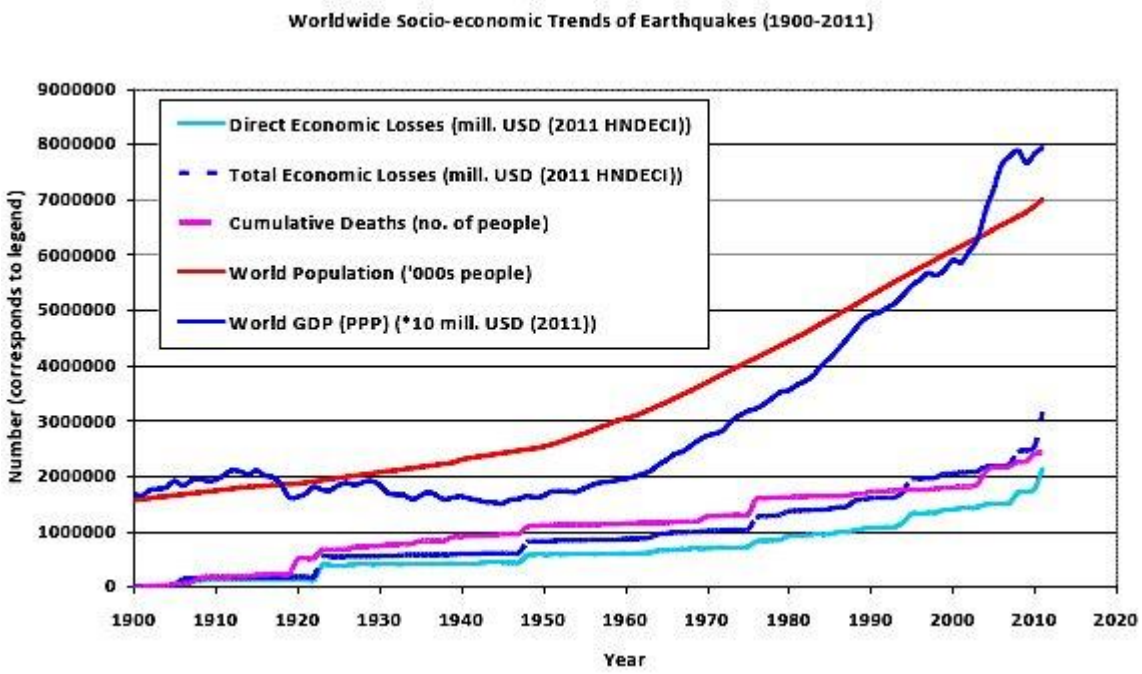


Figure 5.2 *Globally Increased number of earthquakes followed by cumulative human and economic losses 1900-2011* (Vervaeck & Daniell, 2012).

5.2 Consequences

Around 95 % of earthquake victims die in building collapse. The number varies between different countries and is primarily dependent on the difference in building styles and also how compact the built environment is. The majority of the victims are those settled in slums where self-made structures collapse. The society does not pay much attention to the natural disasters, to the risks that follow nor to the loss of security which make the situation even harder to

handle. Moreover, the poor prefer to use the income for daily economic survival, health and education or other important things such as fridge or oven etc., rather than building a more stable house. Thus, the low income population's reluctance to invest in buildings is not because of lack of knowledge or responsibility but their feeling of insecurity as the government can force them to move out anytime. Nevertheless, the aspect of money may worsen the situation as educated builders tend to migrate from rural to rapidly growing urban areas in search for money. In that way, people might be forced to build their own houses despite their lack of knowledge in this field (Aysan & Davis, 1992). Those people might also face many risks such as loss of medical service, education and legal rights and poor infrastructure. Studies have shown that the people settling in dangerous areas would never choose to live there if they could have found other alternatives but they also think that they have much better life conditions than many others who do not even have a shelter, income or anything to eat (Blaikie et.al, 1994).

5.3 Haiti – The Jewel of the Caribbean

To illustrate a specific case in a developing country, Haiti is taken as a good example where vulnerability, poverty and absence of capacity meet to make the 2010 earthquake as one of the most disastrous in the human history.

Haiti, known as French St Dominique in the 1800s, was the richest colony of the French Empire and could provide France with sugar, tobacco and coffee and was therefore called "*la Perle des Antilles*" – the Jewel of the Caribbean. However, that did not last since French St Dominique became isolated by the international community[6] shortly after the revolutionary war that made it to the first Black republic in the Western Hemisphere. The isolation started after pressure from Napoleon and the French colonists that stretched all the way to the United States. Consequently, the Haitian economy that was based on export was ruined, and in turn, the infrastructure such as roads, ports and schools, was destroyed. Until 1915, the country faced different kinds of backwardness, primarily such as no access to foreign technology to improve its economy and agriculture. Also the national treasury was running out, which caused the lack of large educational budgets.

Haiti has never had any international support; beginning from the time of the leader Jean-Jacque Dessalines in 1806 until the time of the democratically elected Jean-Bertrand Aristide in 1991 and 2004. Since 1971, the country has been dependent on foreign non-governmental organizations, NGOs. The donor

[6] A group of people, governments or organizations around the world with common duties. Political leaders and activists use the term when working against political repression and preserving the respect for human rights.

countries had decided to avoid the Haitian government and, instead, work with the NGOs which obviously made changes. After the uprising against the President Duvalier's regime 1986, the NGOs engagement in projects in the country increased by four times as compared to before. By 2010, 10,000 international organizations were said to be working in Haiti but only 500 of them were officially registered with the government (Fransois Pierre-Louis, 2011).

