INTEGRATING TSUNAMI PREPAREDNESS INTO SUSTAINABLE COASTAL CITY PLANNING IN SRI LANKA

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Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Civil Engineering

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Declaration of the Candidate & Supervisors

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Abstract

INTEGRATING TSUNAMI PREPAREDNESS INTO SUSTAINABLE COASTAL CITY PLANNING IN SRI LANKA

Extreme weather events such as coastal storms, sea level rise, heavy rains and tornados often trouble coastal communities. Additionally, tsunamis occur infrequently, but are one of the most potentially devastating hazards faced by coastal cities owing to their unpredictability and the comparatively higher impact caused by one single event. Sri Lanka became the second highest affected country from the 2004 Indian Ocean Tsunami (IOT) among 15 other countries leaving cascading impacts to the whole nation. Despite the ongoing threat posed by such hazards, Sri Lankan legal frameworks and urban planning guidelines appear to lack the necessary regulations to address tsunami and other coastal hazard risk. Though Sri Lanka approaches towards a noteworthy milestone of launching a rating system for cities, it only spotlights the green features leading to sustainability where resilience aspects are unblended. The research aimed at incorporating Tsunami preparedness measures into sustainable coastal city planning through merging a set of Tsunami Preparedness criteria to the GreenSL Rating System for Sustainable Cities. A systematic review of global and local literature allowed identifying the crucial parameters of Tsunami resilience. A series of local experts revealing the present level of implementation, justified the bottlenecks in local urban planning and resilience parameters of significance. Next, effective strategies for Sri Lanka were developed as a set of criteria under 9 main categories to the GreenSL Rating System for Sustainable Cities with the aid of 8 expert (Delphi) surveys. Analytical Hierarchical Process (AHP) was employed to allocate points to the developed criteria based on the significance of each criterion. It resulted the modified GreenSL Rating System for Sustainable and Resilient Cities carrying total of points including 20 points for disaster resilience. It is recommended to be used for city assessments in coastal regions. A ground level application of the rating system was then carried out based on a local coastal city which disclosed appalling information on the actual level of practice and implementation of ideal sustainable and resilient measures suggested in the rating system.

Keywords: Disaster Risk Reduction; Tsunami Resilience; Natural Hazards; Sustainable Cities; Rating System

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1 INTRODUCTION

1.1 Background

1.1.1 Initiation of Green Concepts and Disaster Resilience Concepts

Natural environment and built environment have been in equilibrium since the inception of earth where the elements of nature were shared by the human beings for consumption. The expansion of the built environment within the natural environment initiated with the rise of population and the complication of their needs.

Asian urban areas claim to be the most rapidly growing areas and are believed to accommodate 55% of the world population projected as 5 billion by 2030 [1]. Moreover, the figures reveal that exceptional levels of population are recorded from cities over the past 50 years. [2]. The construction industry and related operations which emerges with urbanization has escalated the discharge of carbon dioxide and other greenhouse gases to the atmosphere. Moreover, it consumes non–renewable sources of energy such as fossil fuel and metals and minerals of earth such as graphite, lead, copper, and zinc in great deal. Also, the building construction material are claimed to be greatest polluters in regions due to the discharge of nitrogen and Sulphur oxides during their manufacturing processes. [3]. A research carried out on various building materials used for the construction of residences revealed that concrete out of all other materials has the highest embodied energy. Production process of the main ingredient of concrete which is cement has been revealed to be the main source of emissions caused by carbonate decomposition. [4]. Moreover, urbanization results in changes in land-use patterns and alters the properties of the ecosystem and connectivity of resources [5]. Irregular and unsound urban development has caused the impairment of the working of the ecosystem [6]. Increased withdrawals of ground and surface water, increased extraction of minerals from the ground, deforestation, and increased energy consumption have given rise to resource depletion [7].The aforementioned resource depletion, harmful emissions, and change in biodiversity undeniably shake the equilibrium of the natural environment triggering climate change. Green building and sustainability concepts were brought into light with the identified threat to the natural environment. In Sri Lanka, the Green Building Council of Sri Lanka pioneered in introducing a Green Rating system for Buildings. It extended a possibility to produce the interested building as an environmentally responsible and resource efficient one through the sound architectural and landscape planning, integrated building design and novel systems for efficient resource management.

As a second phenomenon, the natural environment after losing its equilibrium, charges back at the built environment in the face of natural hazards. Built environment which comprises of buildings and infrastructure is often suffered from the natural hazards. Researchers [1] pinpoint that hazard prone regions have been used to develop the majority

of urban municipalities and Asian mega cities. Figure 1 shows different risk categories that affect the world brought out by the 2020 World Economic Forum Risk Report [8].

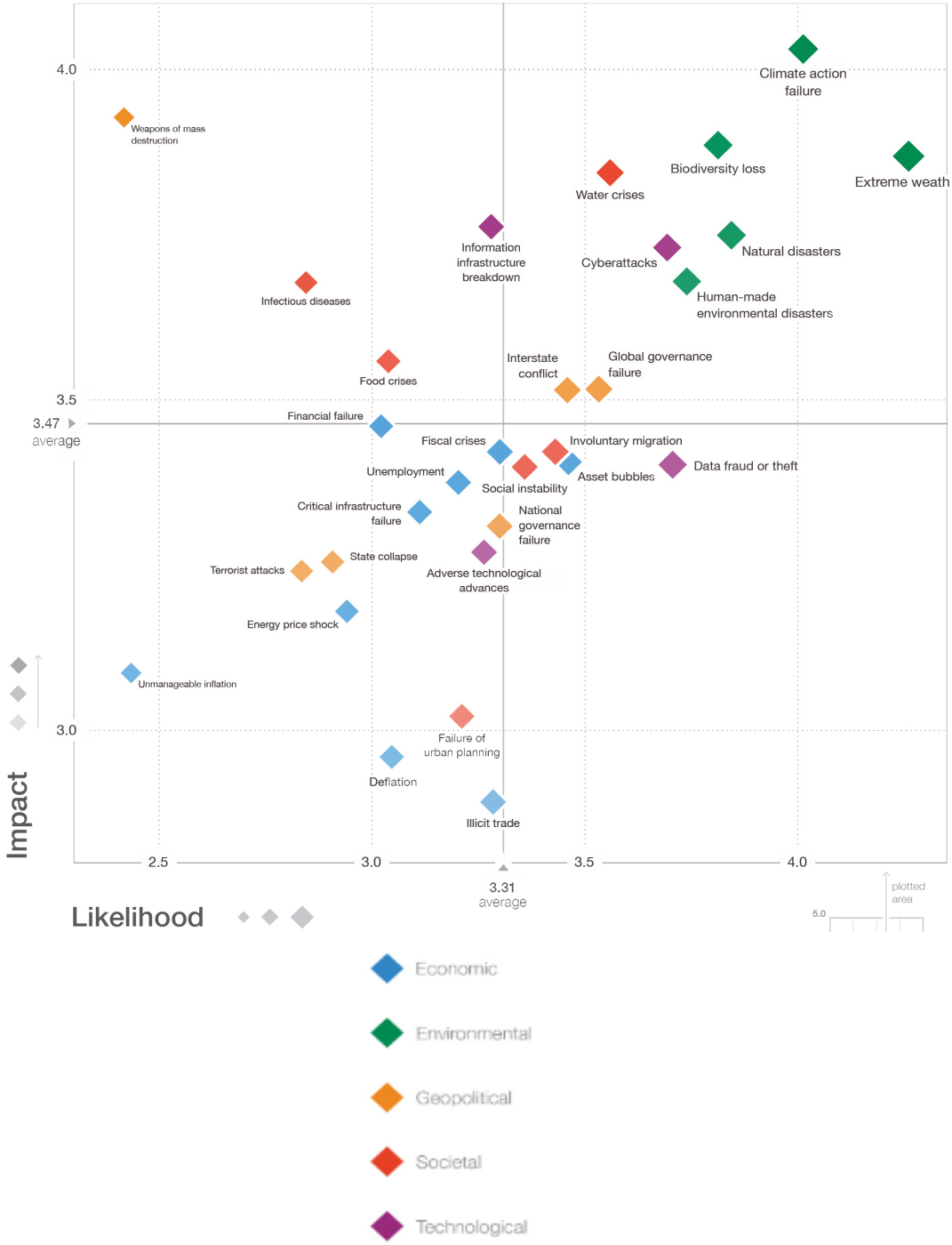


Figure 1:Risk categories that affect the world

It is evident that environmental hazards are more prominent among other types, especially with the climate change action failure. Natural Hazards, that result in not only death, injuries and damages to property but a massive disruption to economies, social systems and environment have been uncovered as a prime cause for death tolls in the past decade. They account for more than 0.4% of annual deaths in many years. Among them coastal hazards are apparent to be the most severe type worldwide causing the most critical impacts [9]. 46 Million people per year are currently at risk from coastal flooding due to storm surges.

Disaster Risk Reduction and Resilience concepts have been initiated to prepare for, mitigate, response to and recover from disasters. According to United Nation's International Strategy for Disaster Risk Reduction (UNISDRR), disaster risk reduction is a conception developed to reduce disaster risks and mitigate damages by investigating, identifying, and combating the growth of tributary causes of disasters [10]. Several principles and plans of actions of international frameworks starting from the Yokohoma Strategy (1994), The Hyugo Framework for action 2005-2015, Sendai Framework for DRR 2015-2030, The Seven Principles for Tsunamis, New Urban Agenda to reduce Disaster Losses and especially the Resilience Roadmap "Making Cities Resilient 2030 – UNDRR" have highlighted the necessity of urban planning to reflect the tsunami and other hazard risks in cities. RELi (Rating Guidelines for Resilient Design and Construction), launched in 2017 by the United States Green Building Council is a resilience rating system. It foregrounds the measures to adapt and thrive in changing environments like the impact from the urban heat island effect, sea level rise, high precipitation, heavy windstorms, and more frequent freeze/thaw cycles and ice storms [10].

1.1.2 Sri Lankan Coastal Cities

Sri Lankan coastal cities occupied more than one-fourth of the total population (Approximately 33 percent of Sri Lanka's population - 4.6 million out of 18.73 million) in 2008 as shown in Figure 2. This includes 65% of the total urban population in Sri Lanka [11].

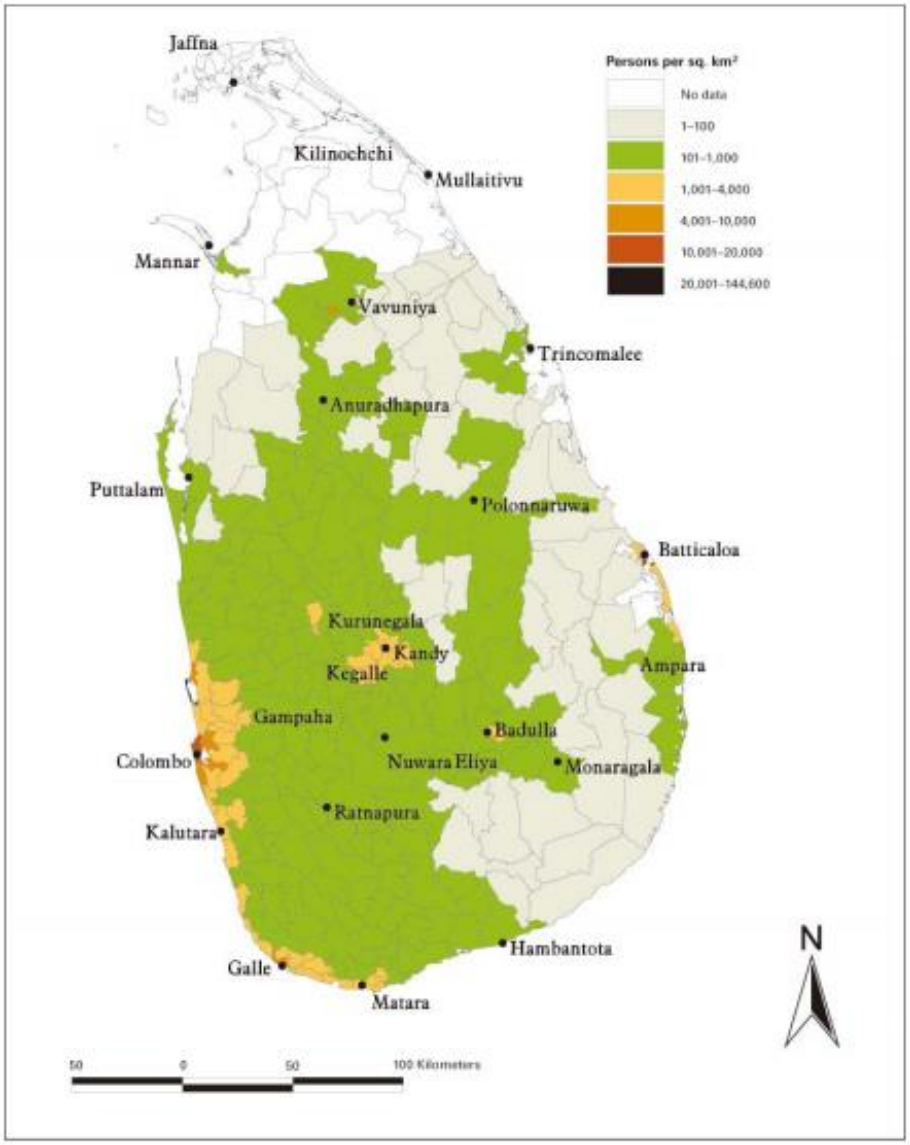


Figure 2: Population Distribution map of Sri Lanka [11]

Sri Lanka's coastline is 1,340 kilometers approximately. Coastal communities support multiple livelihoods, including fisheries, tourism, carpentry, handicrafts, mining, quarrying, production of various other goods and urban services. The infrastructure density is also quite high in coastal cities as shown in Figure 3 due to the heavy concentration of telecommunication, electrical and other facilities and related service departments. This imposes a high risk on the infrastructure elements including the road network and electrical distribution system at a time of a natural hazard.

