Title

CityProgress: Web Portal for Active Data Sharing, Dissemination and Analysis for Disaster Risk Reduction

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1. INTRODUCTION

In February 2000, heavy rainfall in Mozambique, South Africa killed approximately 800 people and destroyed hundreds of homes. In January 2001, a 7.7 Magnitude earthquake struck Gujarat, India and approximately 170,000 people were injured and more than 400,000 homes were destroyed. In August 2005, a category 4 storm that hit the coast of Louisiana killed 1,800 people and flooded 228,000 housing units. In February 2008, a blizzard reduced the temperature in Afghanistan to -30 degree celsius and killed 1,000 people. In March 2011, a 9.0 magnitude earthquake that struck Tohoku, Japan triggered a Tsunami that killed 15,000 people and destroyed countless buildings. In December 2015, the capital city of Tamil Nadu, India received 1218.6 mm of rain that flooded the city, killing 350 people and destroying 1.16 lakh huts.

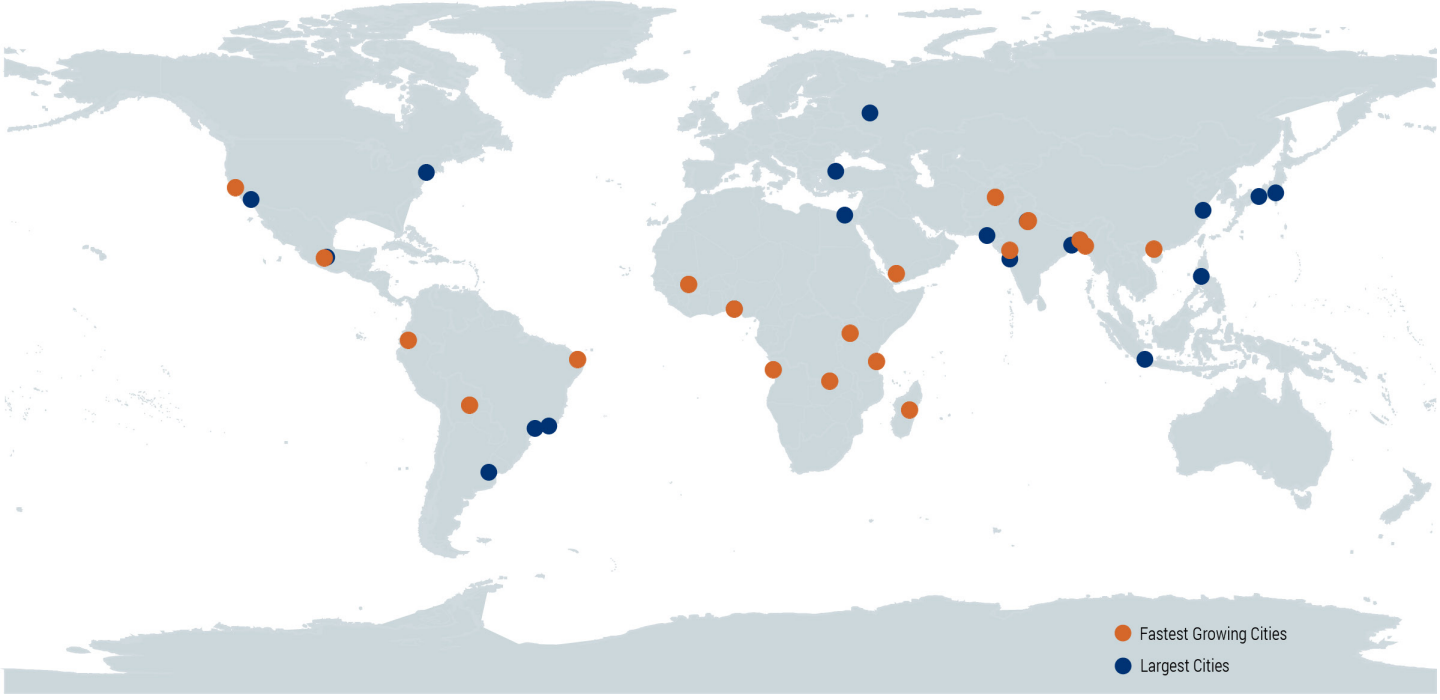
Although these are natural disasters, they are related to and amplified by urban climate change. "IPCC and DM-DAT predict increases of climate driven natural disasters as a consequence of climate change[1]" and these statistics pose questions for urban planning.

As more people are moving to cities and the world is rapidly urbanising, the number and scale of disasters is increasing. In 2014, UN found that 54% of the world's population lived in urban areas. By 2050, they expect this number to increase to 66%. Within these urban areas, there is a large number of people living in slums, especially in the developing world and most people lack access to safe water and sanitation. With lack of access to infrastructure, transport and housing comes poverty in the developed and developing world that is closely intertwined with disaster mitigation. Figure 1 shows the location of the largest and fastest growing cities in the world. Combined with climate change, a rise in population, urban poor and disasters poses a troubling future for the world. From an urban planning perspective, it becomes imperative to address the impact of disasters on the city fabric and expand on the "kind of urbanisation that will nurture sustainable growth and development[2]."

[1] Zarin, K. (n.d.). 10 Deadliest Natural Disasters of 21st Century. Scienceve.

[2] Shah, F., & Ranghieri. (n.d.). A Workbook on Planning for Urban Resilience in the face of Disasters Adapting Experiences from Vietnam's cities to other cities. The World Bank .

Figure 1: Map of the largest and fastest growing cities in the world



1.1. DISASTERS AND ITS MANAGEMENT

Disasters can be manifold and therefore it is important to define them in a manner in which planners can positively contribute to its mitigation. Two of the main parameters in defining disasters for planners is its origin and cause as not all disasters can be planned for. The United Nations International Strategy for Disaster Reduction (UNISDR) has been a pioneer in defining, understanding and mitigating disasters. They define a disaster as a -

"serious disruption of the functioning of a community or a society. Disasters involve widespread human, material, economic or environmental impacts, which exceed the ability of the affected community or society to cope using its own resources[3]."

Though often caused by nature, disasters can have human origins. In fact, the increasing scale of disasters can largely be attributed to human interference in natural ecosystems. Figure 2 shows the worldwide disasters in 2014.

Another methodology used to define disasters is the Pressure and Release (PAR) model. The model is based on the assumption that a disaster is caused by both a hazard and vulnerability to that hazard. According to the model -

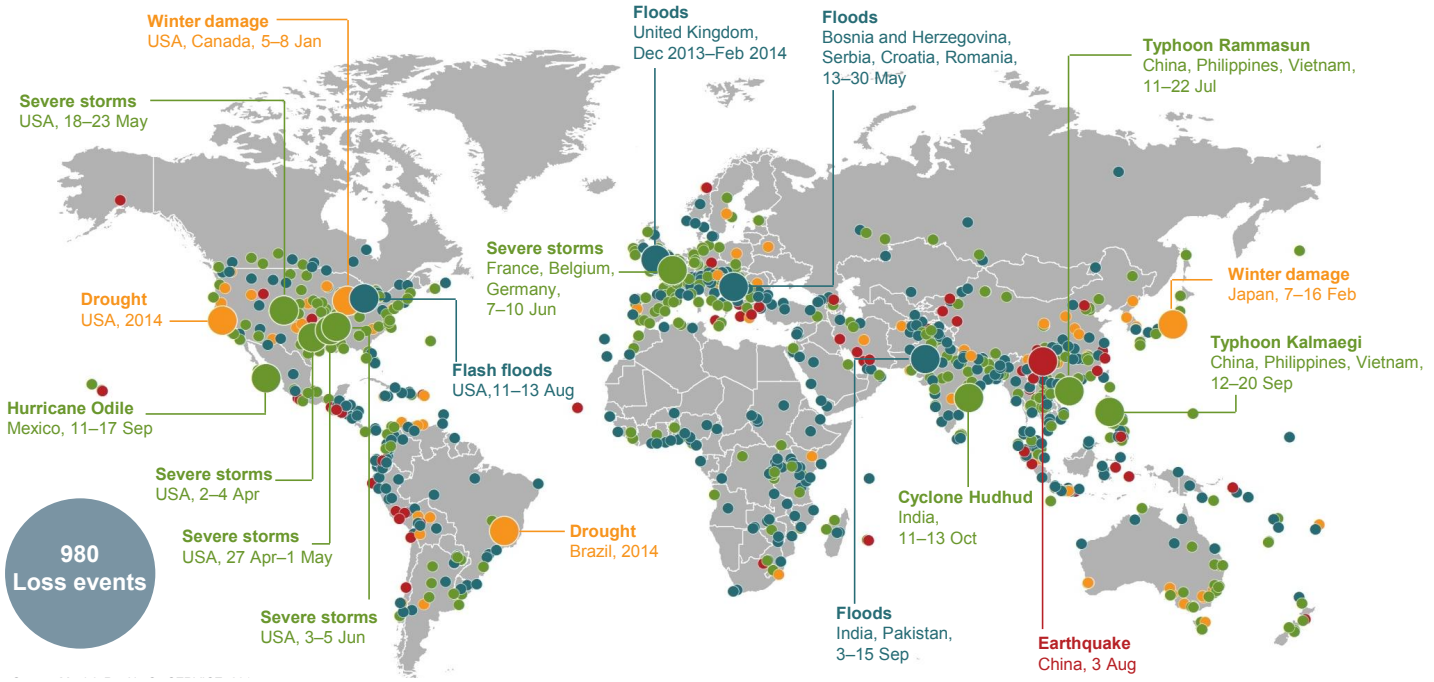
"hazards are understood as any potential threat (external natural or man-made causes) to social, infrastructural, and environmental components within a defined context. Vulnerability refers to the pre-disaster conditions (human or environmental) that can affect the impact and consequences of it[4]."

This is especially important to planners as instead of a generic definition, PAR considers factors causing vulnerability that can be directly addressed. The definition stresses the importance of capacity building at local institutions as their are most affected by and respond to disasters.

The three factors defined by the definition are -

- Root causes - These include the political and economic scenario of the state and lack of access to resources and infrastructure.
- Dynamic pressures - These include lack of availability of efficient institutions, markets etc. Other macro forces such as deforestation, rapid urbanisation, population increase also impact vulnerability.
- Unsafe conditions - These are caused by

Figure 2: Map of the worldwide disasters in 2014; Source: Munich Re, NatCatSERVICE



local economy, social relations, institutional efficiency and physical environment vulnerability.