5.3.1 The 12th January, 2010

The Haitian earthquake on 12 January 2010 was the worst earthquake in 100 years with a magnitude of 7.0 in Richter scale. Haiti is situated on the Caribbean plate, which is surrounded on three sides by two other plates; the North American and the South American plate. The problem is that both plates are trying to move west in relation to the Caribbean plate. The Haitian earthquake was a result of two plates grinding together; the convergent earthquake in the eastern part of the Caribbean plates and the transformed earthquake around Haiti (Squidoo).

According to reports by the Global Disaster Alert and Coordination System (GDACS), the number of the earthquake victims was estimated to 444 people per square kilometer and in total they were 3,725,615 people, out of whom 495,509 were children between the age 0 and 5 years. This makes it to be considered the worst earthquake in modern time (Haiti Earthquake, 2010).

Twelve days later, the 24th January 2010, in total 52 aftershocks with greater magnitude than 4.5 followed, and those aftershocks continued for weeks. After the earthquake 180,000 houses and 4,000 schools were destroyed. 1.5 million people became homeless and had to be settled in camps where 100,000 persons lived in critical zones for storms and flooding. The hazard also resulted in spreading of cholera from which 4,000 died and 216.000 suffered (DEC).

86 % of the population in the capital Port au Prince lived in densely built concrete houses in the slums. Half of that population did not have any access to latrines and only one third of them had access to tap water. According to *Institut Haitien de statistique et d'informatique*, nearly 70 % of the country's buildings were one floor, 15 % cottages of which 92.5 % were in the rural areas and 7.5 % in the cities. Only 10 % of the country's buildings have more than one floor. Almost all walls in the city's buildings are built of concrete and no reinforcement is used, in the rural areas using soil as material is more usual. The same concept is used in floor material where hard packed soil is used in the rural areas while concrete is used in the cities. As roof material steel sheet is the most dominating. The use of these materials had a great

impact on the collapse of the majority of the buildings which was also followed by damages and loss of lives (RMS FAQ, 2010*)*. Even the UN that was established in Haiti and had to cope with the humanitarian assistance and response for the security, experienced big losses; about 300 of the personnel were missing as well as the head of the UN Stabilization Mission in Haiti (MINUSTAH) and many others (Taft-Morales & Margesson, 2010).

As mentioned before, the urbanization during the past decades has a connection to the informal buildings and the building on the outskirts of big cities. In Port au Prince, the poor settle in self-produced houses built with the materials that are available. Accordingly, the insufficient buildings may not be able to resist a natural hazard.

The ground shaking in Port au Prince was followed by a condensation and landslide; big parts of the slopes in that area contain sedimentary material, aerial pictures after the disaster showed widespread condensation areas, specifically around the harbor buildings. The lack of capacity of the harbors contributed to difficulties of transporting emergency aid and staff to the region. A large part of southern Port au Prince has steep slopes which create big landslides, and that also contributed to increased buildings damages. The UN study in 2009 showed that over 90 % of the informal settlements were concentrated on sloped or ravines, which is quite normal in developing countries (RMS FAQ, 2010*).*

Haiti has always been socially and environmentally at risk; according to the World Bank, 54 % of the population lived in extreme poverty with less than 1 $ a day (www.unfpa.org). About 81 % of the population does not manage to acquire the daily ration of food necessary as defined by the World Health Organization (Taft-Morales & Margesson, 2010). The country was also in environmental crisis; after the hurricane in 2008, the president of the Inter-American Development Bank (IDB), Luis Moreno, claimed that Haiti is the most vulnerable Latin American country for natural disasters and economic shocks. It was also listed by the United Nations as one of the world's 50 LCDs failing to overcome poverty. The destruction of the Haitian infrastructure and social damages caused by the earthquake has prominently slowed the development. Therefore, the country needed more attention from the international community to recover. It was also important to learn from previous incidents and focus on the human needs that demand rapid assessment (Haiti Earthquake, 2010).

5.3.2 Humanitarian Country Team

The Haitian government was helpless, the president called for international assistance and the most important thing was to manage the search and rescue

operations. Since the whole infrastructure was destroyed, it was also significant to get the communication systems back in order to coordinate the efforts flexibly. In addition, medical assistance, supplies, food, clean water, sanitation and emergency shelters were needed. Meanwhile, the World Bank and the Haitian government were working together on developing the country's strategy by supplementing the disaster risk management (Taft-Morales & Margesson, 2010).

Disaster Assessment and coordination (UNDAC) and UN Office for the Coordination of Humanitarian Affairs (UNOCHA) were engaged in coordinating the search and rescue teams and also the assistance effort. Normally, a Humanitarian Country Team is gathered right after the disaster. This team includes many actors like UN agencies, national and international NGOs, International Federation of Red Cross, Red Crescent Societies (IFRC) and the International Committee of the Red Cross (ICRC). Accordingly, the humanitarian relief sector's main task is to render the UN Humanitarian Country Team to organize the planning and in Haiti every sector attended to a specific function; the International Organization for Migration had to arrange emergency shelter and non-food items, the World Food Program (WFP) worked on emergency logistics and telecommunications and together with the UN Humanitarian Response Depot (UNHRD) obtained the food help from El Salvador and Panama. Moreover, the medical assistance was managed by the World Health Organization (WHO) and the UN Children Fund (UNICEF) had, in addition to water and sanitation, the task to take care of survived children and get them together with their families (Taft-Morales & Margesson, 2010).

6 Disaster Management

Since natural hazards have always existed, the history of disaster management dates back as far as 3200 BC when an Iraqi community called Asipu started using a process; analyzing the situation, suggesting alternative solutions and assessing their positive results. It is the same process used today for so called decision analysis which is very significant for an overall risk management exertion (Coppola, 2007).