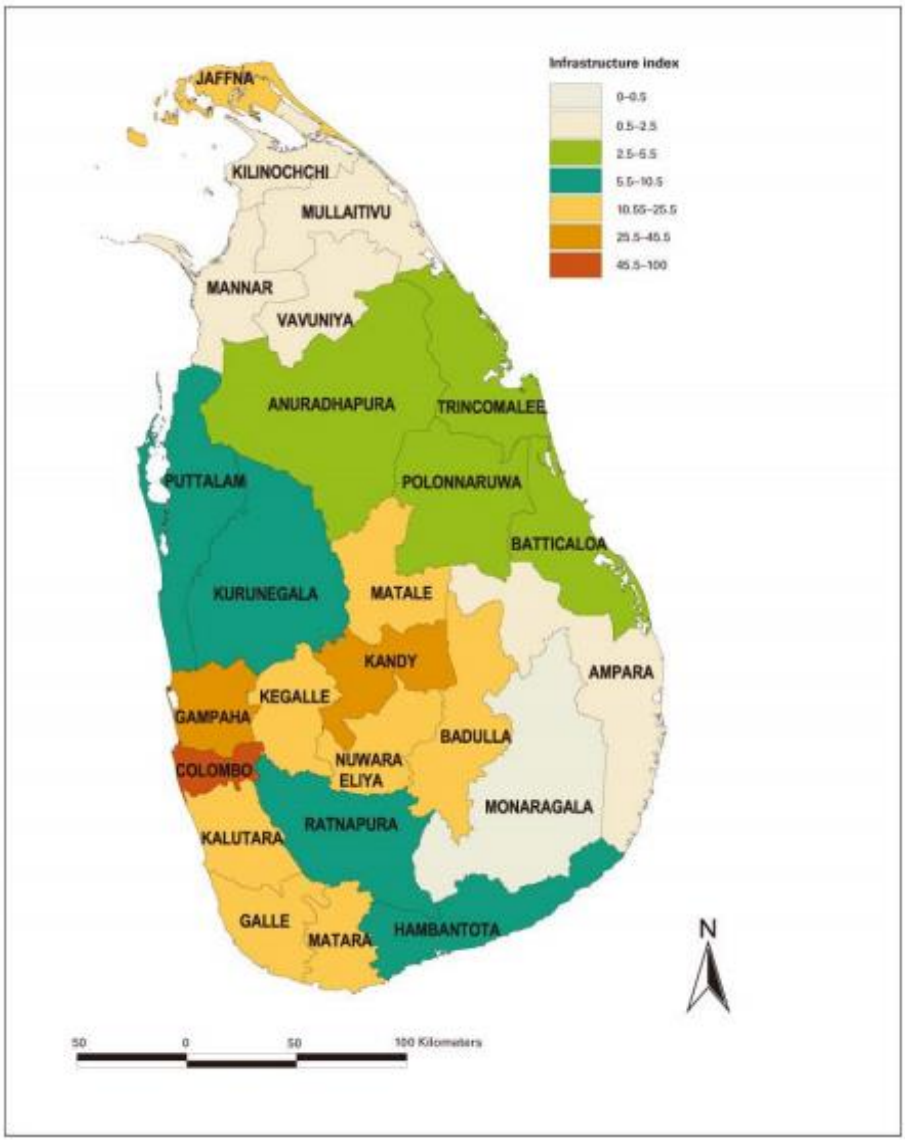


Figure 3: Infrastructure Density map of Sri Lanka [11]

Also, Sri Lanka's current and planned Metro cities are mostly coastal cities including Colombo, Kalutara, Gampaha, Hambantota, Batticaloa and Ampara as shown in Figure 4. The Metro regions dominate not only the human settlement but the industrial and transport network. The cities act as international gateways too where country's main

institutions and manufacturing hubs are located. Ongoing and proposed city development projects are also targeted at these metro cities.

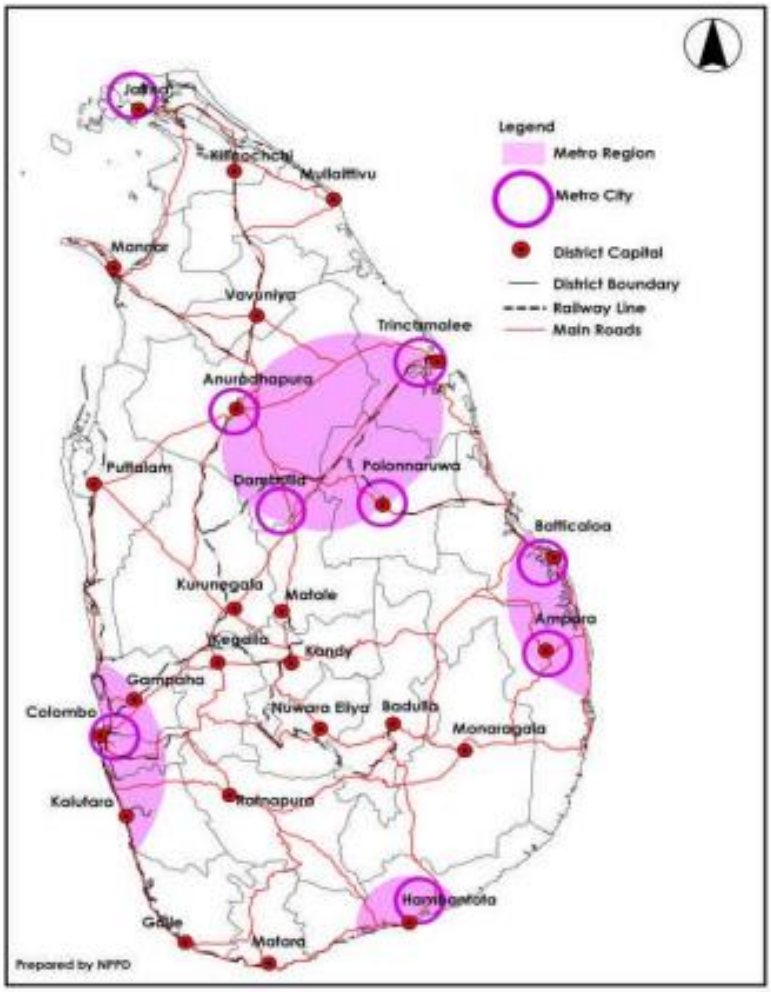


Figure 4 : Planned Metro-Regions and cities by 2030

[12]

Fisheries and tourism sectors alone contribute to 10 percent of Sri Lanka's foreign exchange earnings and 6.7 percent of employment. Fisheries alone make a significant contribution to employment, food security and Gross Domestic Product (GDP), generating close to 4.5 percent of GDP. Figure 5 shows the massive contribution of coastal cities toward the GDP. Western, North-Western, and Southern Provinces show the highest contribution to GDP underlining the significance of coastal districts toward

the country's economic status. Fisheries has a direct impact on Sri Lanka's total export revenue too which has further growth potential in the future. Approximately 90 percent of the total national fish catch is from the marine and coastal fishery, and it creates livelihoods for many artisanal fishermen. 20 formal fish harbors are in operation accommodating more than 4,000 single and multi-day fishing vessels and providing nearly 500,000 formal and informal jobs.

Tourism brings the sixth largest foreign exchange revenue to Sri Lanka [13] Researchers spotlight that nearly one half of the total stay of a tourist is spent in the coastal regions near beaches [14]. Therefore a vast amount of areas in coastal regions are continuously encouraged to build tourist attraction products. Astonishingly, 75% of Sri Lanka's graded hotels and 80% of the total hotel rooms belong to the coastal region. [14] It highlights the significance of regulating the construction and strengthening the protection mechanisms in the coast to prevent massive economic losses from a probable Tsunami.

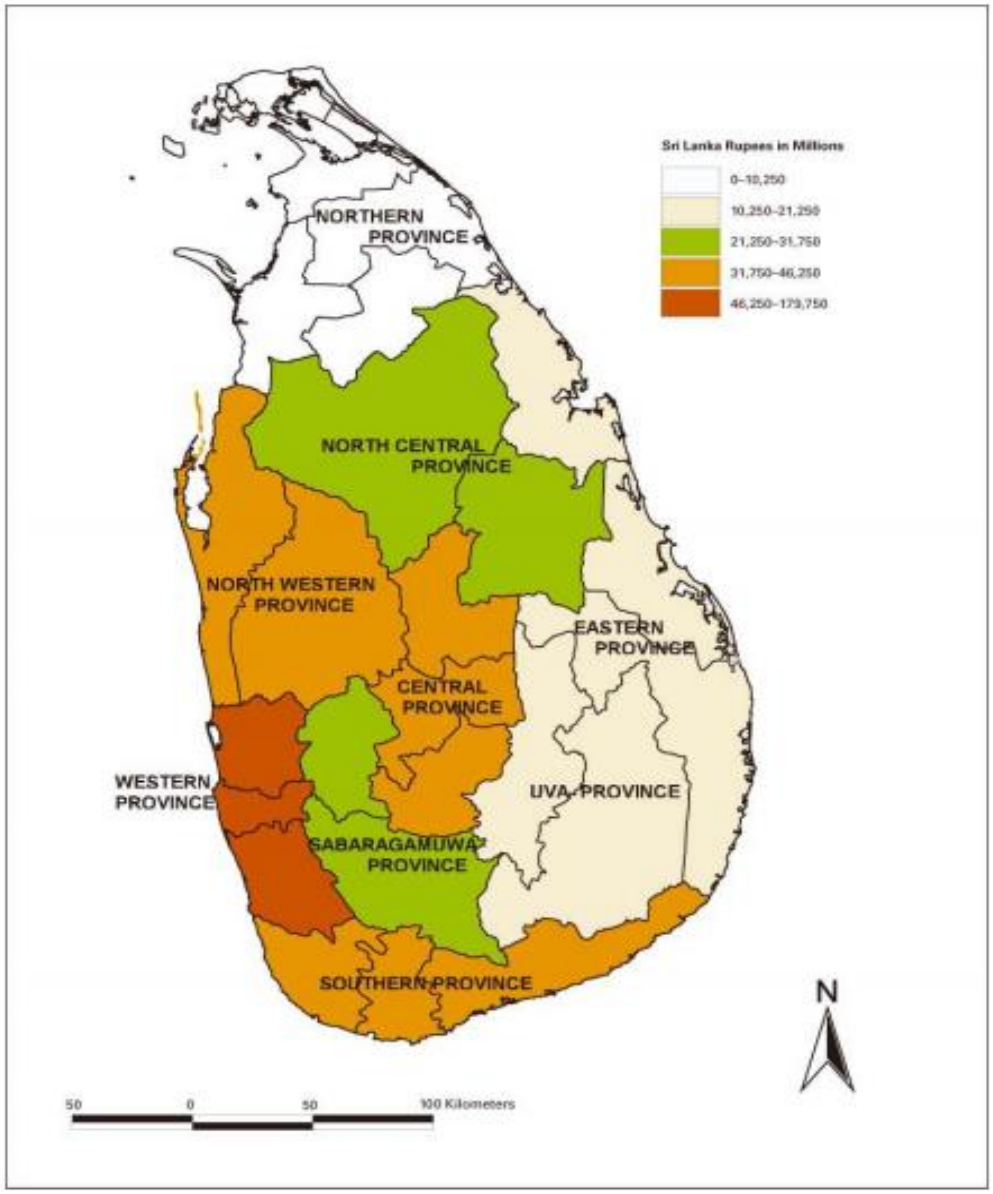


Figure 5: Contribution of cities to GDP of Sri Lanka

[11]

This information proves the significance of coastal belt towards the economic performance and wellbeing of the country. Events that trigger hazardous conditions become threats to nature. The recent marine disaster in Sri Lanka, the sinking of Xpress-Pearl cargo ship caused oil spills and releasing of hazardous chemicals. Release of nitric acid, plastic pallets and hazardous cosmetic material have put Colombo's coral reefs and marine life in danger. This exacerbates long-term impacts on the environment.