As population and urban areas continue to expand, it is necessary for planners to ensure appropriate management of disasters to reduce their impact and the chances of disaster occurrence. More recently, disaster management has come to be known as Disaster Risk Reduction (DRR). UNISDR defines DRR as a way to analyse and manage the causes of disasters
"through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events[5]." Although planners are not responsible for all of the tasks listed above, they have some level of control over them, in varying degrees, in cities across the world.

An important component of DRR is to view it as a continuous process of disaster reduction pre and post the occurrence of the event. In determining the occurrence of the event, it is important for planners to identify the scale of the disasters, both spatially and temporally.

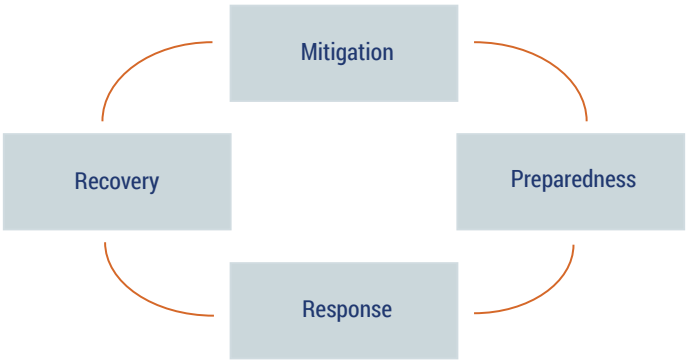
Figure 3: Chennai Floods; Source: www.hindu.com

Every scale should be planned for differently but should include four main steps, as defined by Coppola should in figure 4.

Mitigation measures are the actions/procedures to be undertaken before a disaster. Preventive or mitigation measures are altered as per the type of disasters. These measures include storm cellars for hurricane prone areas, houses on a higher altitude in flood prone areas and earthquake resistant building structures in areas which are prone to earthquakes.

Preparedness involves preparing kits and deciding actions to be undertaken when a disaster occurs. This is used to reduce vulnerability to disaster and mitigate the impact of the same. It is also helpful in responding more efficiently in an emergency.

Figure 4: 4 Steps of DRR



Response includes fulfilling the basic humanitarian needs of the affected population, along with search and rescue operations. National and international agencies usually join hands for undertaking this phase. Effective coordination is key which comes especially handy when there are more than one agencies involved in the operation. The Emergency Support Functions of countries usually covers this phase.

Recovery aims to bring the affected people and area back to normal. This phase starts once the threat of the disaster has subsided. The phase can be divided into two parts - short term and long term. The short term phase includes reviving of day to day life of the population starting with easy access of basic necessities. The long term could run from 5 years upto a decade and focuses on serious damages caused by the disaster and also planning on how to control the same if a similar

disaster occurs.

For the purposes of this study, we are considering calamities in urban areas due to natural or human factors as disasters. The interaction of urban areas and calamities was chosen as we believe that planners are most able to intervene in those scenarios. In addition, our proposal addresses the mitigation and preparedness aspects of DRR. Although addressing all parts of DRR is ideal, we believe the scale of our proposal relates most to the first two steps of DRR.

[3] Nations, U. (2014). Disaster Risk Reduction in Sustainable Development Outcome Documents. New York : United Nations.
[4] Wisner, Blaikie, Cannon and Davis. (2003). At Risk: natural hazards, people's vulnerability and disasters Second edition. Geneva: UNISDR.
[5]Nations, U. (2014). Disaster Risk Reduction in Sustainable Development Outcome Documents. New York : United Nations.

Figure 5: Disaster Relief Efforts in New Orleans; Source: www.bpnews.net

1.2. URBANISATION AND DISASTERS

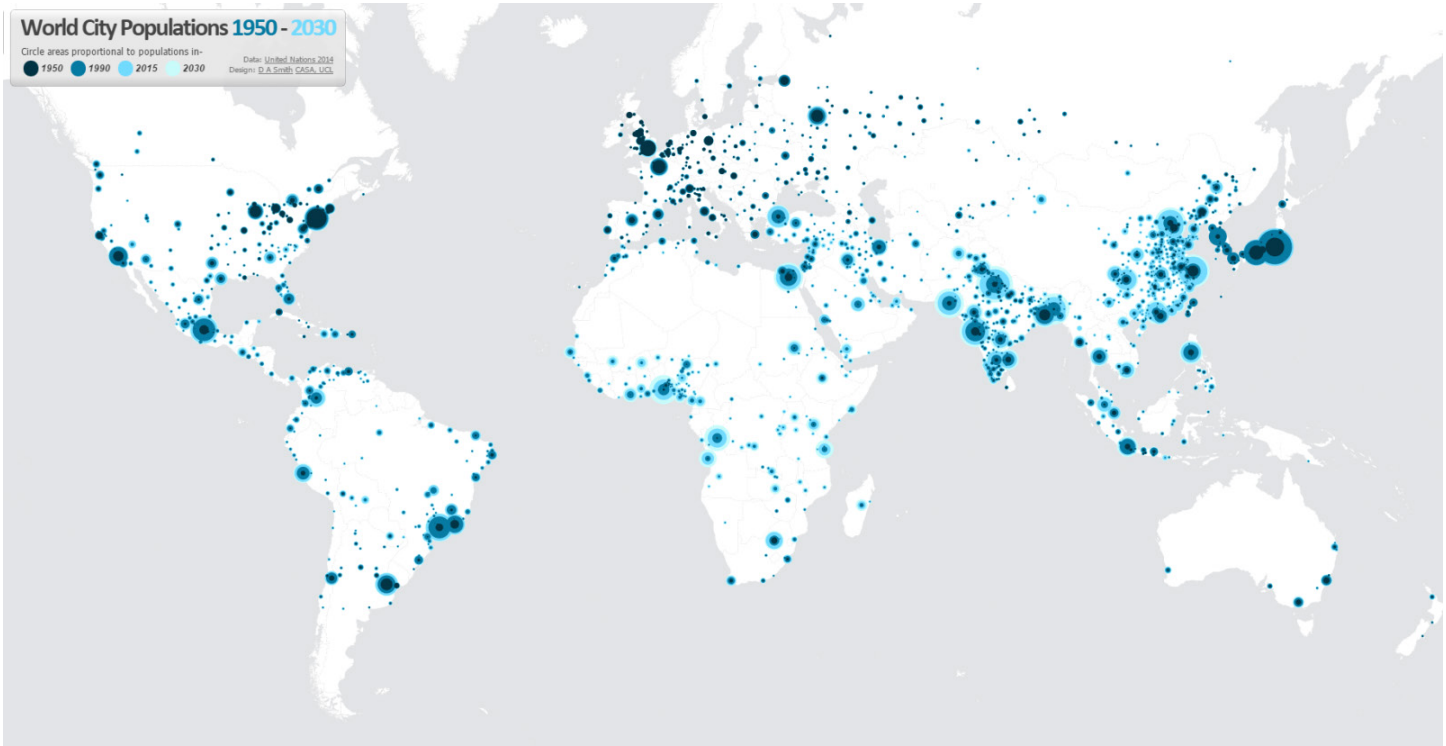
The United Nations (UN) predicts that 70% of the world's population will be living in cities by 2030. In 2010, the World Bank found that 65% of these cities were located in coastal areas and approximately 30% of the world's population was residing within 100 miles of coasts. The Report on Disasters published by The Institution of Mechanical Engineers states that
"at the moment [2013], almost 180,000 people move to cities and urban areas every day. As a result of such rapid growth, urban newcomers often encounter a lack of infrastructure, services, housing and property rights and are often obliged to live in unsafe, informal places. It is estimated that 18% of all urban housing units are currently non-permanent structures and one third of the world's population live in what the UN defines as slum conditions[6]."

Figure 6 shows the map of world cities population from 1950 - 2030. The population growth poses serious questions for planners working in cities as if DRR continues to be neglected, negative impacts of disasters will increase. This proposal focuses on urban areas because we believe that they represent one of the greatest challenges faced by planners in the 21st century. Additionally, the character of urban areas differ significantly from rural areas in terms of population, building density, infrastructure, economy and culture making it difficult to consider both in a single proposal.

The important question of today's urbanisation is whether cities will have sufficient housing and infrastructure to accommodate increases in population. This is especially tricky to navigate as population is a dynamic variable and shifts over time but the amount of land or the build environment is constant. Urbanisation is one of the key dynamic pressures identified by the PAR model that affects vulnerability and in continuation affects disasters. Thus, there is a relationship between urbanisation and disasters. This relationship can be direct or indirect and is mostly a combination of both -

- Direct - The higher the population in a risky area, the higher the number of victims when a disaster strikes and greater would be the

Figure 6: World City Population Growth 1950 - 2030, Source: www.citygeographics.org



economic and social loss.

- Indirect - With the increase in urbanisation, the burden is felt on the environment reducing its capacity to face the unpredicted challenges of climate change.

Urbanisation also experiences other issues that affect disasters in cities. The heat island effect due to concentration in built environment, development in unsafe land due to unsustainable urban structure patterns and weak political and economic governance are some of the issues faced by urbanisation that affects the scale and intensity of disasters. The impact of disasters in cities are accompanied by high costs of impact on people, infrastructure, social, economic and environmental losses and this is largely felt in low and middle income countries. Cities in high income nations generally provide adequate infrastructure for the population it serves. In low and middle income countries, urban infrastructure does not keep pace with the increasing population and urban sprawl that exacerbates the effects of disasters. Although there is a difference in urbanisation between high and low/middle income countries, this proposal is for planners working in both kinds of countries.

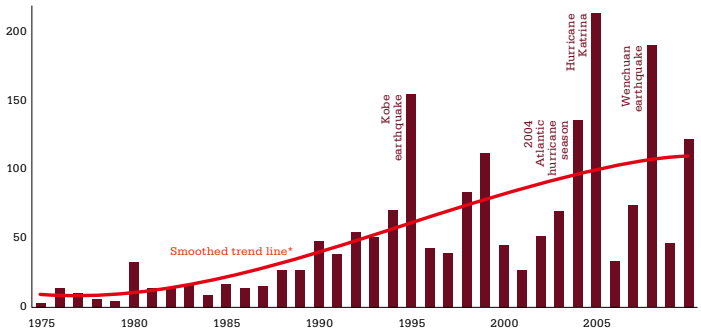
[6]Institution of Mechanical Engineers. (2013). Natural Disasters: Saving lives Today Building Resilience Tomorrow. London: Institution of Mechanical Engineers.