The risks of natural disasters are often not clearly esteemed and sometimes even neglected since the likelihood of their occurrence is low. Therefore, the communities are hardly prepared when the disaster strikes and the consequences become devastating (Global Education). The disaster management is a process that involves planning, organizing, coordinating and implementing measures in order to deal with the disaster impact on the affected community (Deshmukh, R. et.al, 2008). This also includes risk assessment, mitigation, preparedness, emergency efforts and most importantly recovery and reconstruction.

First of all, like in any project, some questions must be asked to know how to start planning and what the expected results are. What is the most acute issue that must be managed? What situations might emerge? How can obstacles or the hazard on the whole be avoided? Generally, the disaster management tends to have some common goals for all types of natural disasters;

1. *Reduce, or avoid losses from hazards.*
2. *Assure rapid assistance to victims.*
3. *Achieve an effective recovery.*
   (Warfield, 2012)

The 1990s International Decade for Natural Disaster Reduction (IDNDR) was announced by the UN General Assembly. The aim was to make a contribution to reduce material and human losses and also to save the economic situation caused by a disaster. IDNDR intended to improve the UN member countries' capacity to reduce the damages and effects by setting goals to achieve after founding an office in Geneva to coordinate the IDNDR activities. The goals included (Lechat, 1990):

- Strengthening the countries' capacity to mitigate the effects of natural disasters effectively, especially in the developing countries; the assessment of the potential of disaster damages, early warning systems and disaster resistant constructions.
- Putting guidelines and strategies for using existing technologies and knowledge considering the economic and cultural difference between nations.

- Supporting the scientists and engineers who are struggling to use the knowledge to decrease the losses following a disaster.
- Making more use of existing technical possibilities for measuring, predicting and mitigating the disaster.
- Developing those technical possibilities through programs for technical assistance, demonstration projects and education and training adapted for specific disasters and locations.

Moreover, the Johannesburg Plan of Implementation of the Sustainable Development 2002 on vulnerability, risk assessment and disaster management embraced some strategic goals (Parsad, 2009):

- Disaster prevention, mitigation, preparedness and vulnerability reduction should be enhanced through sustainable development policies, planning, and programming and in turn reduce the disaster risk.
- Building resilience to disasters through strengthened use of capacities and institutions.
- Risk reduction approaches concluded in the design and implementation of emergency preparedness, response and recovery programs in the reconstruction.

On the other hand, the UN Habitat pointed that the post-disaster reconstruction extends possibilities for developing the community resilience and rebuilding its socio-economic structure and livelihoods in addition to reducing future disaster vulnerability.

6.1 Earthquake Risk Management

Risk is defined as the probability for a certain accident with negative consequences of occurring. Sometimes, even social and psychological aspects are taken into account, beyond the technical aspects. Even though many of the natural disasters cannot be controlled by human beings, the extent of the consequences after an earthquake depends mostly on human action.
The risks can be divided into three phases:

1) initial accident
2) exposure
3) effect

All three phases are dependent on the human influence and also the possibility to affecting the situation. The initial accident means that it is not possible to mitigate the earthquake or even control its intensity. However, risk management would make it possible to prevent some effects from exceeding the level of natural phenomena and turning into a natural disaster. That can be achieved by at least refraining from building in earthquake exposed areas or building more resistant.

The risks that affect a community can be estimated and evaluated; they can be reduced either by reducing the likelihood of the earthquake's occurrence which is almost impossible, or by reducing the consequences. Therefore, reducing the impacts on the affected population will be achieved most effectively by investing in real disaster response. That can be achieved by a risk management process which looks different in each country and with each type of disaster, and where every country struggles to reach some specific goals depending on the country's general goals and laws.

There are three types of risks; health, security and environment. Within the security area, the consequences are measured by the number of deaths while within health and environment areas, they are measured by the number of injured or losses and the natural damages. Since those risks occur in all types of natural disasters, the same process can be used for all of them.

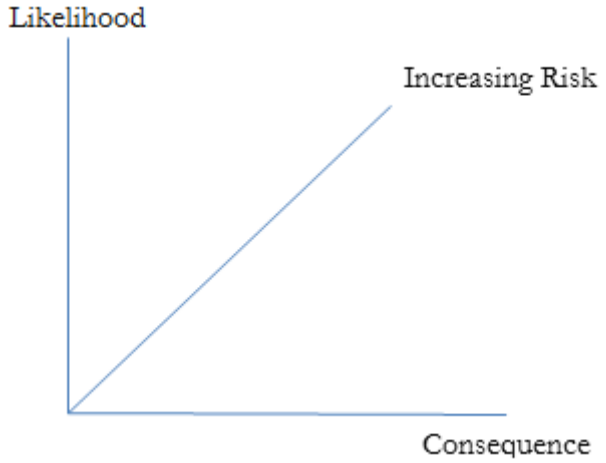


Figure 6.1 *The ratio between risk, likelihood and consequence* (Anderson & Kinnerberg, 2000).

Risk reducing actions can be divided into five phases (Anderson & Kinnerberg, 2000);

1. Mitigation;
2. Preparedness;
3. Response;
4. Recovery;
5. Reconstruction.

These actions are general for all natural disasters with some small exceptions and sometimes with different designation. They are illustrated more profoundly later on.

6.2 The Disaster Management Cycle

To reduce the losses from natural hazards and to recover effectively and rapidly, the disaster management cycle aims to help the integrated actors like governments, planners and agencies to reduce the impact of the hazard (Warfield, 2012), see figure 6.2. There is no standard rule for using the cycle, the different phases are adjusted to the situation and later in the process, even more actors get involved; individuals, groups and communities to minimize the disaster impacts mentioned in previous chapters.