1.1.3 Tsunami Hazard

Sri Lanka, as a country surrounded by Indian Ocean and experiencing urbanization crisis with its developing status, a high vulnerability to such coastal hazards is imposed to communities at coast. German watch Global climate index reports Sri Lanka as the country with the second highest damages from extreme weather events occurred in 2018.

Natural hazards affecting coastal regions can be categorized into five main categories as given in Table 1.

Table 1: Natural hazards affecting coastal cities

Disaster type	**Examples**
Geophysical	Tsunami, landslides
Hydrological	Floods
Climatological	droughts
Meteorological	Heavy storms/cyclones
Biological	Covid 19

Localized and seasonal floods and associated landslides are the most common types of natural hazards in Sri Lanka. But Tsunamis are undoubtedly the event resulted in the greatest impact in the recent past. Tsunami is a series of sudden large sea waves caused by underwater earthquakes or volcanic eruptions that can cause damage to coastal areas from the disruptive nature of waves themselves and overland inundation. Due to its unpredictability, preparing the coastal communities for abrupt Tsunamis and making the structures Tsunami resistant is of utmost importance some researchers [15] even name Tsunami as the most underrated natural disaster of all time. The decade of 1998- 2017- decade accounts for fatalities and damages that are 100 times greater than those reported in the previous decade (1978–1997). Therefore, Tsunami hazard was mainly focused under the purview of this study due to its high impact even with a less frequency of occurrence.

As a country exposed to coastal natural hazards including Tsunamis which brings the most disastrous impacts and severe long-term disruptions to a nation, Sri Lanka's coastal cities should be planned to minimize the risk of such hazards and withstand the impact. Sri Lanka also conducts a series of city center development projects that directly involve the sea and coastal regions. It alarms that Tsunami risk reduction measures should be mandatorily incorporated in the designs of such buildings and landscapes.

Figures 6 and 7 show the global occurrence and total estimated damages from Tsunami hazards from 1900 to 2021, respectively. It is noticeable that even though the countries Indonesia, Japan and Chilie and 7 other countries tops the list of 10 countries with highest

number of occurrences of the hazard, under the total damages from Tsunamis in that period, Sri Lanka appears to be the sixth in the ranking [16].

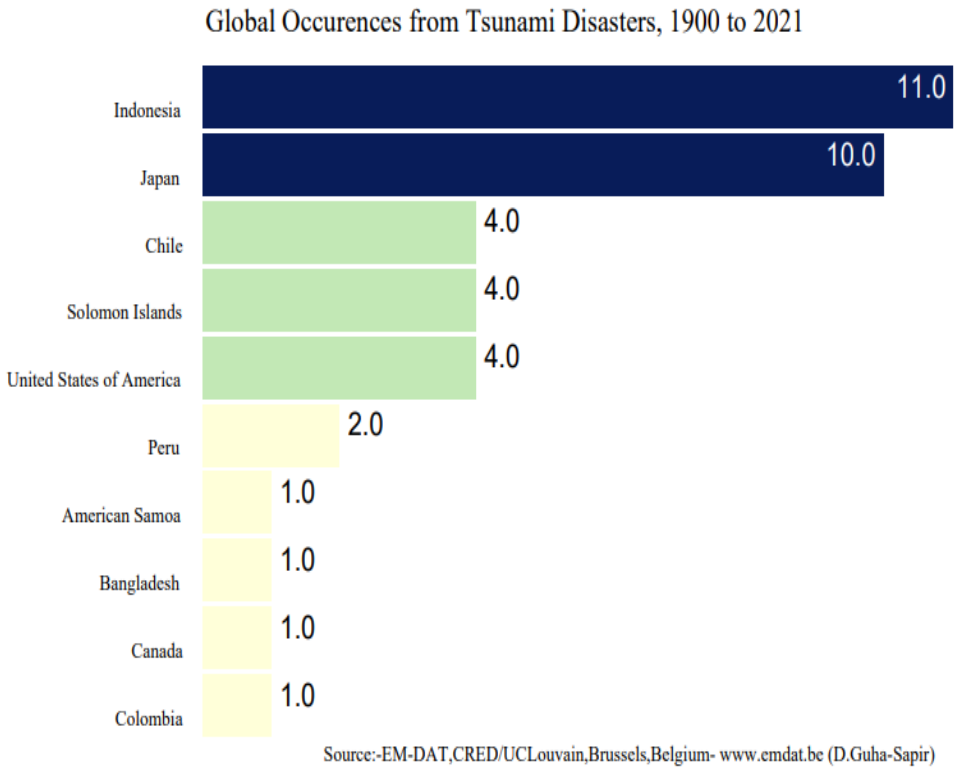


Figure 6: Global Occurrences from Tsunami disasters, 1900 to 2021

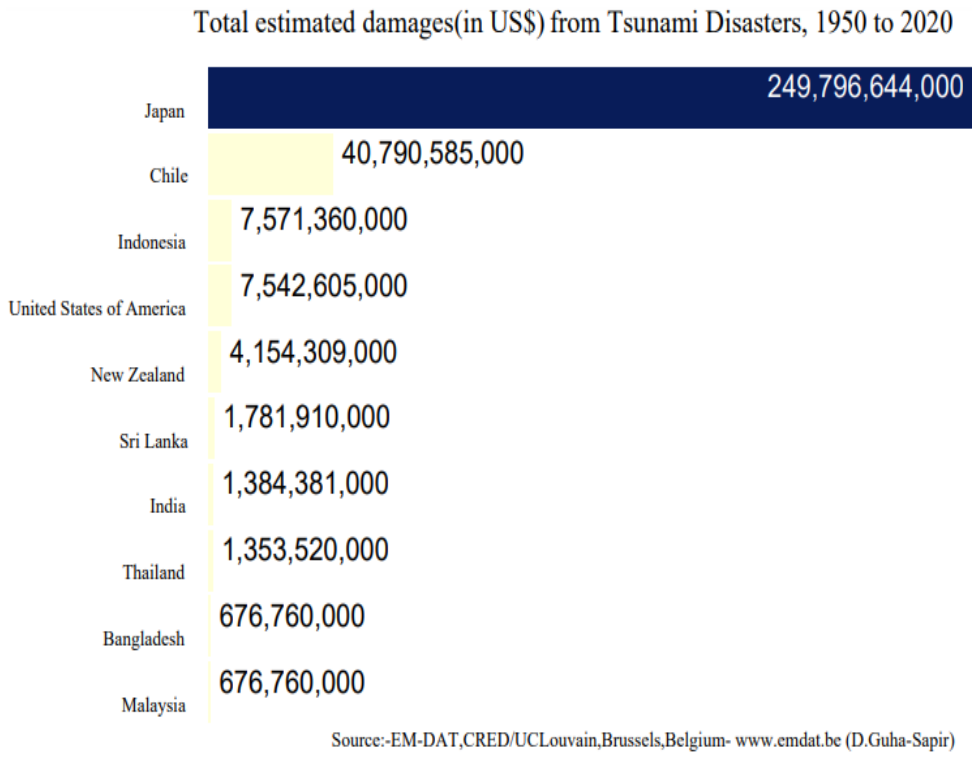


Figure 7: Total estimated damages (in US $) from Tsunami disasters, 1950 to 2020

This was resulted from the most unprecedented natural disaster Sri Lanka faced in the recent past, the 2004 Indian Ocean Tsunami (IOT) or the Boxing Day Tsunami which caused a discernible impact as highlighted in statistics in Table 2 [17].

Table 2: Countries affected by the tsunami, number of dead, missing, total and displaced persons (statistics for 6th May 2005)

Continent/Country	Number of dead	Number missing	Total	Number of displaced persons
Asia				
Indonesia	128645	37063	165708	532898
Sri Lanka	31147	4115	35262	519063
India	10749	5640	16389	638297
Thailand	5395	2845	8240	NA
Maldives	82	26	108	11568
Malaysia	68	6	74	8000
Burma	61	0	61	2592
Bangladesh	2	0	2	0
Africa				
Somalia	150	NA	298	5000
Tanzania	10	NA	10	NA
Seychelles	3	NA	3	40
Kenya	1	NA	1	NA
Total	176313	49695	226008	1717458

The aforementioned statistics and analyzed facts spotlight that city and their infrastructure including buildings, roads, water structures, railways, dams and bridges are of the highest vulnerability to coastal hazards. Especially as Sri Lanka is presently undergoing further development projects it can seriously cause imbalance of environmental equilibrium and eventually minimize resistance to disasters. Therefore, the existing developments as well as the need of redevelopments and their designs have to be reviewed to match the expected resilience.

As mentioned before, the rapid urbanization and related unsound construction practices, poor drainage arrangements, exploitation of earth's material, open land space, water and other resources have been identified as the triggering factors for natural hazards. Even with the low frequency of occurrence, the high direct impact to the built environment and the associated future risks to human and economic wellbeing from coastal hazards has highlighted the necessity of reconceiving building designs and regulations in a more disaster friendly manner. In this context, it is evident that more resilient systems, infrastructure preparedness and response strategies are vital to minimize the hazardous condition itself, vulnerability or both and thereby reduce the risk.

Two rating systems are in place for the Buildings in Sri Lanka at present that are The GreenSL Rating System for Built Environment by the Green Building Council of Sri Lanka [18]. and The Green Building Rating Tool introduced by the Urban Development Authority, in its latest version [19]. An attempt to integrate Disaster Risk Reduction measures into the GreenSL Rating System for Built Environment can be witnessed in recent research [20] where the researcher modifies the existing Green building Rating System by integrating DRR measures.

But, when it comes to cities, the GreenSL Rating System for Sustainable Cities which was compiled in 2020 has not been launched yet for practice. Also, it does not include any Disaster Risk Reduction or resilience measures to combat natural hazards which brings out a gap in Sri Lankan green rating systems.

1.1.4 Research Gaps

In this context, following research gaps were identified.

- Even though Tsunami is the disaster with the greatest impact to Sri Lanka in the past 20 years, Tsunami preparedness measures have not been included in any of the green rating systems in Sri Lanka for buildings/cities.
- No Rating system in Sri Lanka to evaluate disaster resilience in cities.
- Lack of incorporation of disaster guidelines in general urban planning frameworks in Sri Lanka.
- No Rating Assessment has been carried out for a Sri Lankan city/ coastal city for the adaptation of green concepts or disaster resilience or both.

1.1.5 Research Aim

To prepare the GreenSL Rating System for Sustainable and Resilience Cities by modifying the existing GreenSL Rating System for Sustainable Cities to be applied to the coastal districts in Sri Lanka.

1.1.6 Research Objectives

To fulfill the above research gaps, the objectives of this study have been set as follows.

1. To identify the parameters of Tsunami Resilience
2. To identify the actual integration levels of those parameters and related guidelines in Sri Lankan urban planning and identifying gaps

3. To integrate Tsunami resilience measures into the GreenSL Rating System for Sustainable Cities
4. To evaluate a coastal city based on sustainable and resilience measures

1.1.7 Methodology

1.1.7.1 Literature Review

Different methods are being employed to carry out literature reviews depending on the area of study and the required objective from the study. Following are some of the methods in practice.

- Traditional or narrative literature reviews – This method is basically searching for everything related to the research topic in a broader view. Here no methodological approach is being followed, but information is gathered and subjectively analyze to arrive at final interpretations [21].

- Scoping Reviews - These reviews are mostly centered around a primary question and based on the question, the investigation is carried out. But this question mostly is a generic question and solutions can be more board due to the unrestricted nature of the question [22].

- Systematic literature reviews – Systematic reviews on the other hand focus on a more narrowed research question and involves a more systematic methodology. The elimination and inclusion criteria for research articles are more specifically defined in this approach. Meta-Analysis guidelines (PRISMA) are associated with this type of review. Hence this provides more accurate, reliable and relevant information in the area of study [23].