Figure 7: Urbanisation in Chennai; Source: www.india.com

1.3. URBAN PLANNING AND DISASTER MITIGATION

Between 2000 and 2012, UNISDR predicted that disasters had a monetary impact of $1.7 trillion dollars, affected 2.9 billion people and killed 1.2 million people. In 2015, their Global Assessment report found that "economic losses from disasters such as earthquakes, tsunamis, cyclones and flooding are now reaching an average of US $250 billion each year[7]." According to the report, annual losses due to disasters is approximately US $314 billion, for the built environment and in turn for urbanised areas. Despite the large-scale impact of disasters and the established relationship between urbanisation and disasters, steps to mitigate risk through urban planning are fairly recent. DRR with respect to urban planning was first mentioned in the documents related to the 1938-1939 bushfires in Victoria, Australia. Since then, planners have come a long way in acknowledging the necessity of planning for disasters but real action has only come into place in the last two decades.

Figure 8: Estimated damage (US$ billion) caused by reported natural disasters 1975–2009; Source: Natural Disasters Saving Lives Today, Building Resilience for Tomorrow



Amidst a privatized and a competitive market, it has been understood that the responsibility to promote and nurture the collective interests of the society lies in the hands of the public sector. A public sector is expected to create a healthy and sustainable environment by making provisions for the same in the social function of the community, that is largely the focus of planners. There are no doubts that natural calamities such as earthquakes and landslides cannot be prevented, however the risk mitigation and damage control become the essential components in the hands of the public sector. For instance, the location of residential construction in high-risk areas (eg: tsunami) if measured can help in immense risk mitigation when the tsunami actually occurs. Hence, urban planning is an important tool for DRR. Urban planning can not only help frame land use regulations but it can also help define the policies for evacuation, mandating insurance, relocation of critical infrastructure etc. which can hence mitigate the damage and vulnerability of the society.

Today, urban planners do not consider hazard mitigation at the core of their profession and it is considered a secondary activity or a subsidiary role in the development of land for new use towards urban growth. A responsible approach towards land use planning is needed which can help prevent or reduce the depth of impact that a natural hazard can cause to a community. Planning for DRR ideally takes place before a disaster at the mitigation or during the preparation and prevention phase. There are three main areas through which a Planner can reduce risk:

- Zoning of current and future land uses whereby development controls and building codes are applied as appropriate to the type of land and its structures
- Urban infrastructure and settlement design
- Information and mapping

These planning activities take place within the jurisdiction and framework of local governments keeping in mind the constraints on resources and capacity.

It is advantageous to consider DRR and urban planning together as they have many commonalities. One such similarity is the idea that planning places a substantiate emphasis towards identifying and seeking advantageous future opportunities in the social, economic and ecological domain of cities while DRR employs a similar methodology with interrelated stages of mitigation, planning, response and recovery. Additionally, plans and processes such as action agendas, policy framing, vision setting and

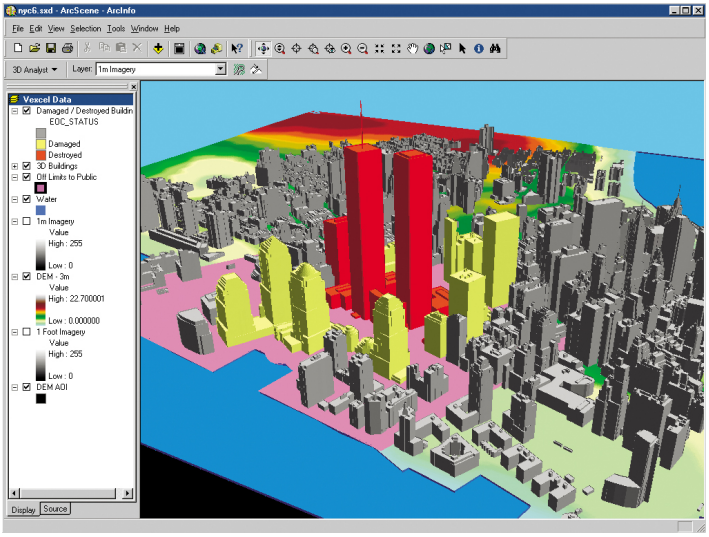
masterplan design is a key component to the synergy between the two fields. The only obstacle currently is the lack of the realization of this synergy as a primary component and not as a subsidiary function.

In addition to methodology, urban planning and DRR rely on gathering, developing and applying various types of analytical techniques as the base for actions. For urban planning, this includes collection of information containing the socio-economic and geographical characteristics, trends for future development and availability of human and material resources. DRR, similarly includes risk identification actions including hazard and vulnerability characteristics. Planning processes draw on multiple knowledge types and can generate creative design to a variety of complex problems and integrate these designs into the decision making processes. DRR also draws from a range of knowledge types and aligns this knowledge to respond to urban planning decisions and to more immediate decisions related to recovery efforts. The latter process has been augmented by the use of developed technological tools such as real time mapping, especially GIS (Geographic Information System).

Lastly, both disciplines seek to manage and alter elements of the built and natural environments based on the temporal understanding of risk and efficient allocation of responsibilities and rights. For example, risk can be reduced by by land use planning and design like constructing away from flood plans. Another example is the establishment of conditions and arrangements in the urban form which provide for better response by emergency agencies such as provision of access routes for emergency vehicles.

Efforts to integrate urban planning with DRR have been taken at the global, national and local level. In the national and local level, this comes in the form of vulnerability indices that have been used to measure how quickly cities can respond to disasters. The indices themselves are of two types - technical and non-technical. The technical index is used for a specific disasters and usually involves complicated spatial and statistical calculations. The non-technical index is more a framework of generic issues that planners should consider than a framework of 'action steps' towards DRR. As part of the study, we have included both global and local efforts towards DRR in the form of frameworks and vulnerability studies.

Figure 9: Integration of GIS and DRR; Source: www.esri.com



[7] UNISDR. (2015). Global Assessment Report on Disaster Risk Reduction 2015. Geneva: UNISDR.

1.4. GLOBAL FRAMEWORKS OF DRR AND URBAN PLANNING

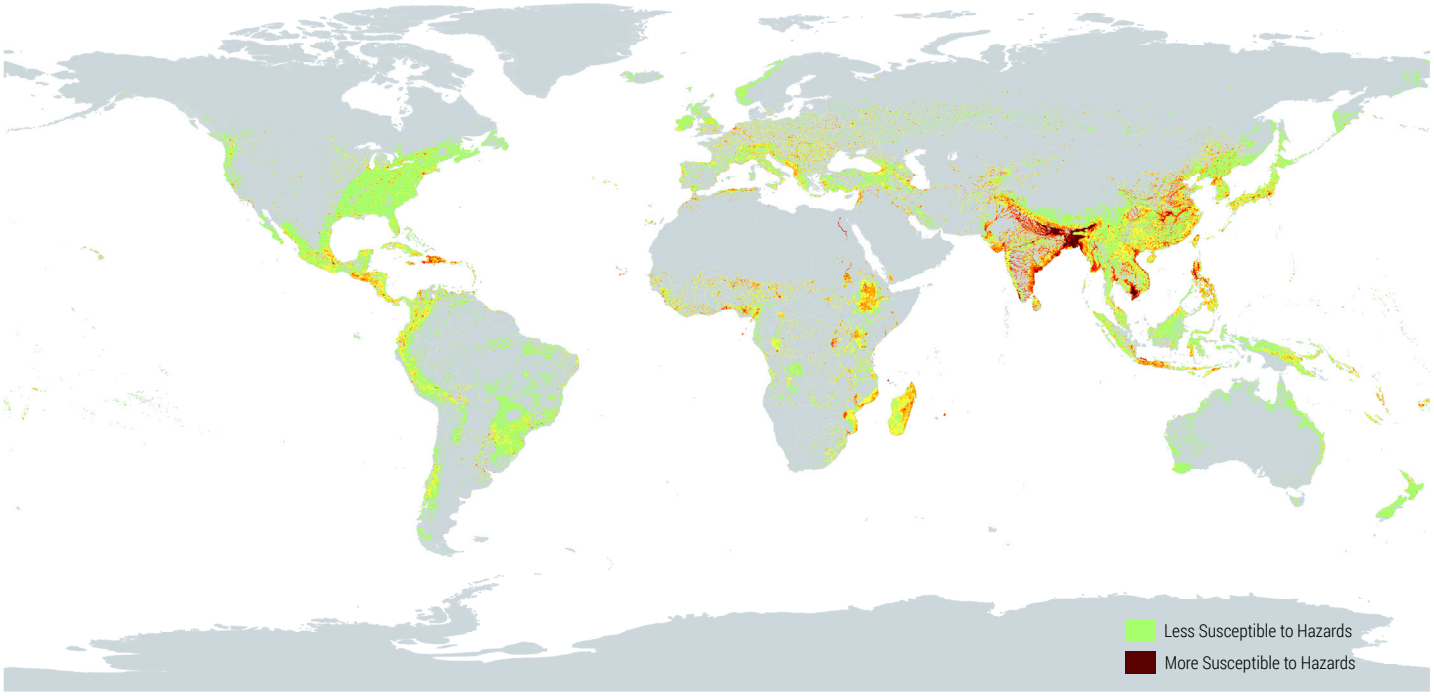
UNISDR was and continues to be a pioneer in the field of disaster risk mitigation. The organisation periodically releases publications on good planning practices related to DRR. UNISDR's global assessment reports that are released once in 2 years is especially useful to planners in understanding natural features in their regions. According to the most recent report, the primary responsibilities of planners involved in DRR are "avoiding the accumulation of new risks, reducing existing risks and supporting the resilience of individuals[8]" that is a useful theoretical model for DRR.

UNISDR also provides a platform called PreventionWeb that can be used to share knowledge about disaster risk. This can be a resource to find out how countries around the world are dealing with disasters. As part of data sharing, UNISDR also makes available GIS information through DesInventar and Global Risk Data Platform. Both tools offer maps of various hazards that have taken place and by locating a city on the platform, a planner can tell what risks they might be susceptible to. Figure 10 shows an example of GIS data from the Global Risk Platform. Our proposal relies on this platform for base data on disasters as it is open source.