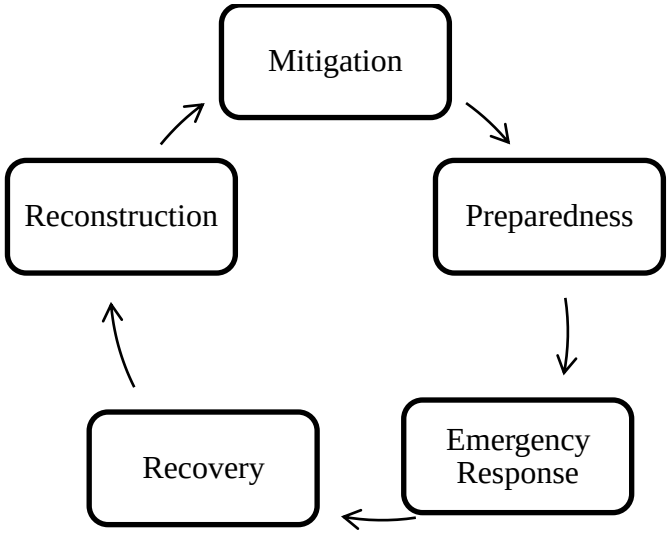


Figure 6.2 *Disaster Management Cycle* (ODPEM).

Risk analysis to assess the vulnerabilities and how to prevent them is important for convenient earthquake mitigation. The different integrated actions in the pre-disaster phase are illustrated here:

Pre-disaster Risk Management	**Mitigation**	Earthquake Risk Assessment	Disaster Prevention Earthquake Prediction
	Disaster Preparedness	Warning & Evacuation	Emergency Response Planning

Figure 6.3 *Pre-disaster phase* (by the author).

6.2.1 Mitigation

The mitigation framework means actions to reduce long-term effects and vulnerability for the disaster. In earthquake-prone areas, the mitigation actions

can be such as relocating the population into safer areas or strengthening structures as mentioned previously. Mitigating economic and social losses is also a significant task (A Supplementary Textbook in Geography, 2006).

As we have seen in the management cycle (figure 6.2), the mitigation phase is ongoing before and after the occurrence of the disaster. However, the actions taken before the disaster are of a greater concern than the actions coming after the post-disaster phase. Earthquake disaster mitigation concludes international actions to mitigate the disaster; assessing the seismic risk and preventing the occurrence of the earthquake (J. Lagorio, 1990).

6.2.1.1 Earthquake Risk Assessment

The earthquake hazard has to be assessed to identify the risks of exposure and vulnerabilities of the prone area where many things will be essential in order to accomplish an effective result such as architectural, engineering, seismological, geotechnical, demographical and urban planning, etc. actions. All interests must be considered to make an overall assessment of the total risk.
The assessment of seismic risk is defined by the four following factors (J.Lagorio, 1990);

1) Hazard: geological hazard that influences the impact of the earthquake like ground fracture, shaking, landslide, liquefaction and tsunami in addition to following fires and other chemical releases.
2) Exposure: the level of impact from the hazard and the impact on public health and safety.
3) Vulnerability: a measure of the damage depending on the exposure level.
4) Location: the position of the total regional area.

Predicting seismic activity, when possible, facilitates the preparedness and response actions. However, it is still important to measure the risks and increase the security in the terms of building resistance. Nevertheless, since predicting seismic activity in developing countries has not been developed yet because of lack of technology and funds, the worst consequences should be expected and thereby make a radical preparedness framework to avoid the consequences (J.Lagorio, 1990).

6.2.1.2 Disaster Prevention

Enhancing the mitigation framework through disaster prevention occurs mainly by (Enhancing urban safety and security, 2007):

- Strengthening local disaster resilience;
- Land-use planning;
- Building codes and regulations;

- Protecting infrastructure and services;
- Early warning.

6.2.2 Pre-disaster Preparedness

The preparedness phase includes strategies and activities to reduce the likelihood of the disaster occurrence or its negative consequences. Since it is not possible to eliminate the disaster or the disaster risk, well-planned disaster response preparedness is very significant for an effective risk reduction. It is important to, in this short term, enhance the preparedness of the organizations and communities to respond rapidly and effectively (National Research Council, 2006). Thus, the planning in this phase requires that the community is conscious enough about their vulnerability since communities normally do not realize that they are at risk. In most cases, a major disaster in a community causes long-lasting damages on several generations. Therefore, the areas' experience from previous disasters must be studied carefully. When the risk reduction is recognized in a community, it would be much easier to implement it at a regional, national and international level. However, there are other communities taking consciously less action than they should because no serious prediction of disasters has been done (Kreimer, 2003). At the World Conference on Disaster Reduction in January 2005, the disaster response preparedness was declared as a very significant part in reducing the disaster risk (Katouch, 2007). It shortens the needed response time and speeds the recovery phase by identifying the disaster and creating a plan to address the requirements of these phases (National Research Council, 2006).

According to the UN General Assembly, the governments of affected countries are responsible for managing a disaster response through local and national authorities. The effective disaster response preparedness and the risk reduction coming with that can be achieved by an early corporation with the affected countries' governments, communities, donors and regional organizations. Accordingly, working on the preparedness before the disaster strikes would certainly improve the situation of both national and international response. The exposed developing countries and their regional organizations are today given a hand by the international communities to improve their risk reduction frameworks. The Coordination of Humanitarian Affairs (OCHA) has used the UN Disaster Assessment and Coordination team (UNDAC) that has proposed upgrading strategies concerning national disaster response in some developing countries such as the Philippines, Mongolia, Afghanistan, Bolivia and the Dominican Republic.