- Integrative Literature Review – Integrative reviews produce novel knowledge on the reviewed topic and substantially contributes to the available knowledge. The method of doing this is not specified [24].

- Theoretical Literature Review -Theoretical review extensively explores previous theories in history and interconnections among them and tries to build up novel hypotheses on the subject which will be tested in the given research or research in future [25].

International frameworks, and research will be reviewed as a traditional in-depth study due to the broad nature of the available information and the fact that a broader review contributes more to find out the global Tsunami resilient parameters.

Systematic review was selected as the best suited approach to conduct the literature review of the local research since local research contributes most to the understanding of what is suited for the Sri Lankan context.

The Structure of the Literature survey is shown in Figure 8.

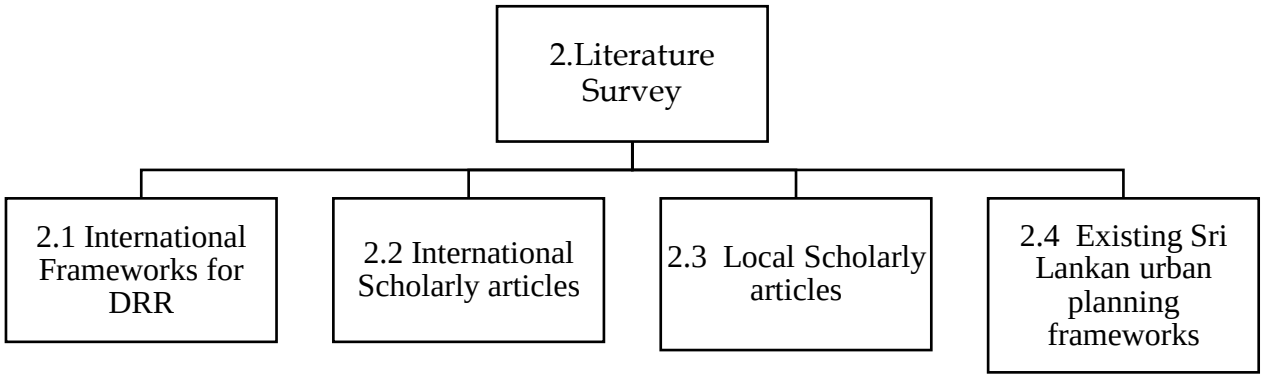


Figure 8: Aspects covered in the Literature Survey

International sources (2.1, 2.2 and 2.3) were subjected to a traditional and integrative review while the local sources (2.3 and 2.4) were subjected to a systematic review.

1.1.7.2 Expert Surveys

Expert Surveys are a frequently used technique in qualitative research. Expert interviews allow researchers to quickly understand a context of a particular issue. Especially it provides more reliable information and insights into an issue raised in a specific region or a field [26].

Experts from the related fields to urban planning will offer current information on urban planning in coastal areas in Sri Lanka and allow a meaningful discussion on the strategies recommended by regulations and its implementation levels and limitations. This empirical investigation will be based on semi-structured interviews for 12 experts to find out the

present Sri Lankan context of urban planning for Tsunami resilience and the validity and practicability of available policies and frameworks. The key findings of the interviews will be then validated through a focused group discussion. (FGD).

This combined approach will bring more benefits than a single series of expert interviews since information will be more detailed and not relied on an individual context but proven in a panel of most related experts. It enables understanding the lessons learned from a wider perspective and facilitates more reliability to the findings.

This is undoubtedly exploring beyond the literature by adding more thoughts, concepts and ideologies to the floor. FGD provides more certification and value to the expert interview findings and clarifies the grey areas to finally assure no significant aspect was ignored from the discussion.

1.1.7.3 Criteria Development

Most of the rating systems (Green Building or Resilience) follow a score-based criteria system since a set of qualitative guidelines will not serve the purpose of awarding a rating. Similarly, the selected GreenSL Rating System for Sustainable Cities already consisted of 100 points divided into 9 main categories. Therefore, under the purview of this study it was only intended to develop additional criteria that would fit into the same format. Due to the specific nature of the problem to Sri Lanka, the most suited method to support the developing and reviewing of the criteria was identified as Delphi method which involves a panel of experts. Delphi surveys will be conducted in two parts.

Interview No 1 - No 4: Focus on developing the criteria

Interview No 5- No 5: Focus on reviewing and finalizing the score criteria

1.1.7.4 Analytical Hierarchical Process (AHP)

Analytical Hierarchical Process is a decision-making tool introduced by Thomas L. Saaty [27]. It presents a hierarchy between several options and criteria. First the alternative options for a given problem is be identified. Then criteria to evaluate those option is identified. The AHP Model/ tree is generated based on the above. The criteria are then quantified according to a suitable value scale based on the relative importance of them. It allows developing a comparison matrix which ultimately calculate a consistency ratio. If the obtained consistency ratio is less than 0.1, selected value scales can be accepted. Same procedure is applied to the selected alternative options where they are valued based on the above finalized criteria. It finally presents the best alternative option for the given

problem. This method facilitates the decomposition of complex problems in a hierarchy which allows to analyze the problem.

Among other decision-making tools AHP has some significant benefits which are mentioned below.

- Facilitates Multi-criteria decision making
- Ability to quantify the criteria
- Analyzing options relating to the overall goal
- Use of the consistency measure

Following are the steps of conducting the AHP.

1. Identifying the decision, options, and criteria
2. Conducting pairwise comparison
3. Calculate the importance weight of each criterion
4. Identifying the best option by calculating utility

1.1.7.5 Validation of Rating Systems

Validation of a rating system of this nature is obviously a tedious task especially when a city is concerned. Rather than a building, the scope of assessing a city is wider and the authorities and stakeholders involved are of a varied range. Moreover, undertaking a complete assessment for a city comes with financial restrictions and limited approvals and consent from the attached parties. Furthermore, a pilot study for a city has not been undertaken in Sri Lanka yet due to the practical concerns and that has to align to government objectives as well which is an external environment factor when considered from this individual research aspect. Hence, a surface level validation is planned to be conducted to a Sri Lankan coastal city where a simple “Yes/ No answer strategy will be used to check the availability of given measures.

Overall, the methodology shown in Figure 9 will depict the achievement of objectives of this research.

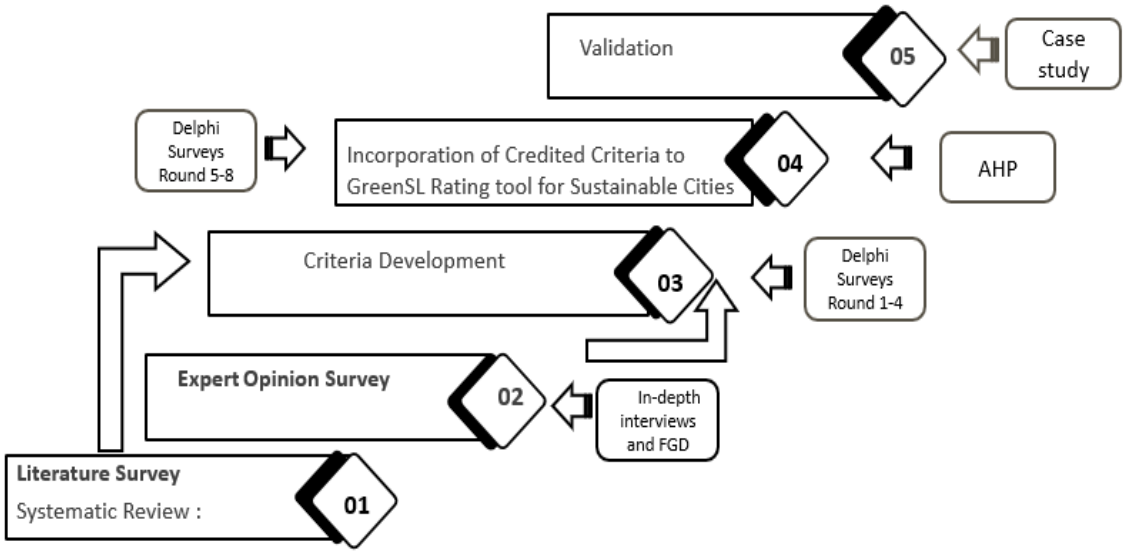


Figure 9: Methodology

2 LITERATURE SURVEY

2.1 International Frameworks for DRR

This section presents the summary of the in-depth literature review carried out on the international frameworks for DRR.

2.1.1 United Nations Strategy for Disaster Risk Reduction

With increased occurrence of natural hazards in 1900's, disaster risk reduction concepts came to light. The decade 1900-1999 was declared by the United Nations as the decade for "Natural Disaster Reduction" to make the world aware of the significance of disaster risk reduction. As a successor of the International Decade for Natural Disaster Reduction, the UN General Assembly in December 1999 formulated the International Strategy for Disaster Reduction (ISDR). ISDR helped countries and organizations to integrate disaster risk reduction to their development programmes. Four objectives were set by ISDR as shown in Figure 10 towards achieving "disaster risk reduction for all" [28].

Figure 10: Objectives set by UNISDR

According to UNISDR, Disaster risk reduction (DRR) is "the concept and practice of minimizing disaster risks through systematic efforts to analyze and reduce the causative factors of disasters" [28]. Minimizing hazard exposure, reducing vulnerability of people and properties and improving preparedness and early warning systems are some of the strategies followed.

UNISDR or UN Office for Disaster Risk Reduction still acts as the coordination point of the UN to establish the strategy through the governments of the UN member countries.

2.1.2 Yokohama Strategy (1994)

The United Nations World Conference on Natural Disaster Reduction, held in Yokohama, Japan in 1994 lead the way to implement the Yokohama Strategy and Plan of Action for a Safer World. It is known to be the very first document that provides guidelines at the international level for the disaster preparedness, prevention and mitigation. The Yokohama Strategy was a result originated due to the International Decade for Natural Disaster Reduction (1990–2000) parallel to the World Conference on Natural Disaster Reduction held in 1994. Yokohama Strategy brings out Principles, Plan of Action and Follow-up Actions [29]. Out of them following items listed in Table 3 are directly related to the urban planning for Disaster Risk Reduction.

Table 3: Items from Yokohama Strategy related to urban planning for DRR

Principle 3	Disaster Prevention and Preparedness should be considered integral aspects of development policy and planning at national, regional, bilateral, multinational, and international levels
Principle 4	The development and strengthening of capacities to prevent, reduce and mitigate disasters is a top priority area to be addressed during the decade so as to provide a strong basis for follow up activities to the decade.
Principle 5	Early warnings of impending disasters and their effective dissemination using telecommunications, including broadcast services are key factors to successful disaster prevention and preparedness.
Principle 7	Vulnerability can be reduced by the application of proper design and patterns of development focused on target groups, by appropriate education and training of the whole community
Plan of action C	Develop a risk assessment programme and emergency plans focusing efforts on disaster preparedness, response and mitigation, and design projects for subregional, regional and international cooperation, as appropriate.
Plan of action F	Take Measures to upgrade the resistance of important infrastructure and lifelines

2.1.3 Hyogo Framework for Action (HFA) (2005)

Empowered by the ISDR, the first 10-year plan was established at the World Conference for Disaster Reduction held in Kobe, Hyogo, Japan in 2005. That encouraged governments to adopt a specific guideline to reduce vulnerabilities, named as the Hyogo Framework for Action (HFA)**.** With the common goal of "building the resilience of nations and communities to disasters, it created a common platform to governments, international organizations, disaster professionals, and many others to minimize disaster losses substantially by 2015 [30].

The HFA had three main strategic goals:

1. The integration of disaster risk reduction into sustainable development policies and planning
2. Development and strengthening of institutions, mechanisms and capacities to build resilience to hazards
3. The systematic incorporation of risk reduction approaches into the implementation of emergency preparedness, response and recovery

Targeting these goals, it focused on five priorities actions mentioned below.

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

Priority for action 2 specifically discusses how to "Identify, assess and monitor disaster risks and enhance early warning" which is related to urban planning. The path for reducing risk through understanding the risk is described as shown in Figure 11. It highlights major aspects of urban planning for hazard resilience.