Lastly, UNISDR hosts a series of world conferences on Disaster Risk Reduction aimed at providing guidelines for disaster mitigation. The first world conference was held in 1994 in Yokohoma, Japan and it established the importance of planning for disasters in a global scale. The second conference held in Kobe, Japan in 2005 was the first time "an integrated multi-hazard approach" was proposed for DRR with specific policies for planners. The conference led to the formation of the Hyogo Framework for Action (2005-2015) that stressed on:

- The importance of hazard mapping and risk assessment prior to development
- Land-use planning for ecosystem sustainability
- Integrated environmental and natural resource management
- Protection of infrastructure through design and retrofitting
- Disaster risk assessment of informal settlements
- Social, environmental and economic assessments of infrastructure projects

Figure 10: Multi-Hazard Mortality Risk in the World



- Floodplain management and
- Upgradation of building codes and standards for climate change adaptation

Although guidelines were laid down for planners, there was less emphasis on how urban planners would mainstream these processes. In 2015, the UNISDR Hyogo Framework was updated to the Sendai Framework that forms a major part of the proposal. The Sendai Framework for DRR is a 15 year non-binding agreement that identifies all the stakeholders responsible for reducing disaster risk and the role they play in doing the same from 2015-2030.

UNISDR is responsible for the implementation and review of the framework and one of the objectives of our proposal is to formulate a robust method of reviewing progress towards the Sendai framework. The goal of the Sendai Framework is to
"prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience[9]."

In order to increase resilience by reducing disaster mortality and number of affected persons, economic and social loss, the Sendai Framework has proposed 7 targets and 4 priorities of action that should be undertaken at the national, regional and local levels as shown in table 1.

Figure 11: Speaker at the Third UN World Conference on DRR; Source: www.publichealthmatters.blog.gov.uk

Figure 12: Delegates at the Third UN World Conference on DRR; Source: www.un.org

Apart from the Sendai framework, other global agreements on the role of urban planning in DRR can be found in the UN Sustainable Development Goals (SDGs) and the UNFCCC (United Nations Framework Convention on Climate Change) treaty on Climate Change. Of the 16 SDGs, DRR is mentioned in different capacities, in 10 of them. Our proposal can be tied to goal 3, 11 and 13. These stress the importance of early warning systems, builing resilience and an increase in the number of cities with robust DRR processes.

Table 1: Sendai Framework; Source: Sendai Framework of Action, UNISDR

	Priority 1 - Understanding disaster risk	Priority 2- Strengthening disaster risk governance to manage disaster risk	Priority 3 - Investing in disaster risk reduction for resilience	Priority 4 - Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction
Objective	The different dimensions of disaster risk include - a) vulnerability, b) capacity, c) exposure of persons and assets,d) hazard characteristics e) the environment. This data is useful for assessing disaster risk, prevention and mitigation of disaster, and preparedness and response.	The main aim is enhance collaboration and partnership among different stakeholders.	Investment is needed to enhance the resilience of the communities and environment by enhancing economic, social and cultural aspects.	Including disaster risk in development measures to build back better if disaster occurs. This requires empowerment of all sections of society including women and the differently abled.
Steps to achieve priority	To understand this risk, it is important to evaluate and keep a record of the following at a local and national level- • The frequency of assessment of the above risk dimensions • Dissemination of location based disaster risk information • Sharing of experiences and good practices among ULBs • Use of traditional, indigenous practices in risk reduction and sharing of these local techniques. • Strengthen technical and scientific knowledge and sharing; • Investment made on disaster risk research at the local and national level • Incorporation of disaster management knowledge in civic and public education	• Integration of risk management across stakeholders through policies and laws at the local and national level with clear role definition of stakeholders. • Creation and implementation of disaster risk reduction strategies and plans across different timelines. • Assessment of the institutions' capacity to deal with disaster risk from financial, administrative and technical aspects. • Compliance with safety regulations including land use planning guidelines, building codes etc. • Empowerment of local bodies to work with the citizens, non governmental organisations through regulatory framework.	• Mechanism for insurance, risk sharing and financial protection. • Investment on construction based on universal design standards. • Integration of disaster risk assessment to land use planning through guidelines and follow up tools. • Integration of disaster risk management in health care. • Investment for disaster preparedness in physical and social infrastructure. • Integration of disaster resilience in business models and practices.	• Periodically review contingency plan and programmes for disaster preparedness considering different time scale scenarios. • Development of early warning systems for multi hazard disasters. • Promotion of response exercises such as evacuation drills and training of volunteers for response to disasters. • Preparedness for reconstruction on occurrence of disaster through land use planning and standards.

The UNFCCC treaty, also known as COP 21 or the Paris Agreement is a landmark case in ensuring that all countries strengthen their response to climate change by
"keeping a global temperature rise this century well below 2 degrees celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees celsius[10]." Although it does not directly link to planners to DRR, the agreement states that in order to achieve their goals, "an enhanced capacity building framework and technology framework" should be put in place in every country. In this way, our proposal also responds to this treaty on climate change. Therefore, progress towards the Sendai Framework, SDGs and the Paris Agreement can be measured by our proposal, making it an incentive for cities to use the proposed platform.

[8] UNISDR. (2015). Global Assessment Report on Disaster Risk Reduction 2015. Geneva: UNISDR.
[9] Nations, U. (n.d.). Sendai Framework for Disaster Risk Reduction 2015 - 2030.
[10] UNFCCC. (2015). Conference of the Parties: twenty first session. Paris: United Nations.

Figure 13: Sustainable Development Goals; Source: www.wri.org

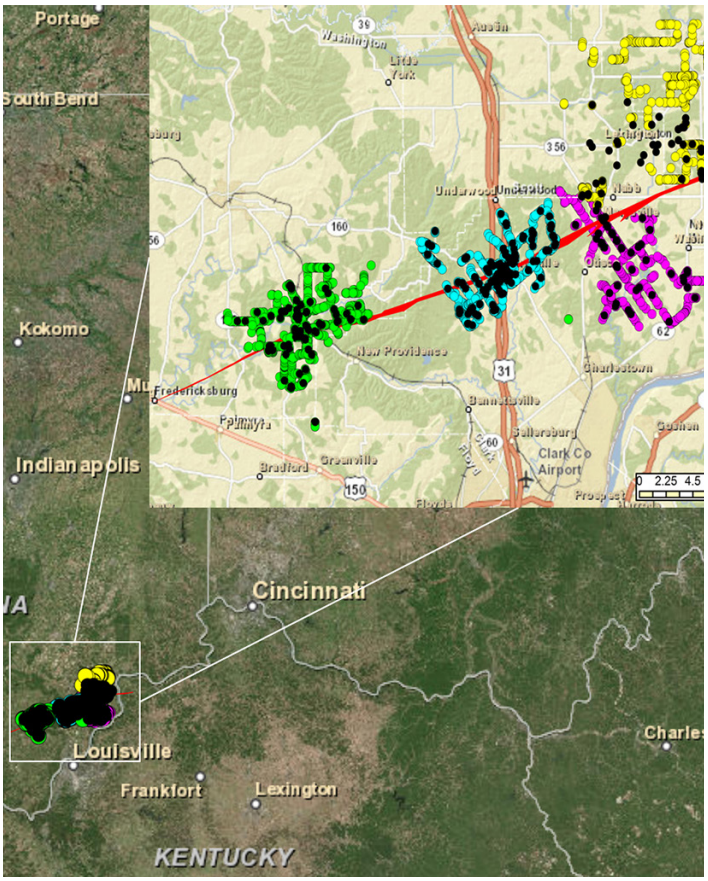
1.5. CURRENT PRACTICES OF DRR

As stated before, the goal of DRR is to reduce the impact of disasters and although there are examples of integrating disaster mitigation with urban planning there are no wider principles to follow. The most popular response towards disaster management takes place post-disaster through relief activities. ULBs, NGOs and other agencies provide medical assistance, food and water supply and economic relief that helps people recover from the effects of a disaster. However, this takes place after the disaster claims certain level of damage. Moreover, external aid effectiveness depends a lot on the circumstantial people-agency coordination and it would not be desirable to always rely on it.

Recent approaches have started to take a more comprehensive view of tackling disasters. Hence, disaster management activities are incorporated at various stages of its occurrence. Every country follows its own set of policies and methods to control the risks of disasters. Some of the common approaches used are -

- Traditional Relief Approach - This considers disasters to be inevitable and focuses on repairing the damage once a disaster strikes. It treats affected people as helpless and in need of external assistance. This is the oldest concept towards disaster management, and it has continued to be a dominant way to respond to disasters even today. The approach is ad hoc, based on the inherent kindness and humanity in people.
- Developmental Relief Approach - This approach is a more evolved form of the traditional relief approach. It entails understanding the development of the target area and responding with relevant relief activities. While in the traditional approach, people are considered to be helpless victims, this approach considers them as active participants with certain capacities to offer. The activities in this approach includes surveying the community and creating a database of their profiles. This serves as a reference to decide the kind of relief and recovery activity that should be undertaken. The overall efficiency of the approach depends on how comprehensive the analysis of the community is and on how well the implementation is linked with the analysis. Hence, there should be appropriate information flow at the local level and to the agencies that are involved in relief activities in that area.
- Vulnerability Reduction Approach - Vulnerability of a community is the degree of its exposure to disasters and its ability to recover from one. Hence, this approach addresses both prevention of a hazard and resilience. The activities include planning of an area to make it more disaster proof and training activities for communities to be able to respond to a disaster, thereby increasing the preparedness of a community to disasters. It is a more recent concept and looks at disaster management as an interaction between a community, its environment and the hazard.

Figure 14: Development Relief Approach; Source: www.purdue.edu



- Vulnerability to Resilience Approach - This approach talks about building capacities of the communities' livelihood to enhance their resilience to disasters. It addresses both concerns - reducing risk to avoid the possibility of a disaster occurrence and on the other hand, enhancing coping mechanisms for recovery after the disaster. The concept of inter community linkages is strongly regarded in this approach.
- Sustainable Development Approach - This approach brings together several domains and agencies in working towards a long term goal of safeguarding the environment, eliminating disaster risk and building resilience through capacity building. Hence, it is a more holistic approach that works at a local level through several structural and nonstructural measures.
- Total Risk Management Approach - It combines the approaches in the other methods in a more comprehensive manner. Total risk management is multilevel and multidisciplinary. It focuses on the underlying causes of the disasters and looks at planning in such a way to reduce vulnerability and risk of the people. It also considers the capacity and the assets available to people which can be leveraged in preparedness and response to a disaster.

Community based participatory Hazard Mapping (Bangladesh)

In Bangladesh, a hazard venn diagram was used to identify and analyze the hazards in a locality, their magnitude and probability of occurrence. Through a participatory process, people from the community identify the hazards, and map out in a graph representing the boundaries of the locality with the use of art pieces, the bigger the size of which means the bigger the intensity and damage. These areas are then delineated in the actual boundary map of the locality.