Analyzing the disaster risk reduction through emergency response preparedness in a community can be done by analysis of its vulnerabilities and then adjusting plans to them. The main actors are the police, NGOs and other

local agencies while the local government should prepare an early-warning plan for example facilitating the evacuation.

Regionally, investing in disaster response mechanism and including regional aid groups like for example South Asian Association for Regional Cooperation (SAARC) and the Caribbean Disaster Emergency Response Agency (CDERA) could also contribute to an efficient risk reduction, primarily by organizing seminars and exercises. A great example is the earthquake response exercises in developing countries lead by the International Search and Rescue Advisory Groups (INSARAG) where the International Urban Search and Rescue teams (USAR) take part together with national USAR teams, UNDAC teams, Local Emergency Management, NGOs and private sector companies (Katouch, 2007).

At the international level, the disaster response preparedness requires an international process in addition to local planning so that international actions can be realized flexibly together with the national response efforts. Building some international response networks like UNDAC, Environmental Emergencies networks and INSARAG plays also a major role in disaster risk reduction.

Thus, both nationally and internationally effective disaster response framework and risk reduction must be strengthened by the governments. In order to achieve that, there are some important points that the national government must develop for an effective risk reduction (Katouch, 2007);

- Form a sustainable national policy and legal framework;
- Nominate a ministry for disaster response;
- Make the same structure at the district level;
- Provide educated and equipped cadre;
- Enable room for operations and communication with other districts;
- Link the incoming international organizations with responders such as UN and NGOs and create new ways of integrating international responders with a local emergency management authority like the case was during the earthquake in Bam, Iran in 2001where almost 1,300 international responders from 34 different countries were present in four days, which was appreciably enough for a sufficient management.

6.2.3 Emergency Response

When the response to a disaster begins, humanitarian agencies have the most intensified contact with the government to lead the initial assessment and distribution of aid in addition to planning for the recovery phase (Jha, 2010).

The emergency response comprises measures that aim at saving lives and properties and dealing with the social disruption caused by the disaster. The activities in this phase can be divided as follows (National Research Council, 2006):

- Appropriate mitigation actions: cleaning operations to, for example, clear earthquake fire debris and other dangerous materials to avoid further harm.
- Population protection actions: warning, evacuation, search and rescue, temporary shelter and medical care.
- Agent-generated demands: survey the type of losses and assess the needs caused by these losses.
- Response-generated demands: situation assessment, communication and management.

A preparation and integration plan by the government is a crucial component in the emergency management for helping a community with the response and recovering. Besides, properly chosen staff, facilitated dialogue between stakeholders, and well-managed information, are all important to guarantee sustainability in the emergency phase (Lauffer, 2006).

Post-disaster response	**Search & Rescue**	Debris Removal
		Human Rescue
		Security
	Humanitarian Assistance	Material & Food Aid
		Shelter
		Medical Aid
	Recovery	Relocation
		Shelter
		Livelihood
		Reconstruction

Figure 6.4 *Post-disaster, response phase* (Made by the author).

6.2.3.1 Pakistan Earthquake Response

Pakistan is an ideal example to illustrate the post-disaster emergency response in a developing country. In October 2005, an earthquake of the magnitude 7.6 hit a large area of the north part of the country where 145,000 people were killed and about 600,000 homes were damaged. Afterwards, the majority of

the rescue effort, in addition to relief efforts and volunteers, was carried out by Pakistani civilians. Even though their responses were generous, no type of planning or organizing existed which resulted in traffic jams due to transport of relief supplies for the victims and blockage of all roads leading to the earthquake zone. Still, their efforts were crucial for undertaking the relief and rescue the first few days. The UN agencies and hundreds of International NGOs beginning with the Turkish Red Crescent Society started their work during the first days. The UN Disaster Assessment and Coordination (UNDAC) team worked with the Government of Pakistan (GoP), UN agencies and NGOs to create "coordination structures" and a so called Flash Appeal[7] for $312 million was prepared a couple of days later, a sum that was meant to support a six-month's emergency response. The amount was almost doubled in two weeks.

Since there were no disaster response strategies in Pakistan before the earthquake, the army was responsible for providing relief efforts and the president Musharraf asked, the day after the earthquake, a military officer to found a Federal Relief Commission (FRC) to gather all the stakeholders (Wilder, 2008).

The non-existence of any preparedness and the lack of understanding of the international standards led to many mistakes in Pakistan's emergency response framework; the government closed organized camps and let the population leave the camps before alternative shelters were arranged. Despite all the efforts done by the civilians during the emergency response, they could neither take part in decision-making nor could they get protection or be guaranteed of at least the basic human rights (Lauffer, 2006*)*. Habitat for Humanity Pakistan (HFHP) tried to improve the situation by introducing dome-shaped transitional shelters produced from reusable materials such as for example galvanized corrugated iron sheets and foam insulation, materials that can be re-used later in the permanent houses. With the supervision of the government's Earthquake Reconstruction and Rehabilitation Authority, HFHP built in 2006 new earthquake-resistant houses and created a new construction program that entailed recycling of heavy timber from old damaged houses and transforming it to lighter wood elements and using the galvanized corrugated iron sheets as roof elements (Jha, 2010).