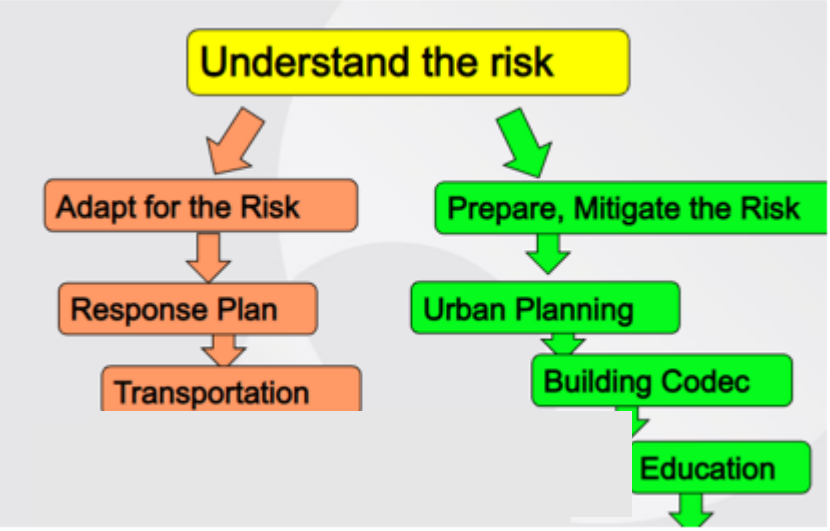


Figure 11: Urban planning to reduce disaster risk as discussed in Priorities of Action 2

2.1.4 Sendai Framework for Disaster Risk Reduction (2015-2030)

The Sendai Framework for Disaster Risk Reduction 2015-2030 was established on 18 March 2015 at the Third UN World Conference on Disaster Risk Reduction in Sendai City, Japan. It was adopted by the UN member states and it was the first major agreement of the post-2015 development agenda. The Framework targets to achieve a substantial reduction of disaster risk and losses in terms of death tolls, human livelihoods, health and damages to economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years [31]. SFDRR 2015 also replaced the Hyogo Framework for Action 2005–2015 (HFA) and presented some important gains to frame the international and national policy on DRR where it brings out,

- 7 Global Targets
- 4 Priorities for action
- 13 Guiding Principles

The 7 global targets of SFDRR 2015 are listed in Figure 12 and it is apparent that the global target 4 and the global target 7 directly highlight the elements of urban planning for disaster risk reduction.

Global Target	Description	Aspect highlighted
1	Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortalities between 2020-2030 compared to 2005-2015	Mortality rate
2	Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015	No of affected people
3	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030	Economic Loss
 4	Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030	Critical Infrastructure
5	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020	No of the countries with DRR strategies
6	Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030	International cooperation
 7	Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030	Availability of information to people

Figure 12 : Global Targets of SFDRR 2015

The 4 Priorities of action of SFDRR 2015 are shown in Figure 13.

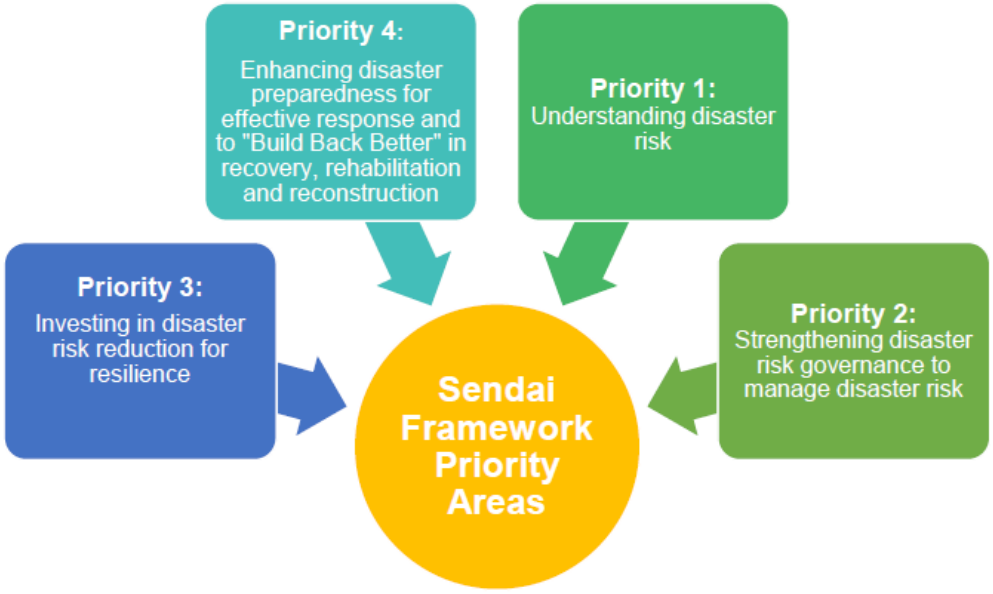


Figure 13: Priorities of Action of SFDRR 2015

Priorities of Action 3 has prioritized on investing in disaster risk reduction for resilience which is centered around urban planning and related policy development which is the scope of this study.

The 13 guiding principles are shown in Figure 14. Guiding Principle 8 highlights the importance of sustainable development policies and mechanisms within different sectors which is a part of urban planning.

1. Primary responsibility of States to prevent and reduce disaster risk, including through cooperation
2. Shared responsibility between central Government and national authorities, sectors and stakeholders as appropriate to national circumstances
3. Protection of persons and their assets while promoting and protecting all human rights including the right to development
4. Engagement from all of society
5. Full engagement of all State institutions of an executive and legislative nature at national and local levels
6. Empowerment of local authorities and communities through resources, incentives and decision making responsibilities as appropriate
7. Decision-making to be inclusive and risk-informed while using a multi-hazard approach
8. Coherence of disaster risk reduction and sustainable development policies, plans, practices and mechanisms, across different sectors
9. Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk
10. Addressing underlying risk factors cost-effectively through investment versus relying primarily on post disaster response and recovery
11. «Build Back Better» for preventing the creation of, and reducing existing, disaster risk
12. The quality of global partnership and international cooperation to be effective, meaningful and strong
13. Support from developed countries and partners to developing countries to be tailored according to needs and priorities as identified by them

Figure 14 : Guiding Principles of SFDRR 2015

Interestingly there is an interconnection between the United Nations Sustainable Development Goals (SDGs) and the Sendai Framework that their expected outcomes are resulted through similar social and economic processes. This synergy allows the monitoring of Sendai Framework goals to be facilitated through the monitoring of 11 SDG indicators listed below as shown in Figure 15.

Figure 15: Interconnection between SFDRR 2015 and SDGs

2.1.5 The New Urban agenda to reduce disaster losses

The New Urban Agenda (NUA) was adopted by United Nations Conference on Housing and Sustainable Urban Development or Habitat III, held on October 20, 2017. It was adopted as a 20-year global blueprint. It foregrounds the importance of investigating and finding feasible solutions for climate and disaster risks in urban areas and communities [32].

It speaks about disaster risk reduction and management, reducing vulnerability, building resilience and responding to natural and man-made hazards, and promoting climate change adaptation and mitigation of losses. Figure 16 shows the main goals of New Urban Agenda and Figure 17 demonstrates the implementation plan of the above goals.

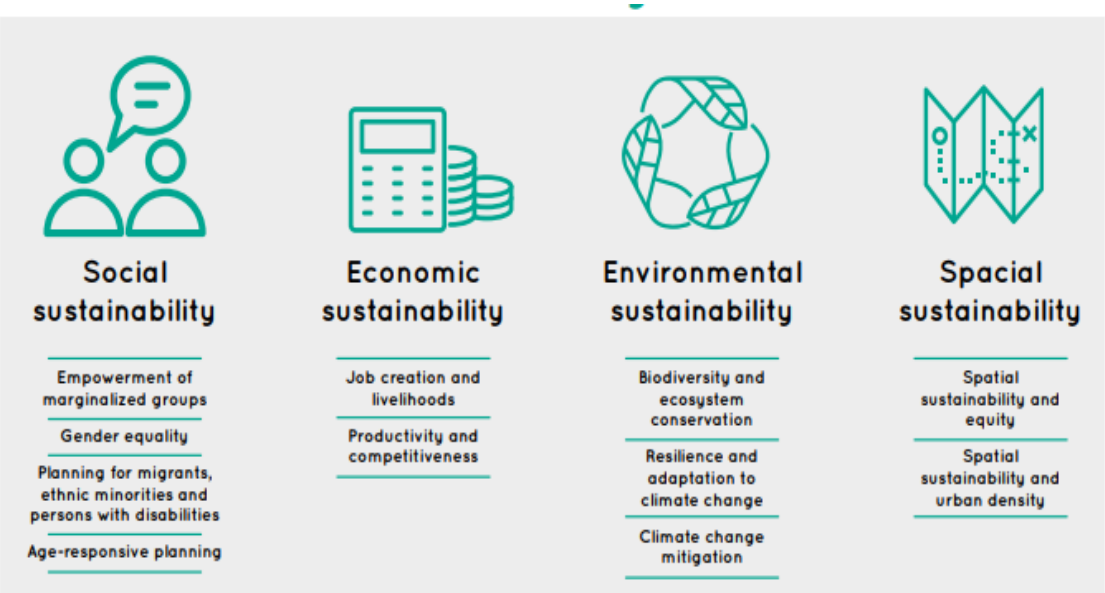


Figure 16: Main Goals of New Urban Agenda

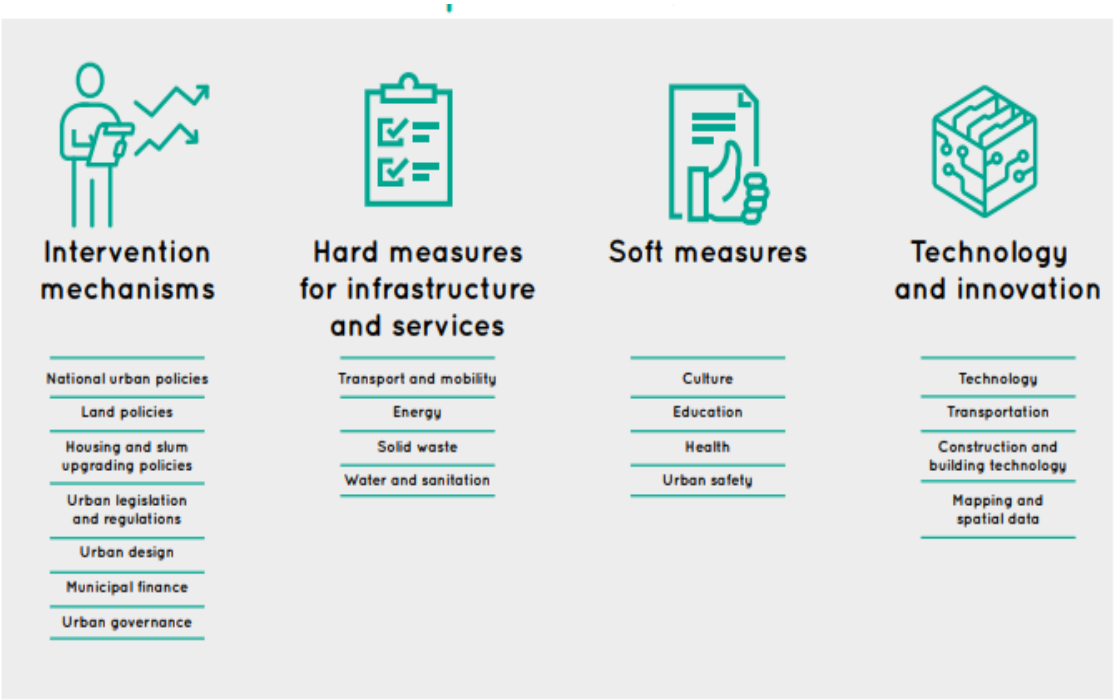


Figure 17: Implementation Plan of Goals of New Urban Agenda

The implementation plan of NUA identifies some naval elements of urban planning as key factors of urban planning for disaster risk reduction. Urban design, municipal finance, transport and mobility, mapping and spatial data, construction and building technology are some of the factors which were specified in a framework for the first time. This move provides a great insight towards resilient coastal city planning in the affected regions.

2.1.6 Seven Principles

Seven Principles were introduced specifically targeting the Tsunami hazard preparedness by the National Tsunami Hazard Mitigation Program (NTHMP) of the United States in 2001. It is a guideline on the design of Tsunami prevention strategies, plans and structures. These guidelines were originally developed to support coastal regions and their people in the five Pacific states (Alaska, California, Hawaii, Oregon, and Washington) identify their tsunami hazards, vulnerability and to minimize the resulted risk through building design, land use and site planning [33]. The seven principles of Tsunami Risk Reduction are listed in Table 4.

Table 4: Seven Principles of Tsunami Risk Reduction

Principle	Description
Principle 1	Know your community's tsunami risk, hazard, vulnerability, and exposure
Principle 2	Avoid new development in tsunami run-up areas to minimize future tsunami losses
Principle 3	Locate and configure new development that occurs in tsunami run-up areas to minimize future tsunami losses
Principle 4	Design and construct new buildings to minimize tsunami damage
Principle 5	Protect existing development from tsunami losses through redevelopment, retrofit, and land reuse plans and projects
Principle 6	Take special precautions in locating and designing infrastructure and critical facilities to minimize tsunami damage
Principle 7	Plan for evacuation

Some nations have adopted seven principles in their development plans across the years. The city of Hawaii is a great example where the seven principles have been utilized as shown in Figure 18.