Figure 15: Commnity based participatory hazard mapping; Source: www.iied.org

Zoning regulation as a tool (Indonesia)

Zoning regulations should be adjusted with respect to different preferences and characteristics of the residents in each area, while the building codes should be applied selectively, particularly to public buildings, due to building costs being unaffordable to the community at large. The most common approach to limiting the number of victims is to reduce building density in high disaster prone areas as major disasters such as Yogyakarta earthquake sand Sidoarjo mud flows hit in density built up area.

A more recent development in planning and DRR is the use of GIS to integrate efforts. This was seen in the Chennai floods where a crowd-sourced map was created to map the effects of the floods to help in relief efforts. Like the UNISDR, many global, national and local agencies collect spatial information about their cities that can be a powerful tool in integrating planning and DRR. In addition, ArcGIS Online is becoming a more common as a platform of data sharing among planners that forms the base map for the proposal.

Guidelines for mainstreaming DM into sub national development (Philippines)

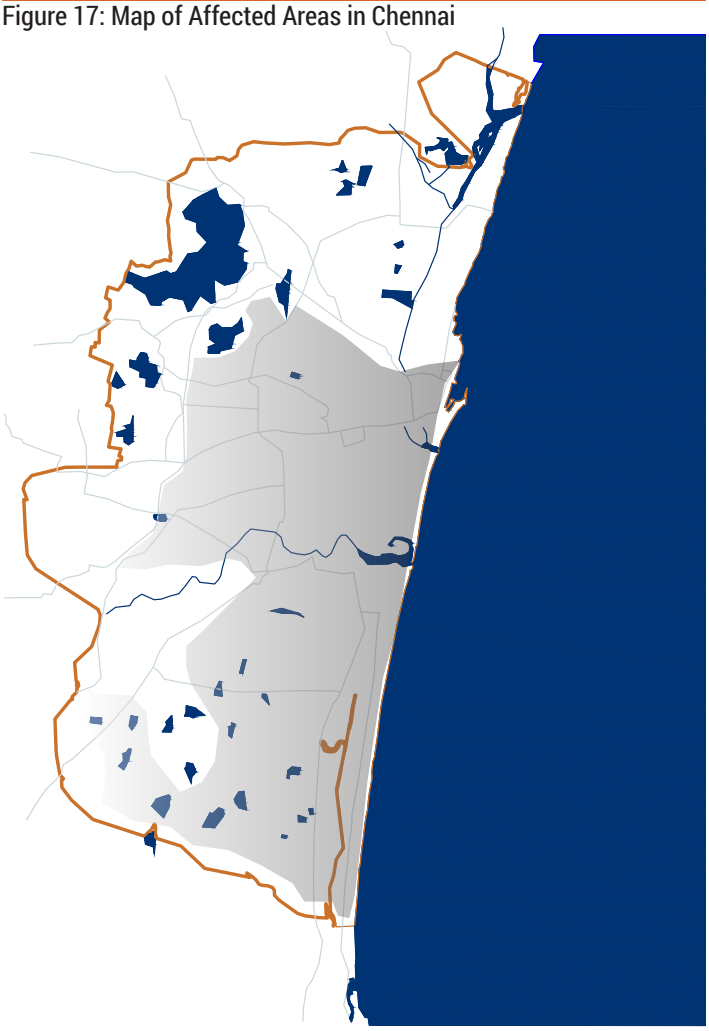
The National Economic and Development Authority (NEDA), with assistance from the United Nations Development Program and the European Commission Humanitarian Aid Department, formulated the Guidelines as an instrument to direct natural disaster risk reduction efforts in development planning processes. The Guidelines is useful in the following: a. Identifying areas that are highly restricted to human settlements and economic activities, b. Highlighting the use of development criteria or indicators as measures to identify and describe vulnerability (or resilience) and their integration in the disaster risk management framework, c. Making differentiated decisions on land uses which may involve specifying acceptable land uses based on the risk assessment results, e.g., agricultural use of flood prone areas might be allowed but not settlements, d. Developing disaster risk criteria in land use planning and zoning, e. Identifying all other appropriate risk management decisions depending on the risk estimates are used to prioritize areas for further evaluation of vulnerability.

Figure 16: Flooding in Chennai; Source: www.thequint.com

Crowd-sourcing mapping in the face of a disaster (India)

In December 2015, Chennai, an Indian coastal metropolis was inundated by floodwaters following a month of unprecedented rainfall. Thousands were displaced and the city was stranded without electricity, phone connection or food for several days. Hospitals failed to function and a death toll of 470 was recorded. In response to the floods, a crowd-sourced map was created using OpenStreetMap that allowed people to report flooding. This was used by relief efforts that could follow resident reports and respond in an efficient manner. Over 2,500 streets were reported and this data is still available online and can be used to show flooding patterns in the city.

Figure 17: Map of Affected Areas in Chennai



2. VULNERABILITY INDICES

According to UNISDR vulnerability includes "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard arising from various physical, social, economic, and environmental factors[11]". It can also be quantified as the percentage of population loss against the percentage of people exposed to the risk.

In the following study, vulnerability will be considered in the context of vulnerability towards natural disasters. This includes factors that make a city where disaster occurrence is more probable as well the social factors and capacities of the people to recover from disasters. There are several facets of vulnerability that can be considered in this domain such as economic vulnerability, social vulnerability, environmental vulnerability and so on. The next section attempts to report the most comprehensive of vulnerability indices that exist with relevance to disaster management.

Cadastral-based Expert Dasymetric System

CEDS uses dasymetric mapping system to segregate population and subpopulation at the property lot level. This is effective in understanding the difference in vulnerability level for different minority groups, which is not considered in the traditional model of vulnerability assessment. It uses detailed cadastral maps and uses several land use filters and layers to analyze hyper heterogenous urban areas.

Figure 18: CEDS; Source: www.lehman.edu

Social Vulnerability Index

This index was developed to explore the impact of hurricane Katrina on the local population with a focus on social and economic factors which affect the resilience capabilities of a community. This index constitutes of four domains.

Domains of Variables	Variables Included
Socio economic status	Income, Education, poverty and employment
Household consumption and disability	Age composition, single parenting, disability
Minority status and language	Race, ethnicity, English language proficiency
Housing and transportation	Housing structure, crowding, vehicle access

15 census variables were identified which were ranked from lowest to highest with lowest being least vulnerability. Percentile ranks were calculated for each variable for each tract. The sum of all the variables in each domain gave the percentile rank for the tract.

Over the past years, quantitative indices have been formulated to measure the risk a group of people have with respect to aspects such as environmental sustainability, development and resilience. Although most indices are straightforward, planners face a challenge when it comes to the execution of these indices. Therefore, our proposal strives to address the availbility of data and synthesis of indices into one measure. Secondly, an extensive study of 106 vulnerability research indices have pointed out that more than 60% of the indices were formulated for application at a provincial or national level. Very few studies have been done for application at a local level but it is imperative to keep local bodies involved in DRR. Therefore, we propose an index that is applicable at a local level and can be standardized globally.

[11] UNISDR. (2009). Terminology. Retrieved from UNISDR: https://www.unisdr.org/we/inform/terminology

New York City Hazard Vulnerability Index

This model considers a set of indices that are applicable at the local level analysis of vulnerability. It focuses on the socio economic component of vulnerability and classifies population under hazard using the following parameters:

Socio Economic Status	Household Structure & Disability	Minority Status & Language	Housing & Transportation	Public Health
% below poverty	% older than 65 years	% minority	% multi unit structures	% AIDS related hospitalization
Household consumption and disability	% younger than 10 years	% older than 5 years old and speak 'less than well' English	Crowding	% diabetes related hospitalization
Per capita income	% older than 5 years with disability		No vehicle available	% asthma related hospitalization
% with no high school diploma	% household with male or female householders		Institutionalized population	% cancer related hospitalization
				% heart disease related hospitalization

Figure 19: New York Hazard Vulnerability Index; Source: www.lehman.edu

3. CONCLUSION

A critical question we tried to look at was whether natural disasters could have been prevented. Taking the instance of Chennai, it is located very close to the sea level and is prone to flooding. It is known to have witnessed major floods in the years 1903, 1943, 1978, 1985, 2002 and 2005. This was a common occurrence and goes almost unnoticed, except for the one in 2015. The surrounding plains that were mostly rural in the past have transformed into a heavily populated coastal area today. Lakes and marshlands have dried up over the years and are crowded with low-income residential houses, illegally or legally. When disaster struck, an international airport, IT parks, and educational institutes among other residential areas obstructed the floodwater flow.

While this is one such example of natural disasters being aggravated by human intervention, the incidence of natural disasters have risen from about 100 disasters per year in the 1980s to more than 300 since 2000. Today, one in three people living within 100 km of the coastline and more than half of the megacities are located in coastal zone. By increasing human density, built cover and filling up of wetlands, we are stressing the natural safety net provided by our ecosystem. Second aspect that is common in most disasters is that it affects some groups of people more than the other either due to exposure to different kinds of natural forces, community resilience or economic conditions. This makes understanding the difference in risk exposure of different communities to disasters. Lastly, when a disaster strikes a community, they have limited access to the outside world and the local body functions play a key role in execution of disaster mitigation strategies. While most governments try to implement policies that can be incorporated at the local level, more effort needs to be made in mainstreaming DRR steps at the local level.

The further sections attempt to address the following:

- Do local governments play a key role in disaster management and are they less equipped in terms of technical capacity?
- Could proper urban planning have prevented/ controlled the disaster?
- Can planning be integrated with DRR in a manner that includes aspects from both branches of study?