Simultaneously, the International Federation of regional offices which provides training and learning support services for development and relief called RedR-IHE, worked mainly on using international standards and

[7] "*A tool for organizing humanitarian emergency response to a sudden disaster*." It is established by the UN's humanitarian coordinator, Inter-Agency Standing Committee (IASC) country team, Emergency Relief Coordinator (ERC) and the government of the effected country (Global Humanitarian Assistance, 2012).

cooperation and communication in addition to attitude changing. In Pakistan, by training and individually coaching 1,800 people from local and international NGOs, military and UN agencies in different cities, the support showed real progress through improved capacity-building[8] but still there were obstacles emerging because of further earthquakes, which resulted in destroyed infrastructure, reduced or lack of training and also lack of policies in early phases (Lauffer, 2006). In this phase it is important to have a plan including citizen preparedness and coordinating it with other local, regional and national plans. The plan should also take some critical points into account; adopting it to the public facilities, including both citizens and animals and most importantly, the officials should be thorough and be able to link everything appropriately. It is the officials' responsibility to act and take decisions at the community level and, therefore, they must have a clear idea about the best way to respond and plan steps that must be taken in order to achieve effective results without further problems (Hildreth, 2007).

In summary, the disaster emergency response is a process for which the included steps should be studied and managed with consideration of the type of disaster, population's needs and emerging obstacles and challenges encountered by the humanitarian agencies. An effective response requires the following (Perry, 2007):

Involvement of the local population and organization
Even though the local community does not have the capacity or the resources to respond, the local authorities and the local and international NGOs are benefitting by following the local community which facilitates the framework.

Coordinating local needs assessment
Bearing in mind that the population has different needs, it is of great importance to understand the social, environmental and cultural attributes of these people. Additionally, attention should be given to the dangers that might be encountered by either the population or the region.

Communication between the parties
Facilitating the communication and information distribution is critical for an effective disaster response since information is crucial to the main operation during the first two phases in the management cycle where humanitarian agencies need information to survey the situation, the affected population and

[8] Even called capacity-development; actions to enhance human and institutional, technological and scientific capacity as well as ecological and geographical conditions. A basic goal is to strengthen the ability to address the most important issues in policy-making and ways of implementation (Agenda 21, 1992).

the resources. The information might be hard to gather because of destructed infrastructure; however, the assessment of needs facilitates the decisions.

Early involvement of logisticians

Logisticians play an important role in the emergency phase but they are often not included in assessing the needs of the population and once they are, they will be given very limited authority to implement their decisions. The logisticians should be supported in early stages so that problems faced during the response phase and in the aftermath can be avoided or at least reduced.

Box 6.1 Rapid Response Mechanism (RRM)

The RRM emergency response capacity arrangement was established in 2004 to provide the badly affected victims, by different disaster types, with assistance in the Democratic Republic of Congo (DRC). The RRM succeeded to assist more than two million victims who were in need for emergency help. The RRM is recognized by humanitarian actors, donors and other effective organizations and sectors. It is managed by UNICEF and the Coordination of Humanitarian Affairs (OCHA) and implemented with three international NGOs; Solidarités, the International Rescue Committee (IRC) and Catholic Relief Services (CRS).

The idea of RRM was a response to the limited capacity for a systematic and predictable response to the morbidity, mortality and malnutrition caused by the conflict between armed groups followed by displacement in DRC since the 1990s. With the DRC Humanitarian Coordinator help, the RRM was established to guarantee capacity for some key activities;

- Rapid assessment by different sectors within 72 hours of news f crisis, security and access permitting.
- Response by different sectors in three primary sectors; household family relief, water, sanitation and hygiene assistance and primary education in addition to two secondary services; provision of basic medicines and health supplies to partner organizations and health facilities, and distribution of high-protein biscuits.
- Advocacy and coordination with other actors to foster complementary emergency activities concerning food security, health and protection.
- Systematic monitoring of activities and interventions.

The responsible RRM actors assess the needs of the accessible vulnerable population and thereby provide them with assistance.

In the beginning, UNICEF made an agreement with the NGOs about providing them with financial and material resources to fulfill the RRM activities above while each NGO partner coordinated by arranging sufficient staff and logistical capacity. At the same time, OCHA managed the Rapid Response Fund (RRF) to make it possible for non-RRM sectors to respond to emergency needs.

Beyond the daily cooperation between the RRM actors, NGOs, OCHA and UNICEF also have weekly meetings attended by all UN agencies and NGO humanitarian partners (Danielov, 2008).

6.2.4 Post-disaster Recovery and Reconstruction

The post-disaster reconstruction starts simultaneously with the emergency response; as soon as the disaster strikes. It is the most complex of all phases and the more harmful the disaster is and the more deficient the plan of collateral response is, the more complex the reconstruction is going to be. That is why it is important to work fast in order to assess the damages and form policy basis for reconstruction.

According to UN Habitat, disasters can provide opportunities for sustainable development but, at the same time, efforts during relief and reconstruction must be included in long-term development strategies (figure 6.5) mainly through a policy for a sustainable relief and reconstruction (Parsad, 2009). The policy must be done by the government and define some main areas (Jha, 2010):

Risk Management

The policy must first of all have a risk management plan embracing governance and corruption; environment; social issues and the disaster, and should be foreseen to reduce the vulnerability since any deficiency in the risk management brings unnecessary consequences.

Reconstruction Approach

How will the physical reconstruction be undertaken in the community? Different types of support must be observed like training or finance. The reconstruction policy should develop coordination of housing and infrastructure through better safety and use of standards to decrease the vulnerability in long-term even if it means relocation of households or the whole community. Concerning land-use it is necessary to create a new plan for housing and infrastructure to increase the security.

Community Participation Approach

The communities have a major role in the disaster management and it is therefore very important to assess their capability, vulnerability and knowledge in order to know what they are able to contribute with. By identifying the role of the affected communities, the reconstruction policy can allocate resources to either empower or to exclude them. Communication with the affected communities is crucial as also is including them in policy making, institutional and financial strategies. When this is implemented, the communities will be able to rebuild their own shelters and livelihoods. Transitional shelters must be provided during the reconstruction until the permanent shelters are completed and in the light of the true idea about reconstruction, which means, not only rebuilding the own house but reconstructing the whole community inclusively infrastructure.