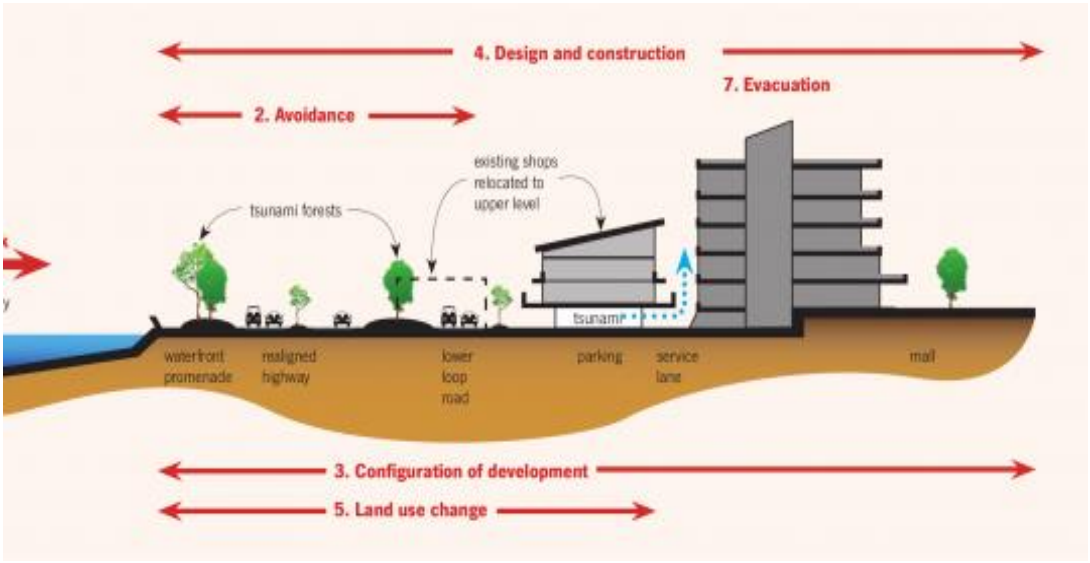


Figure 18: Downtown redevelopment plan for Hilo, Hawaii, with the seven key principles for incorporating tsunami risk into design (adapted from the National Tsunami Hazard Mitigation Program 2001)

2.1.7 Making Cities Resilient 2030 – a Resilience Roadmap (January 2021 – December 2030)

The first Making Cities Resilient (MCR) campaign was launched in 2010 at Bonn, Germany engaging with 4360 cities globally. With the below crucial learnings of the programme for 10 years, MCR 2030 was launched in January 2021 by the UNDRR to promote resilient city planning [34].

- DRR and resilience strategies cannot be stand-alone
- Cities need access to different tools, partners, and services at different stages of their resilience journey
- Access to financing is one of the biggest hurdles for building resilience for cities
- Vertical integration between national and local governments contributes towards sustainability The private sector needs to be brought in

The objectives of MCR 2030 are mentioned below.

Strategic objectives:

- 1. Improve cities' understanding of risk and secure their commitment to local disaster risk reduction & resilience [Know Better]

- 2. Strengthen cities' capacity to develop local strategies/plans to enhance resilience [Plan better]
- 3. Support cities to implement local strategies/plans to enhance resilience [Implement better]

Cross cutting objectives:

- Strengthening vertical links between local government with the national governments and national associations of local governments
- Strengthening horizontal links amongst local partners to ensure sustainability
- Connecting cities with cities to learn and share

MCR2030 is an initiative co-owned and co-delivered by key partners. Non-governmental organizations (NGOs)/civil society organizations (CSOs), development agencies, academia and research institutions, media, and others, are encouraged to join as Supporting Entities. Service providers can offer fee-based technical support and advice to cities which includes services to cities including assessing risks, uplift and update existing building codes and land use regulations, tackle climate change impacts, rating (and issuance) of bonds for municipal finance, city ranking criteria, innovative research, and others. A registry is also available to connect service providers with cities - Dashboard

As shown in Figure 19, MCR 2030 comprehends to 3 main stages.

1. Stage A – Cities Know Better

Spread the message, awareness raising on Disaster Risk Reduction and Resilience

2. Stage B – Cities Plan Better

Improving risk analysis

Improving strategies, planning, policies, and responses

3. Stage C- Cities Implement Better

Towards stage B and C, it directly addresses the resilient city planning aspects such as improving the ability to design and build critical resilient infrastructure and developing and scaling of nature-based solutions. MCR 2030 brings further extended city planning criteria where it introduces a Resilience Rating Tool and Public Health Addendum. This is a milestone in the history of UNDRR's efforts to mainstream DRR into planning where an actual constructive framework has been introduced for cities for better evaluation and monitoring. Advancing from the conceptual frameworks, this provides a massive incentive for nations to adopt the measures.

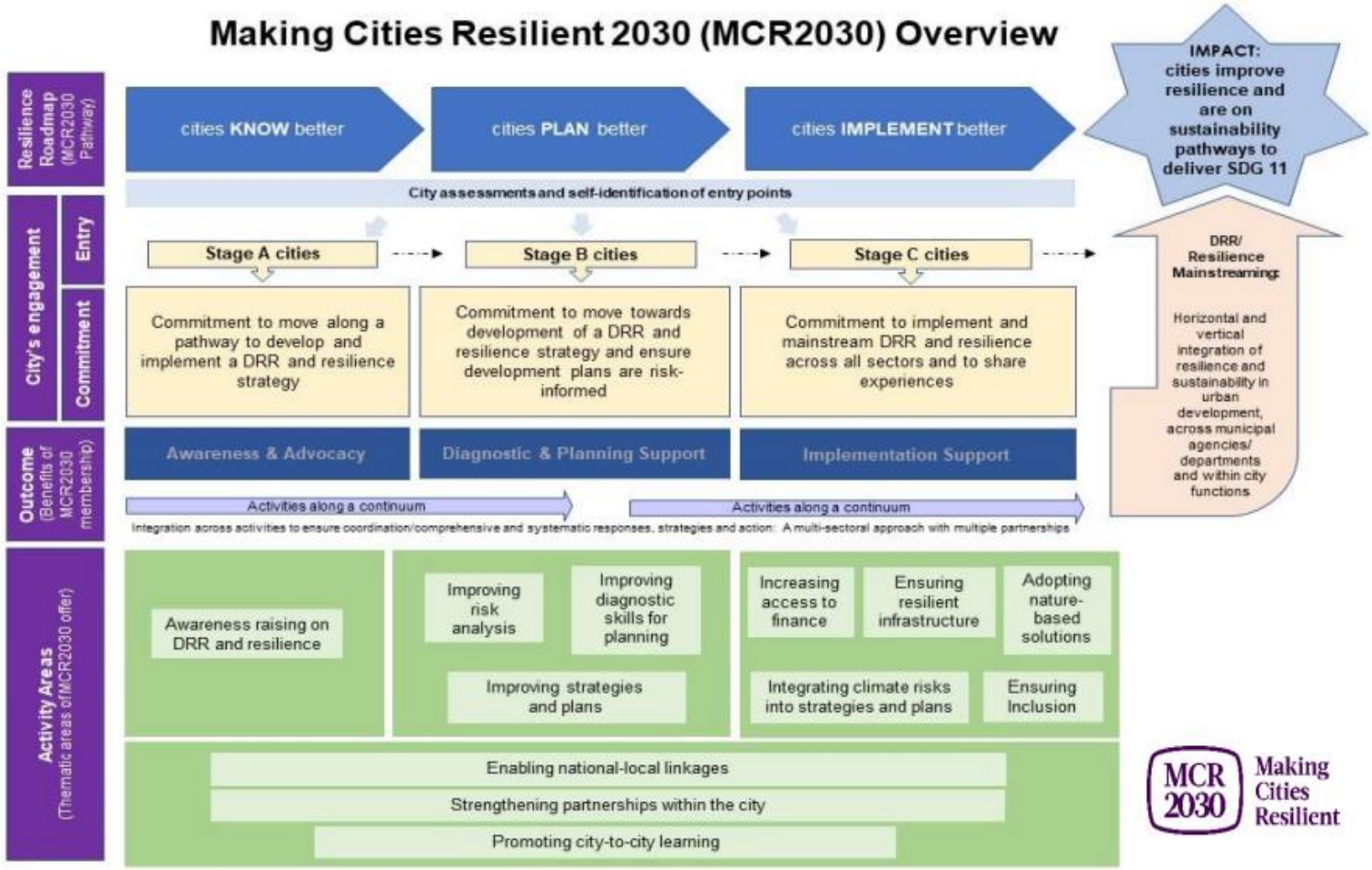


Figure 19: Overview of MCR 2030

2.2 International Scholarly Articles

International scholarly articles were subjected to an integrative review where 55 articles were referred for the search of existing and suggested strategies for Tsunami risk reduction in the coastal regions. The strategies were recorded (Annexure 1) and thoroughly analyzed for the purpose of formulating similar guidelines for Sri Lanka.

2.2.1 Identification of Parameters of Tsunami Resilience

This analysis allowed identifying the major parameters of Tsunami resilience. Five critical parameters were identified as;

1. Pre-planning and Development
2. Spatial and Infrastructure Planning
3. Capacity Building of Human Resources
4. Emergency Response and Evacuation Planning
5. Structural and Non-Structural Interventions

By analyzing all literature referred, the five parameters were further fragmented into three sub-parameters per each main parameter to obtain a specific understanding and carry out deep research. Figure 20 illustrates the identified configuration of parameters.

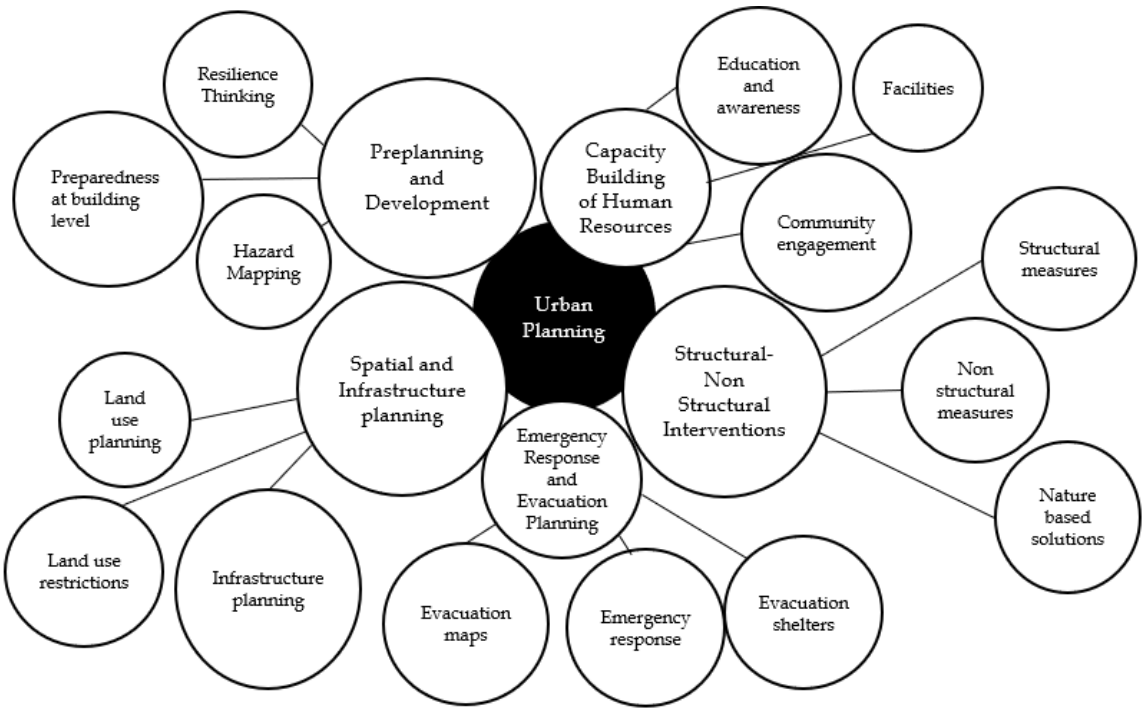


Figure 20: Parameters of Tsunami Resilience

2.2.2 Pre- Planning and Development

Pre-planning and development parameter focuses on the planning in a broader perspective where the formulation of policy frameworks, laws and regulations can be enriched and inculcated with resilience concepts. This is the first stages of planning in the national and local regional level where mapping of previous common hazards, incorporation of special concepts to city development projects, formation of structure of local bodies and dedicating responsibilities are taking place. Table 5 lists the strategies and concepts found under this subcategory.