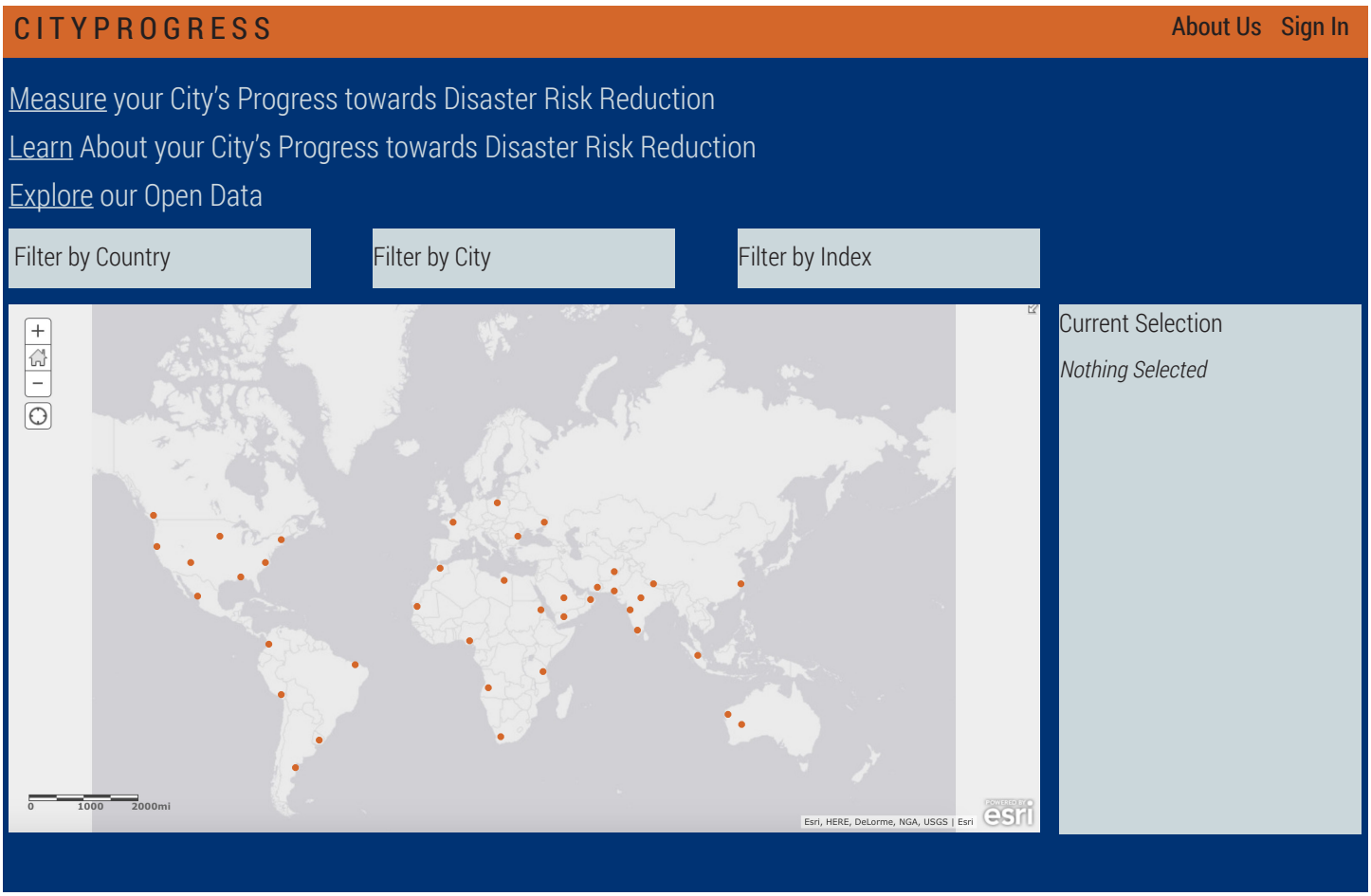
Figure 20: Enroachments on Adyar River in Chennai, India; Source: www.articles.economictimes.indiatimes.com

4. PROPOSAL

The previous sections show that today, there are multiple theories of how planners should work towards DRR and how they should carry out processes to reduce risk in their cities. It also shows that there are multiple frameworks to analyse how effective DRR is implemented in cities at the global level. On the other hand, there are also technical resources available to measure disaster risk but these tend to be scientific, expensive and dependent on the type of disaster and availability of data at the local government level. That directly relates to the last point of data availability in small amounts in various websites. All of these factors deter city planners from implementing DRR.

If the goal of city planning is to create positive change in communities, one of the primary responsibilities is to respond to the urbanisation process in a way that growth and development is sustainable. Through our research, we see a problem of access to data and confusing parameters to measure DRR. Our vision is to provide city planners with a work platform that will help them consolidate data and organize it in a useful manner. In addition, we seek to provide a one-stop shop for planners that will measure current DRR practices in the city and provide an action framework for how they can better the process. This will promote an active, competitive data-sharing environment among cities at a global level and can be used to satisfy requirements of the Sendai Framework, SDGs and UNFCCC COP 21 among others. Therefore, we propose an ambitious global platform that will help cities mainstream DRR in their planning processes by 2030.

Figure 21: Proposed CityProgress Portal - Home Page



4.1. GOALS AND OBJECTIVES

Goals:

- To use GIS to create an open work platform for the ULBs to keep track of their cities' progress towards the global framework of DRR
- To create a framework of 'action' for urban planners as compared to 'instruction' that can be used to assess DRR
- To create a data exchange platform to promote DRR awareness and sharing of information across borders

Objectives:

- Use Global Risk open data portal to create a map of the world and natural disasters in GIS
- Create a social enterprise to run the crowd-sourced platform and incentives for urban planners to participate in the process
- Formulate a comprehensive vulnerability index to assess progress of urban areas towards DRR
- Package the index and GIS map as an interactive website that can be used by urban planners and citizens to keep track of DRR measures adopted by cities

Figure 22: Proposed CityProgress Portal - Home Page with Filters

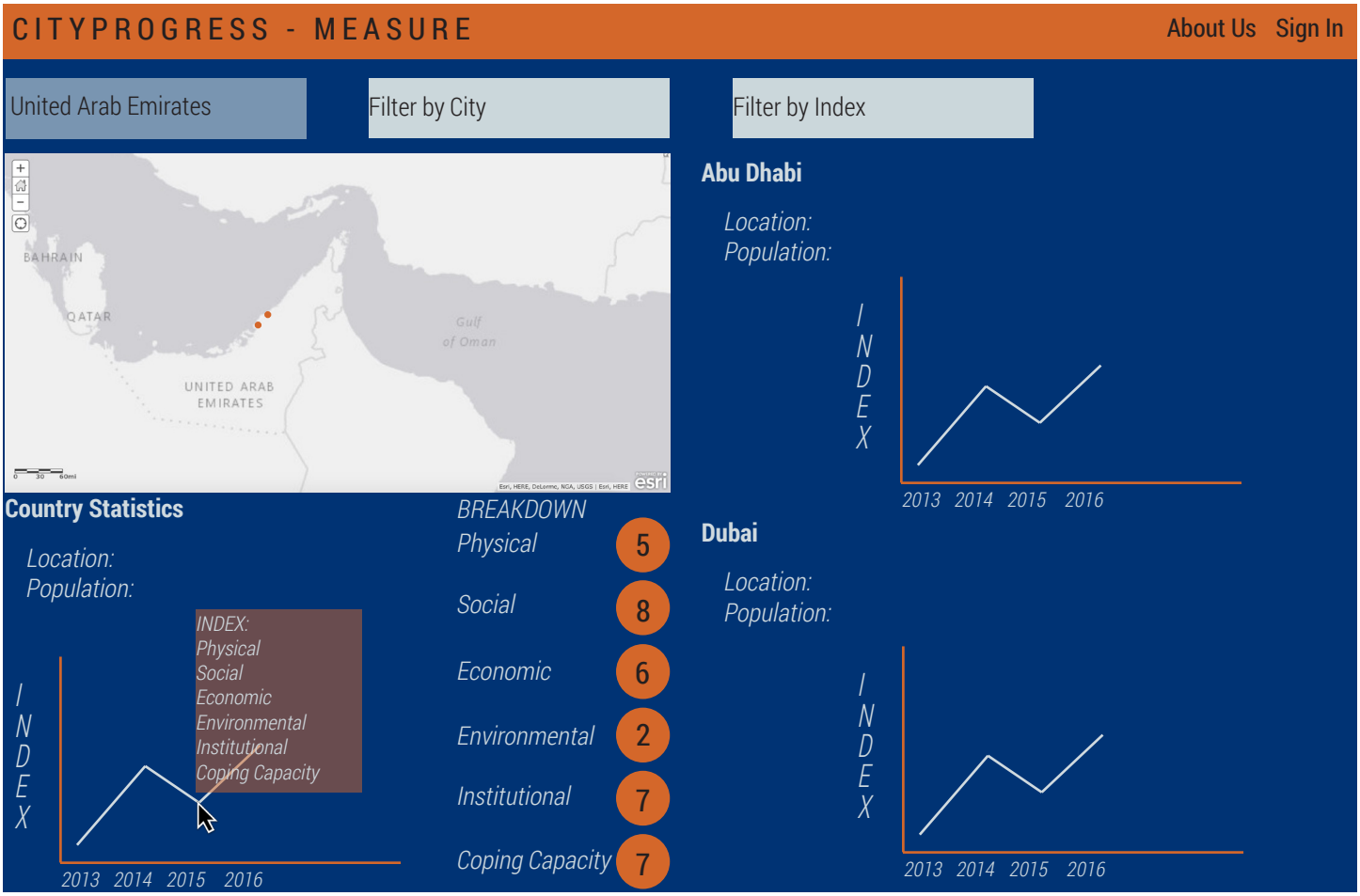
4.2. CREATION OF CITYPROGRESS

In order to implement the proposal, a social enterprise will be created to manage the CityProgress website. This enterprise will primarily require GIS experts and web developers. Two processes will be carried out in parallel in the initial stages - the creation of the open data map explained in section 4.4 and the development of the website explained in section 4.3. CityProgress will be responsible for ensuring the smooth running of the website, the integration of the vulnerability index with the GIS map and the collection of data from city planners that sign up for the service. In addition, they will be responsible for advertising the platform to cities and gaining grant money from sources that provide funding to GIS based planning processes, innovation in planning and disaster mitigation. We propose that the social enterprise focus on gaining the support of UNISDR as the index and information gathered will be useful in their efforts towards DRR.