Financial Strategy
Managing the financial resources gained from different national and international donors must be taken in consideration to avoid some risks such as lack of control and efficiency of the resources. It is beneficial for the post-disaster financial management as well. After the disaster, the population's biggest trouble is housing and therefore, the assistance strategy for housing will be their assessment of the whole policy framework while there are, for the policy maker, a lot of aspects they should take into account such as social, economic, logistic aspects etc. That is to say, the policy should be adapted to the situation in which the country and its existing social policy must be implemented.

Institutional Strategy
When the policy making begins, assessment of the collaboration between different parties such as humanitarian agencies and reconstruction agencies is significant for the flexibility. Moreover, the governance during the reconstruction is also important; to identify how formal and informal regulations, laws and institutional agreements will be implemented, if the NGOs will be involved and how their efforts will reach the affected communities. The competence and capability of the participating organizations must be evaluated as well as the responsibilities of the local governments.

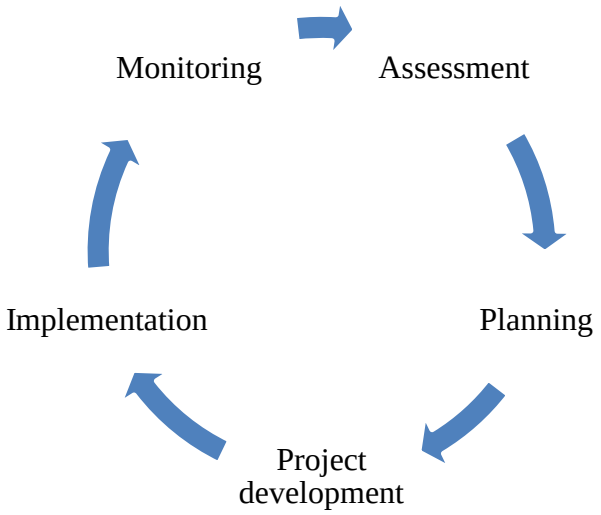


Figure 6.5 *The Post-disaster reconstruction cycle* (Jha, 2010).

The recovery and reconstruction might take some years and the population should not expect to be placed in the pre-disaster locations or have the same circumstances. Anyway, the level of vulnerability is determined by the extent of affection and the basic economic situation besides gender and age.

Box 6.2 Providing shelters & housing units, learning from the example of New Madrid, USA:

As earthquakes leave thousands of people homeless, 300,000 after the Mexican earthquake 1985 and 500,000 after the Armenian 1988, emergency shelters must be provided for them. Learning from the example of New Madrid, USA, which in just one year 1811-1812 experienced three earthquakes of a magnitude above 8.0, the response in the post-earthquake phase was occurring by replacing the damaged houses in the following stages (J. Lagorio, 1990):

1) Emergency shelter; immediate emergency: anything available in this period can be used as a basic shelter. Tents are often used while the responsible authorities prepare official shelters. After the Italian earthquake Compania-Basilikata 1980, the government provided people with numbers of metal shipping containers to be used as emergency shelters. Thus, emergency shelters do not need to have the installation systems like electric power, sewerage or kitchen. The most important thing is to make a safe sleeping place.
2) Temporary housing; intermediate recovery: more considerable housing units must, when available, replace the emergency shelters during the reconstruction phase. These buildings are usually used in longer periods since the reconstruction process might take several years. Therefore, the danger arises in developing countries when these temporary buildings become permanent ones instead.
   Before the temporary housing units are available, it is significant to find proper locations in order to install sewerage, water systems, etc. which were not required in the emergency shelters. Another significant task is that these temporary units should be of lightweight to be transported and set-up an easily.
3) Permanent housing; basic reconstruction: although the building of new permanent housing (in the reconstruction phase) has to occur quickly, there is more time for planning and design.

7 Summary & Conclusion

More than 86 % of the population in developing countries is exposed to at least one major natural hazard. Natural hazards interact directly with vulnerability to put people's lives and properties at risk. When dealing with earthquakes, the built environment plays a major role where the poorly built slum housing with substandard constructions increases the vulnerability of the population. The destruction caused by earthquake vibrations is not only related to the intensity of the earthquake but also to the stability of the houses in the affected areas. Therefore, it is important to list some basic designing principles to reduce the human and material damages by avoiding collapse, mitigating structural and non-structural damages;

- The location should not be on steeper area than 15 %.
- The shape should preferably be square; otherwise the width should not be less than 1/3 of the length. Furthermore, projections should be avoided and buildings with different functions should be separated.
- Foundations must be well-anchored in the ground and deep enough depending on the number of floors.
- The soil must be expansive, not water-saturated and have good bearing ability.
- Suitable reinforcement in columns so that they are strong enough to resist buckling and bending.
- Connected floor boards in wood floor and reinforced steel in concrete floor.
- Bracing in wood constructions and horizontal and vertical reinforcement in stone and concrete constructions and also steel reinforcement placed vertically and horizontally close to doors, window openings, connections and intersections.
- Doors and windows should have as small openings as possible and the length of the opening should not exceed 50 % of the wall length in single-story buildings, 42 % in two-story buildings and 33 % in three-story buildings.
- Flat roof must be avoided, hipped roof with gradient 25-40 is recommended.

Wood is considered to have high seismic resistance and because of its light weight, the earthquake forces on the structure will be much less than for other frame materials such as stone and brick. Furthermore, for designing earthquake-resistant buildings recommended simplicity, symmetric plan, low density materials, short scope, low height and uniform floor heights.