Table 05: Strategies from literature under "Pre-planning and Development"

Preparedness at building level	**Resilience Thinking**	**Hazard Mapping**
Tsunami hazard preparedness manuals	Safe-to-fail'' model - build urban resilience capacity	Natural hazard maps and other physical parameters in land-use planning
Emergency response plans for buildings	Living with floods "Concept	Assessing floodability
Improving Housing conditions of the urban poor	Building back safer' instead of 'Build back better'	Tsunami vulnerability mapping using GIS, GPS and Remote sensing
		CITSU maps
		Multi hazard mapping

Special focus should be given to the preparedness at building level which starts from the identification of vulnerable urban settings and improvement of entire housing schemes and the moves forward with facilitating emergency response plans and Tsunami preparedness manuals. Tsunami preparedness information manual produced by Intergovernmental Oceanographic Commission discusses the steps of implementing a Tsunami hazard mitigation plan in the National level as shown in Figure 21.

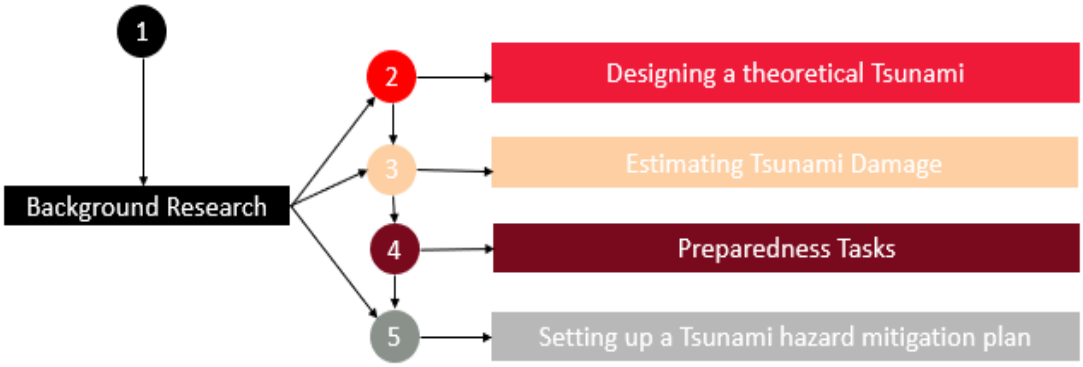


Figure 21: Tsunami Hazard Mitigation Plan. [35]

According to literature different resilient thinking approached have been adopted in different regions of the world, of which safe to fail model, build back better, build back safer and living with floods concepts are very common. In the early days, a concept called chaos or non-equilibrium theory claimed that the elements of nature are inevitably inconsistent and can show sudden and strange behaviours [36]. Later it was argued that through effective resource management (adaptive management technique) this uncertainty could be dealt with. The concept of "learn-by-doing" emerged and subsequently encouraged to learn new techniques for effective resource, landscape and urban planning. The resilience concept of "fail-safe" which prevailed until recent past believed achieving one-time sustainability can serve the threat of natural hazards for an eternity. An improved and more practical version of the concept was brought about recently in the name, "safe-to-fail". It accepts failures and advises for continuous strategical advancement of practices according to the failures encountered [37]. In this resilience, the concept of sustainability is often challenged and continuously designed with technological advancements addressing new trending hazards with climate change [38]. Ahem, 2011 claims essential elements of urban resilience to be multi-functionality, redundancy and modularization, (bio and social) diversity, multi-scale networks and connectivity, and adaptive planning and design [39].

Hazard Mapping was identified to be an equally important element where Hazard maps are recommended to be developed on a regular basis. Inundation modelling needs to be undertaken to provide for accurate hazard mapping. Based on geographical, historical, geological, and experimental records, numerical models can be developed to identify inundation areas and paths in coastal cities. Inundation differs with geomorphological setting and land use patterns. Restrictions in tsunami modeling are mainly the lack of topographic, bathymetric, or ground roughness data with sufficient spatial resolution [40].

presented a 10m resolution tsunami flooding map for Lisbon downtown. Tsunami modeling was conducted using a non-linear shallow water model with four levels of nested grids. The results showed that, even today, despite the significant morphologic differences in the city riverfront due to the AD 1755 earthquake and tsunami, a similar event in future would result in tsunami to flow depths larger than one meter in a large area along the Tagus estuary and Lisbon downtown [41]. brings detailed inundation maps joint with the existing information of the local infrastructures which produced high scale vulnerability maps, evacuation routes and emergency maps for that region of Portugal. In a study conducted for Tsunami wave modelling in the Hellenic Arc the wave propagation in 15,30, 45 and 60 minutes were obtained [42]. In a Sri Lankan study, deep-water propagation and inundation modelling for Galle was conducted as shown in Figure 22 [43]. Similar modelling can be recommended for atleast critical coastal cities.

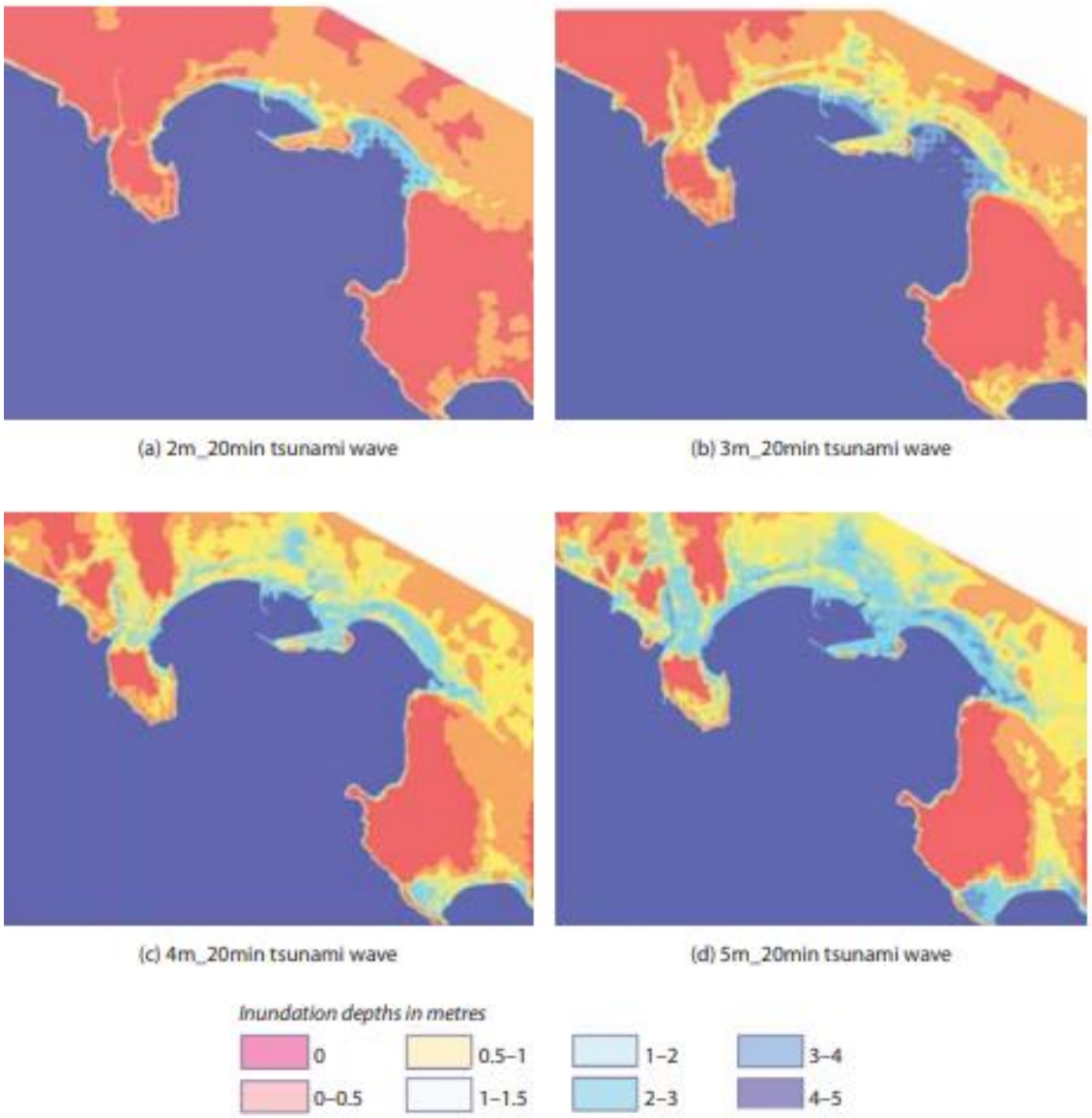


Figure 22: Deepwater propagation and inundation modelling for Galle

2.2.3 Spatial and Infrastructure Planning

Neutralizing potential Tsunami Damage can be achieved in two ways; by excluding building and people entirely from damage prone areas and through engineering interventions on Urban Planning. Latter is often recommended in literature and by experts. Evaluating the geographic and geomorphological characteristics of a given coastal area is the first step of spatial and infrastructure planning according to literature. Advanced planning in terms of building infrastructures, escape routes and mitigation measures can be then followed. Eg: Establishing high risk zones of Tsunami inundation such as beaches, estuaries, and coastal lagoons. In zones with higher risk, legislation should forbid/constrain construction of critical infra-structure Eg: schools, hospitals, emergency services, power plants and factories, industrial zones, and transport networks. Table 6: lists the strategies and concepts found from literature under this subcategory.

Table 6: Strategies from Literature under "Spatial and Infrastructure Planning"

Land use restrictions	**Landscape planning**	**Infrastructure planning**
Establishment of no construction buffer zones	Communication facilities	Participatory risk zone planning into urban planning
Land use restrictions	The protection of natural buffers such as forests, compacted dunes, and wetlands	Road network planning
Planning building lots (gaps, shapes and orientations)	Public open spaces and urban parks	
Gross plot ratios and story heights	Public green spaces	

Land use restrictions have been the first actions taken after the very first Tsunamis experienced by many countries. Effective landscaping planning was accepted to be a better strategy to cater for high population growth and urban land availability issues. Public open and green spaces are a great highlight from literature which will be further discussed in the following section related to Sri Lankan context. Road network and traffic planning were spotlighted in international literature which is an eye-opener for the Sri Lankan authorities. Participatory approach can help putting up correct infrastructure at correct places according to the actual needs of the community.

2.2.4 Capacity Building of Human Resources

Capacity Building of Human Resources has been identified as a major contributor for Tsunami resilient urban planning. Literacy and level of education and awareness affects the emergency control and rate of adaptation of response plans. According to literature past case studies should be readily available for vulnerable communities. Disaster education at the school level, local-level public education and awareness programs, enhancement of information management systems and improved coordination and communication mechanisms within the system of disaster management are some major highlighted aspects in literature. Table 7 lists the strategies and concepts found from literature under this subcategory.

Table 7: Strategies from Literature under "Capacity Building of Human Resources"

Education and Awareness	**Facilities**	**Community Engagement**
Learning through case studies	Communication facilities	Participatory risk zone planning into urban planning
Awareness and information sharing	First aid	Institutional Collaboration
Drills	Backup power system	Recognition and Rewarding
Education at school level	Health and Sanitation	Information Management Systems
	Transport facilities	

According to [44], educational sessions carried out via general sources to disseminate basic information (e.g., use of pamphlets, mass media etc.) are not much effective. Hence alternative approaches to hazard education such as use of art and media is recommended. Eg: Playing Street drams, short-films, theatrics, and creative flyers on social media convey the same information through much sensitive channels such as music and visual impressions. This especially works better for younger generation. Centers can be created for the awareness on tsunami preparedness (permanent/ mobile) that are dedicated to transmitting information to the public. The establishment of Museums in the remembrance of Natural Catastrophes of the nation or the declaration of existing museums to a particular hazard to disseminate experience-based knowledge on preparedness is also advised [45].

describe three main aspects for a preparedness strategy to be successful. Alarmingly most of them are related to the human resources.

- information content (e.g., outcome expectancy)
- social context (community participation, problem solving)
- community-agency relationship (empowerment, trust) factors

Strategies should consider their beliefs on outcome expectancy. For instance, some believe that the consequences of an uncontrollable event like Tsunami are also uncontrollable. Hence, the information shared should help such people understand the difference between uncontrollable causes and controllable consequences. The ways and means of managing hazard consequences should be emphasized.