4.3. CITYPROGRESS WEBSITE

The web developers will be involved with acquiring a domain name and a web server and the creation of individual web pages on the site. There are four main tabs that can be explored on the website. Three of them - 'measure', 'learn' and 'explore' are open to non-planners and each of them provide ways in which city planners can raise awareness about their efforts. 'Measure' opens a series of graphs that link to the vulnerability index that will be discussed in section 4.6. This is shown in figure 23. The 'measure' tab will be updated quarterly by CityProgress and people will be able to view time series data on how far their city has progressed over time. 'Learn' allows the user to filter by city and country and look at detailed statistics and information provided by city planners about their efforts towards DRR. Finally, 'explore' opens an interactive map that will include all the information listed in section

Figure 23: Proposed CityProgress Portal - Measure tab that is open to all users

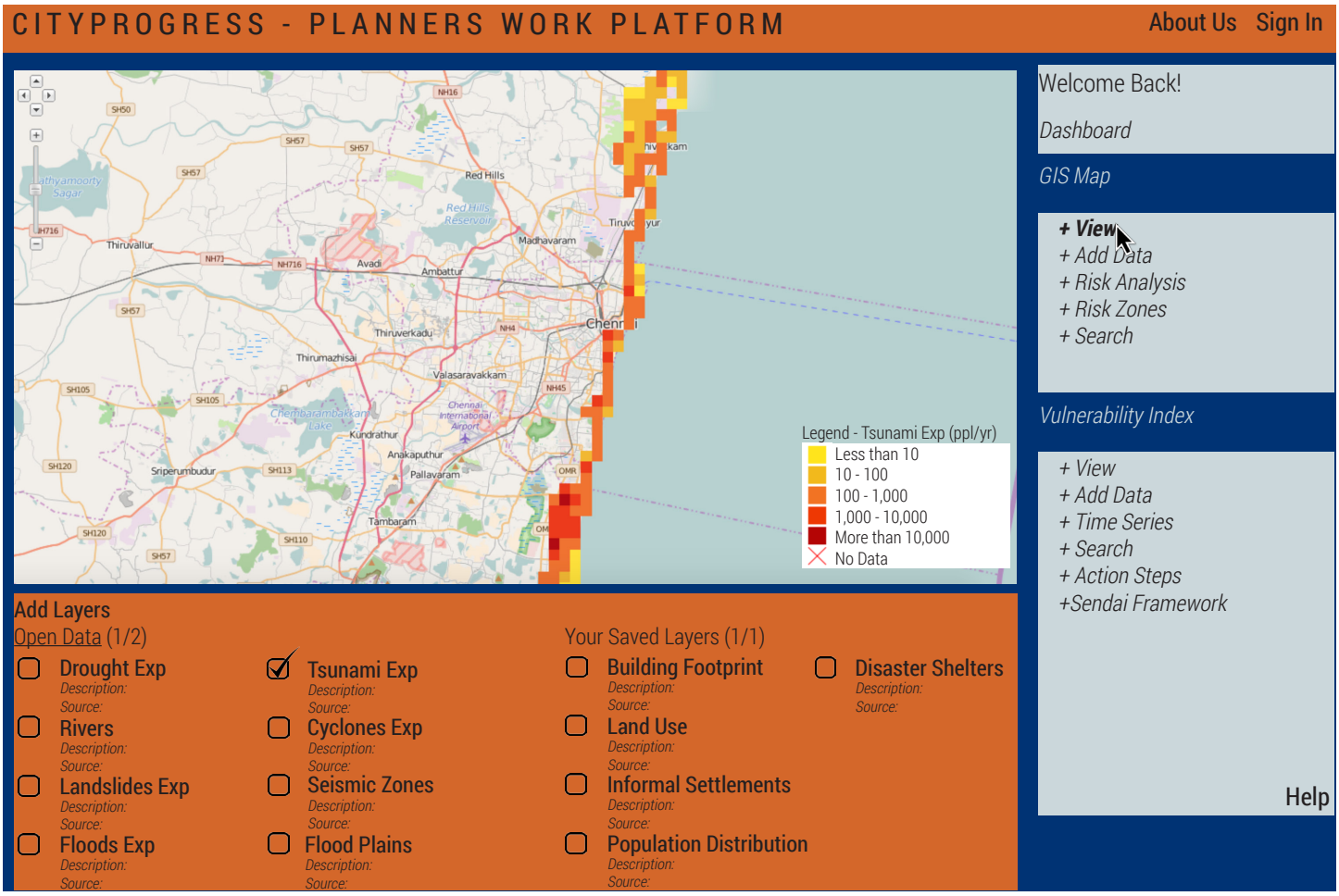


4.4. The last tab - 'sign in' is for planners and this will open a register page where they can access and provide more information about their cities and others that are using the server. This tab will be linked to additional spatial data provided by planners about their cities and the calculation of their vulnerability score. On their dashboard, they will be able to view the breakdown of their vulnerability score. The explanation the planners work platform is included in section 4.5.

4.4. CREATION OF GIS OPEN DATA MAP

The first step in implementing the proposal is to collect open source data related to disasters that can form the base of the crowd-sourced map. This step relies heavily on the Global Risk Data Platform, where shapefiles related to past events, risk, exposure and hazards is available. While all the shapefiles will be downloaded, exposure to tsunamis, droughts, floods, cyclones and landslides will be displayed along with country borders and city points. Other than information from the global risk data platform, shapefiles of city points, rivers, seismic zones, flood plains, elevation and roads available through open source data will be collected and added as layers to the map. These shapefiles will be consolidated in one map through ArcGIS online that will be embedded in the website. When the 'explore' tab is opened, the map will open and clicking on a city will show the users its vulnerability score, progress towards Sendai Framework and provide the contact number of the planner responsible for that city. This is done so that non-planning users and planners that are not related to the city can provide comments and information about the city that is displayed.

Figure 24: Proposed CityProgress Portal - GIS portal for planners

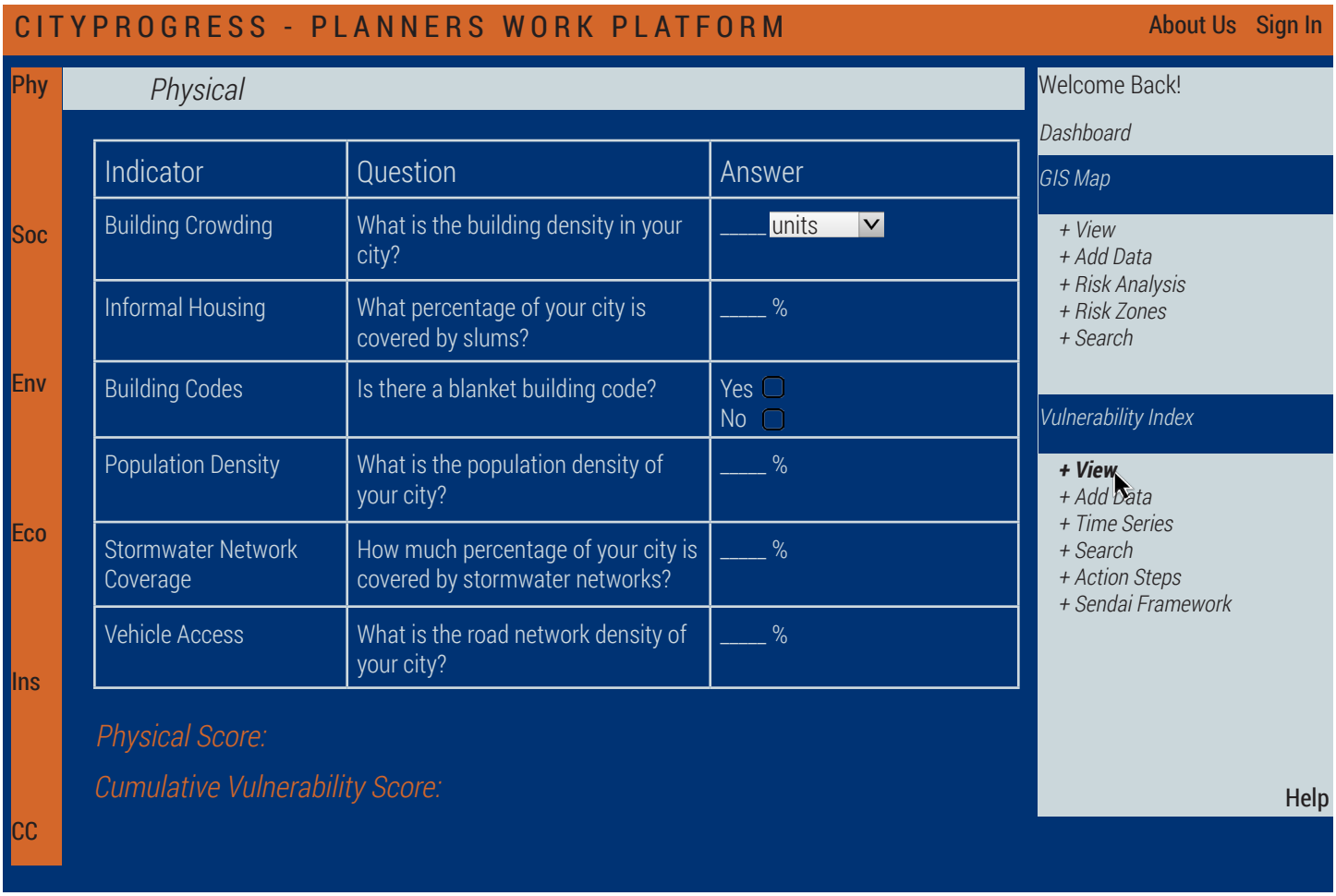


This rich and comprehensive dataset will be the base used by planners when they sign in to the website. When cities provide their sign up details, they will be able to provide additional layers that they might have access to that will only be viewed by them and any other city planners signed up for the service. The addition of layers by the city will have to be approved by CityProgress' GIS experts. In the long term, a basic GIS model will be constructed using the kinds of data cities upload that will create a spatial hazard index layer using the vulnerability index. For the purposes of this proposal, this has not been explored as it is dependent on the kind of data submitted by cities and the level of information they are able to provide. In this way, this extensive open data mapping exercise is instrumental in viewing information and achieving our future objectives.