The disaster risk reduction in urban slums in developing countries should start firstly by understanding the connection between urbanization and vulnerability

of the urban poor and, thereafter by housing financing mechanisms for the urban poor to reduce their vulnerability. That can be achieved by:

- Developing and expanding existing housing financing policies so that even insurance is included;
- Using more intensive and extensive social, cultural and economic measures to assess the capability of a community to get involved in different development operations since the population is directly affected by occurring disasters;
- Ensuring good communication between the local authority and the communities.

Undoubtedly, the development operations in slums around the world are also dependent on the prevailing global situation such as the slow progress in achieving of the Millennium Development Goals and the global warming. However, an international disaster management reduces the negative effects of a disaster event, since earthquakes cannot be predicted.

The disaster management cycle, which is used in all types of disasters, helps reducing the losses and also recovering effectively and rapidly. In the pre-disaster stage, the mitigation phase, which is ongoing before and after the disaster, reduces the long-term effects and vulnerability for the disaster by risk assessments and disaster prevention frameworks while the preparedness phase includes strategies and activities like warning and evacuation and emergency response planning. The post-disaster response stage begins with search and rescue activities and ends with the recovery frameworks including reconstruction. All these phases are crucial for achieving a successful disaster management taking into account the geographic, demographic and social changes. Figure 7.1 below summarizes all the integrated actions in both pre-disaster and post-disaster phases. One of the most essential goals is the action of providing safe shelters and housing units.

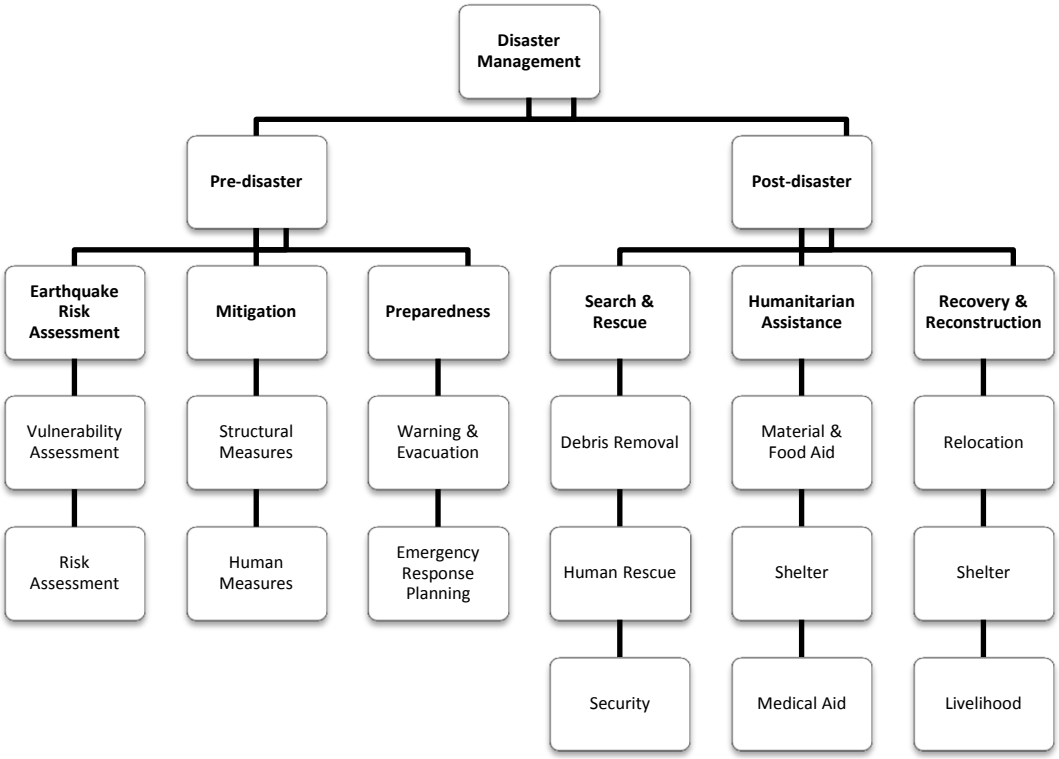


Figure 7.1 *The Disaster Management steps* (Deshmukh, 2008).

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8.3 Pictures

Figure 2.1: United Nations: http://www.un.org/esa/population/publications/WUP2005/2005wup.htm (2012-03-20)

Figure 2.3: Jolkona: http://www.jolkona.org/blog/mdgs-and-jolkona/ (2012-03-22)

Figure 4.1: World Maps: http://www.justmaps.org/ (12-03-21)

Figure 4.3: EngPedia: http://www.enggpedia.com/civil-engineering-encyclopedia/articles/1553-earthquake-resistant-buildings-design (2012-04-22)

Figure 4.4: Marco Dormino, MINUSTAH, UN, National Geographic: http://news.nationalgeographic.com/news/2010/02/photogalleries/100202-haiti-earthquake-pictures/#/haiti-earthquake-fire_12573_600x450.jpg (2012-03-19)

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9 Appendix

9.1 Appendix A – The Least Developed Countries (LDCs)

Afghanistan, Angola, Bangladesh, Benin, Burkina Faso, Burma, Burundi, Central African Republic, Djibouti, Eritrea, Gambia, Ethiopia, Guinea, Guinea-Bissau, Haiti, Yemen, Cambodia, Cap Verde, Kiribati, Comoros, Democratic Republic of Congo, Laos, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mozambique, Nepal, Niger, Rwanda, Solomon Islands, Samoa, Sao Tomé and Principe, Sierra Leone, Senegal, Somalia, Sudan, Tanzania, Togo, Chad, Tuvalu, Uganda, Vanuatu, Zambia, East Timor (Globalis).