4.5. PLANNERS WORK PLATFORM

When planners sign in to the website, they will be provided will a unique user identification and password. This will give them access to an interactive workspace that integrates a vulnerability index score and GIS mapping of their city. This window will consist of a detailed GIS map of the city combining all the layers listed in section 4.4 with additional data available to the city that they would like to add to the map. A tab on the right as shown in Figure 25 will allow planners to calculate their vulnerability score based on a questionnaire that they will have to fill up. The details of this index is included in section 4.6. Further, the GIS map will automatically generate risk zones in the based on the open data and layers that the city planner adds to the map. That part of the proposal has not been detailed out because it

Figure 25: Proposed CityProgress Portal - Completing the Vulnerability Index



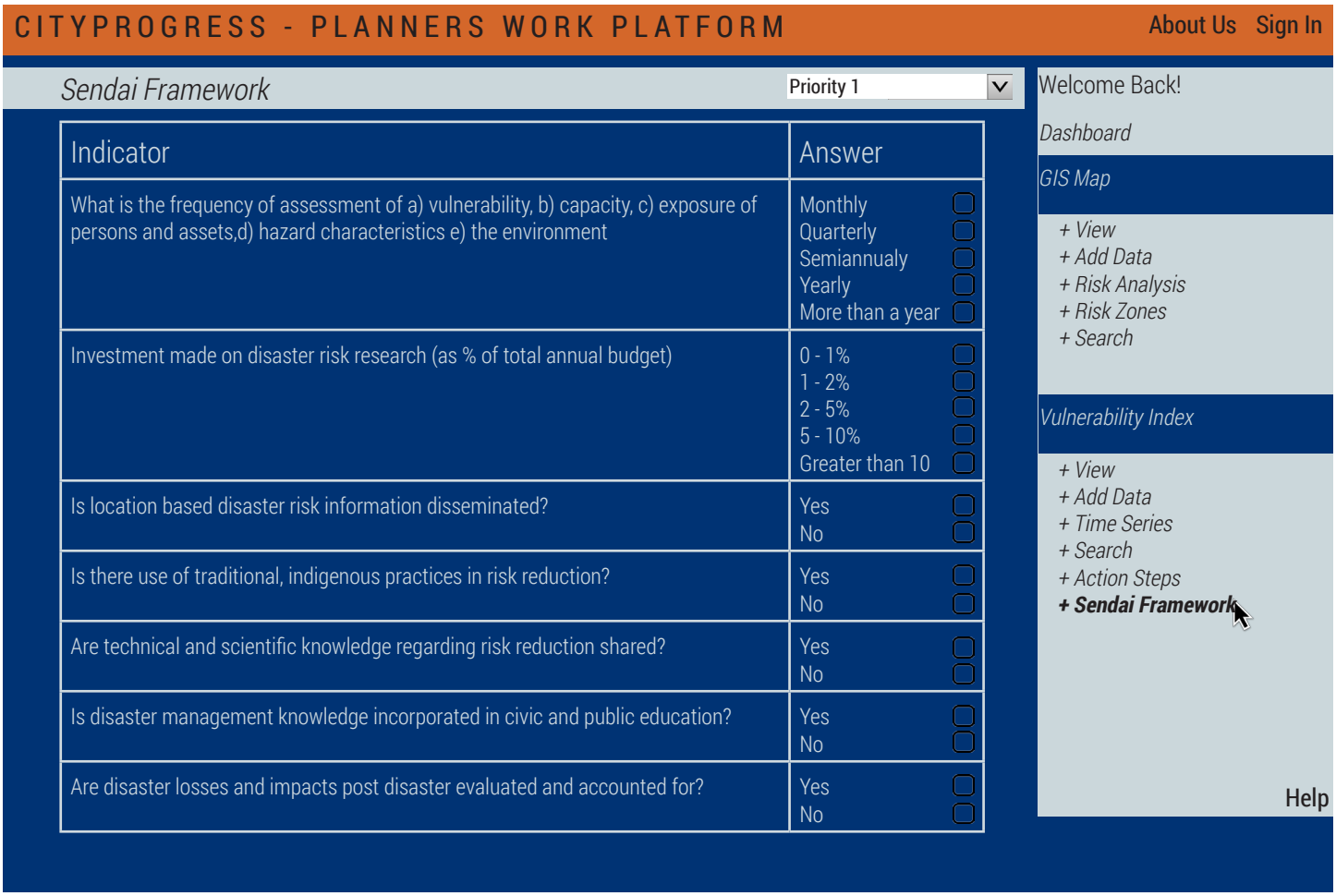
is a long-term goal and is dependent on the kind of information that planners submit. This is a functionality that will be developed six months - one year after the opening of CityProgress.

Both the index and the GIS map will be available to the planner and can be shared will other planners on the server if he/she chooses to do so. The questionnaire will be generated quarterly so that planners can update their progress and modifications can be made to the questions based on new ideas in DRR. Additionally, planners will also be able to click on individual risk areas in their cities and add notes for specific steps they have taken to reduce risk. This way, CityProgress acknowledges that local planners have the most in-depth information about their city and can work towards DRR provided they have the tools to do so.

4.6. VULNERABILITY INDEX

The proposed Vulnerability Assessment Structure is to be based on a hierarchical approach. It is a relatively simple deductive approach that combines variables in a resilience equation format. This is most commonly used because of the simplicity of the procedure and the actual difference in the indices that fall under this approach lies on the weightages and indicators used. The data collection mode is one of the unique propositions made in this structure. The proposal integrates measures from the 106 vulnerability indices that were studied. The CityProgress index incorporates population density, unemployment, population 65 years or older, GDP per capita, percent female population, doctors per population, literacy rate, total population, beds in population per hospital, percent population below poverty line and GINI

Figure 26: Proposed CityProgress Portal - Completing the Sendai Framework Questionnaire



index. These lie in analyzing sectors - demography, education, health, infrastructure, economy and disaster hazards and impact respectively. Table 2 gives a brief of indicators that are to proposed to be used as a local level for benchmarking areas according to vulnerability to disasters. These indicators will be weighted differently with more emphasis on physical, environmental and coping capacity factors.

Table 3 shows the questionnaire that planners will fill up to determine their progress towards

Table 2: Vulnerability Assesssment Framework

Physical factors	**Social factors**	**Economic factors**	**Environmental factors**	**Institutional factors**	**Coping capacity factors**
Building crowding	Population density	% population unemployed	% loss of natural green cover in 5 years	Disaster mitigation plans at Federal/ State/Local level	No of physicians per 100 people
% area under slums	% with no high school diploma	% households below poverty line	% vegetation cover (including wetlands, praries, etc.)	Presense of emergency Response support	No of hospital beds per 100 people
Blanket building codes	% dependent (elderly and young) population	Per capita income	Annual deviation in sea surface temperatures	Number of departments that carry out disaster mitigation	
Vehicle access	% living temporary structures/settlements	% Risk Insurance coverage	% population living in coastal settlements (100 km from a maritime or a lake coast)	Disaster management curriculum in civic education	
Population density	% population undernourished				
Stormwater network coverage	% disabled population				
	% minority population (race, ethnicity, language proficiency)				
	% of population below the poverty line				

the Sendai Framework. Both the vulnerability index and progress towards Sendai provide a robust mechanism for planners to determine their DRR strategies.

	Adherance to priorities						
	Priority 1 - Understanding disaster risk.						
Question Number	Scores	1	2	3	4	5	
1	What is the frequency of assessment of a) vulnerability, b) capacity, c) exposure of persons and assets, d) hazard characteristics e) the environment.	Monthly	Quaterly		Yearly	More than a year	
2	Investment made on disaster risk research (as % of total annual budget)	0-1%	1-2%	2-5%	5-10%	greater than 10%	
	Scores	0	1				
3	Is location based disaster risk information disseminated?	No	Yes				
4	There is use of traditional, indigenous practices in risk reduction	No	Yes				
5	Technical and scientific knowledge regarding risk reduction is shared	No	Yes				
6	Is disaster management knowledge incorporated in civic and public education?	No	Yes				
7	Are disaster losses and impacts post disaster evaluated and accounted for?	No	Yes				
	Priority 2- Strengthening disaster risk governance to manage disaster risk						

8	There are policies and laws to integrate risk management among stakeholders with the clear role definition of stakeholders.	No	Yes		
9	Disaster risk reduction strategies and plans have been created and implemented across different timelines.	No	Yes		
10	There has been assessment of the institutions' capacity to deal with disaster risk from financial aspect.	No	Yes		
11	There has been assessment of the institutions' capacity to deal with disaster risk from administrative aspect.	No	Yes		
12	here has been assessment of the institutions' capacity to deal with disaster risk from technical aspect.	No	Yes		
13	There is compliance with safety regulations to land use planning	No	Yes		
14	There is compliance with safety regulations to building codes	No	Yes		
	Priority 3 - Investing in disaster risk reduction for resilience				

15	There is existing mechanism for insurance, risk sharing and financial protection.	No	Yes				
16	There is integration of disaster risk assessment to land use planning through guidelines and follow up tools.	No	Yes				
17	Disaster risk management has been integrated with civic health care	No	Yes				
18	Physical infratstructure plans include disaster preparedness aspects.	No	Yes				
19	Social infratstructure plans include disaster preparedness aspects.	No	Yes				
	Priority 4 - Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction						
17	Frequency of review of contingency plans and programmes for disaster preparedness considering different time scale scenarios.	Monthly	Quaterly		Yearly	More than a year	

18	Existing of early warning systems for multi hazard disasters.	No	Yes				
19	There is promotion of response exercises such as evacuation drills and training of volunteers for response to disasters.	No	Yes				
20	Land use planning and standards include reconstrcution preparedness in case of disaster occurence	No	Yes				
21	Community centres have been establisehd for the promotion of public awareness and the stockpiling of necessary materials to implement rescue and relief activities.	No	Yes				

	Methodology to determine % of priorities achieved			
	Question number	Response	Score alloted	
Priority 1 example	1	2	40%	Average (40%, 80%) = 60%
	2	4	80%	
	3	Yes	1	Sum(yes, no) /5 -->3/5 --> 60%
	4	No	0	
	5	Yes	1	
	6	No	0	
	7	Yes	1	
		Final average --> (60%,60%) --> 60% of priority one has been acheived		
		Final average of all priorities are taken.		

5. FUTURE SCOPE

The proposed model initiates the process of measuring, learning and exploring various facets of disaster risk reduction. The strength of the model lies in the simplicity of the model and easy usability for both citizens and local governments. The type of data that the model demands is not very intricate and it tries to make these simple data layers more useful and meaningful.

The proposal is also scalable - it can be evolved to do more complex analysis as per the complexity of the GIS layers that we feed in. It is also easily replicable across the world since all local governments already possess most of the initial data required to work with. Additionally, the portal has a built in data sharing component that keeps expanding the data pool available for the policy makers.

Possible challenges that can be faced during implementation is the acceptability of the portal by the planners and to ensure the widespread use of the portal. The local governments need to be incentivized on doing the additional work by leveraging the benefits of the automated GIS analysis. Also, to ensure maximum involvement of both policy makers and other contributors, the long term benefits of the portal need to be marketed aggressively.

Once the proposed framework is established, there is immense future scope in the project in terms of usability. This portal gives a universal repository of disaster management data, best practices and performance evaluation of cities. This gathered for cities across the world allows international bodies to benchmark and evaluate the type of assistance that a city requires. The portal itself can be evolved in the future to incorporate generation of an action framework that a city can follow to tackle vulnerability. Hence, the foundation of the model lies in simple collection of geographical and temporal data and it has a wide scope of practical application in the subject of DRR for cities across the world.

Table 27: Emergency Preparedness Checklist

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