2.2.5 Emergency Response and Evacuation Planning

Emergency and Evacuation planning are major aspects of disaster response planning. Even though the response stage comes after a disaster, planning for response is still crucial under preparedness. Table 8 lists the strategies and concepts found from literature under this subcategory.

Table 8: Strategies from Literature under "Emergency Response and Evacuation Planning"

Evacuation maps, routes, and signage	**Emergency needs**	**Evacuation shelters**
Evacuation routes	Disable communities	Vertical shelters
Emergency pathways along the sidewalks	Basic facilities	Horizontal shelters
Display places	First aid	Social infrastructure facilities, safe assembly areas
Drills		Public open spaces

Referred literature contained the information on Tsunami drills and suggested means of conducting them. Ideally, tsunami drills are advised to take place at the nighttime too and

under different climatic conditions. The drill in Mawella, Sri Lanka was initiated with mobile sirens and final instructions were aired with it. As anticipated, no panic was observed among the residents and the success rate was computed to be 80% [46]. Contrary to the drills, Many negative impacts on society can be triggered through false alarms such as reducing public faith and leading to great economic losses. A false alarm in Hawaii that initiated the evacuation of Honolulu on May 7, 1986, costed more than $30 million in for lost salaries and business incomes [47]. Tsunami signage is vital to help community see the risk and ideal ways to respond to tsunami warnings. They display knowledge on characteristics of a Tsunami and the recommended response patterns and escape routes, etc. They are recommended to be located very visibly on public access roads to beaches or to waterfronts. They should demonstrate the title, the relevant symbol (i.e., tsunami hazard zone/ evacuation route/evacuation zone/ or other), with the name of the Local Authority. Figure 23 shows common Tsunami signage.

Figure 23: Common Tsunami Signage

In evacuation maps, inundation boundaries for local and distant tsunamis should be exhibited. Also, different risk zones including the zones that should be subjected to evacuation during a tsunami should be clearly demarcated. This can be prepared with the aid of- geological signs (allowing for the maximum run-up and a safety buffer) and

historical inundation information in the region. Local topography should also be considered [48]. A sample evacuation map is shown in Figure 24.

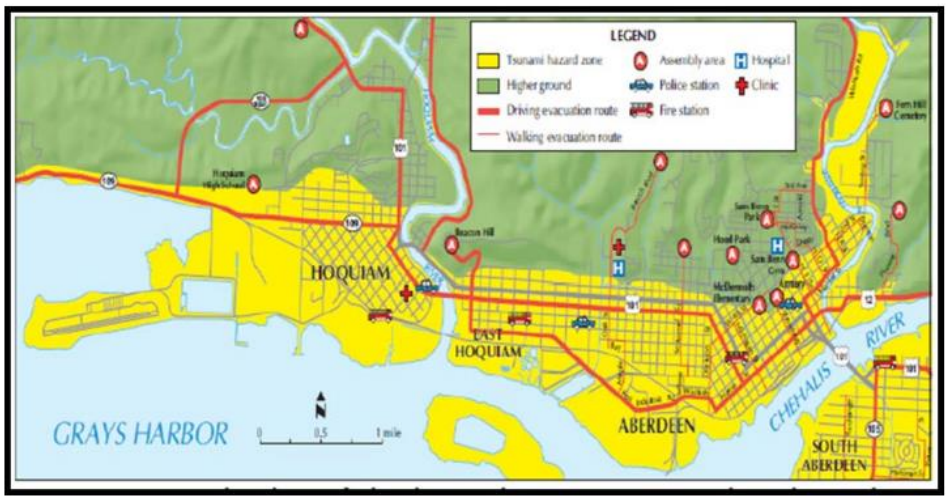


Figure 24: Evacuation map in a brochure of Aberdeen and Hoquiam counties along the Washington coast

The following must be addressed in evacuation route planning and producing evacuation maps.

- An accurate description of the transportation infrastructure, most notably the highway network.
- An accurate description of the spatial distribution of population, by time of day and type of activity.
- An accurate representation of vehicle utilization during an emergency of the type under consideration.
- An accurate representation of the timing of people's response to the emergency, and how this timing varies by a person's location and current activity at the time he/she finds out about the threat.
- An accurate representation of evacuation route and destination selection behavior. f. an accurate representation of any traffic management controls that may be incorporated within the evacuation plan.
- An accurate representation of any non-evacuation based protective actions (e.g., in situ sheltering) taken by significant population subgroups within the at-risk area.

Major steps in evacuation planning are as follows.

- A traffic generation sub-model
- A traffic departure time (often termed a traffic loading rate or traffic mobilization) sub-model

- A destination selection sub-model
- A traffic route selection (often termed a traffic route assignment) sub-model
- A user specified plan set-up, analysis, and revision procedure.

There are two commonly used evacuation practices.

1. Horizontal Evacuation on hills
2. Evacuation buildings (VEB)

Figure 25 shows vertical evacuation buildings [49]

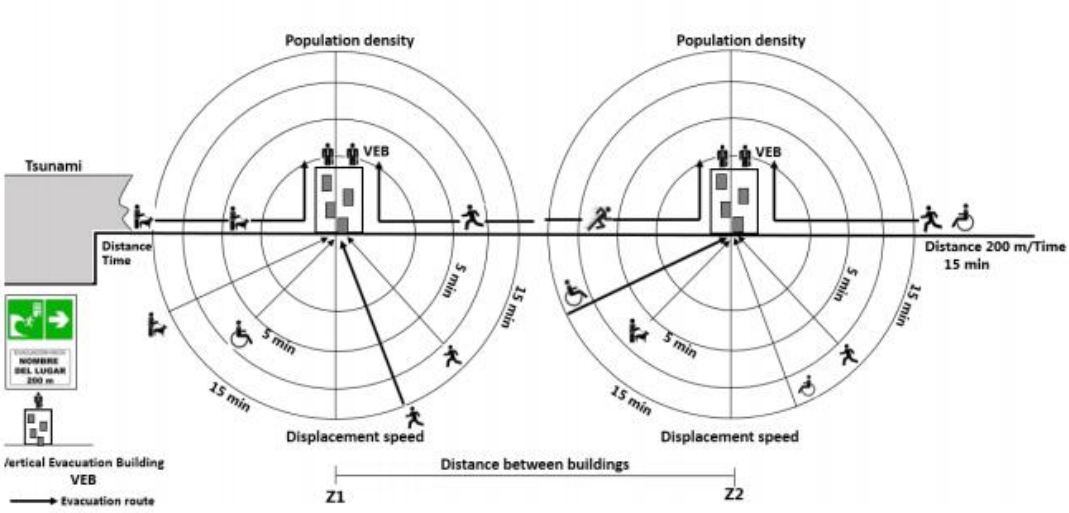


Figure 25: Vertical Evacuation Buildings

The design of a vertical evacuation center should consider,

- Geographical condition of area
- Tsunami evacuation route
- Population density, community settlement format
- Maximum run-up height recorded in the past tsunami events

Also, a rectangular layout is generally preferred over L-shape or irregular shape as shown in Figure 26.

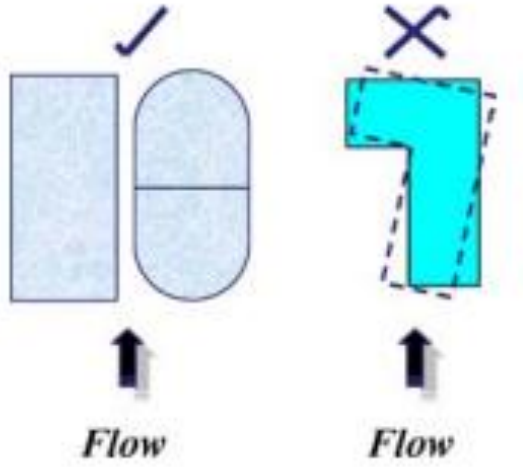


Figure 26: Suggested building configuration for an evacuation center

Cast in-situ reinforced concrete slabs are recommended over prefabricated slabs to maintain the monolithic nature that facilitates the floor to act as a rigid diaphragm that transfers lateral forces to all lateral force resisting elements. Pile foundation is preferable for the shelter building to withstand lateral loads. When designing the pile foundation, the additional free length of pile generated from the soil scouring below the base of footing should be considered [50].

Access to clean water and sanitation and storage of adequate first aid at buildings and evacuation shelters are also important aspects according to literature. Rescue of disabled communities is also a separately discussed topic in literature.

2.2.6 Structural and Nonstructural Interventions

According to literature and experts, the most intelligent and conservative option is not to isolate the coastline but to design incorporating structural and non- structural interventions.

Table 9 lists the strategies and concepts found from literature under this subcategory.

Table 9 : Strategies from Literature under " Structural and Non-Structural Interventions"

Structural Measures	**Non-Structural Measures**	**Nature Based Solutions**
Coastal protection structures Seawalls Engineered Tsunami barriers and gates Levees	Environmental Impact Assessment	Sand dunes
Special architectural features and structural measures in buildings	Erosion and sedimentation control	mangroves
Hazard resilient construction material	hydrological arrangements/drainage methods	Coastal forests
Structural health monitoring of buildings	Beach nourishment	
Critical infrastructure planning	Waste management systems	

Different countries have adopted various structural measures where Sri Lanka has not advanced yet from the basic breakwaters.

1. Australia

Australia's coastal zone extends more than 5 km inland from the coast and the land level is 10 m below mean sea level.

Building restrictions in the Coastal Plan for Queensland: The Coastal Policy Plan aims at limiting and regulating the development footprint in the coastal zone by restricting development to infill, redevelopment of existing urban areas and allowing only coastal-dependent development in other areas [51].

2. Japan

- Seawalls

Figure 27 shows a sea wall with stairway evacuation route used to protect a coastal town against tsunami inundation in Japan [52].

Figure 27: a Seawall in Japan

- Elevated shelters

Figure 28 shows an elevated shelter in Japan.

Figure 28: an elevated shelter at Shirahama, Tokushima Prefecture, Japan

- Tsunami refuge built in reinforced concrete

Figure 29 shows a large Tsunami tower made from reinforced concrete.

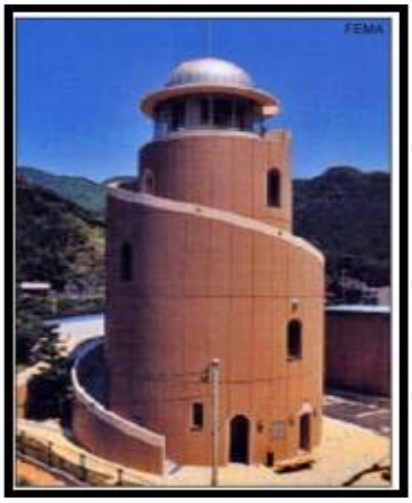


Figure 29: Nishiki Tower in the town of Nishiki, Mie Prefecture, Japan

- Water gates

Figure 30 shows a water gate in Japan. The gate automatically closes within seconds after a shake due to an earthquake triggers its seismic sensors.

Figure 30: Water Gates, Okushiri Island, Japan. [53]

3. India

India has focused on construction of sea walls or beach protection measures

- Shelter belt development
- Mangrove plantations along the coastline

Also New legislation was brought out to enlarge the Coastal Reserve Zones and its area of influence to coastal stretches of seas, estuaries, bays, creeks, backwaters, and rivers which can be affected by the tides on the landward side (up to 500 meters from the high tide line and the land between the low and high tide line) [54].

4. Thailand

Following are some non-structural measures followed in Thailand.

- Integrated coastal zone management plan which is site specific to cater the needs of coastal communities.
- Natural bio shields which mitigate the impact to people and property from Tsunamis [55].

In research in Thailand coastal communities have been divided into three categories.

1. tourism community
2. local densely populated community
3. individual resort community.

The research shows that the requirement of constructing a new evacuation shelter or retrofitting an existing structure for tsunami resistance can be decided from the settlement patterns [50].

If the target area has strong existing structures, it is possible to retrofit the structures to function as tsunami shelter.

The construction of simple raised platforms as temporary shelters is recommended for the areas with low density population since there are no strong buildings (Eg: an individual resort) [50].

Nature-based solutions are also a recent focused area of many coastal countries where protection of sand dunes, mangroves and coastal forests are involved.

2.3 Local Scholarly Articles

A literature survey was carried out in the form of a systematic review using Google Scholar and Science Direct databases. Using the keywords, Sustainable Urban Planning; Tsunami Preparedness Measures; Sri Lankan Policy Frameworks and Guidelines; Resilient Cities. The scholarly articles written in English language during the period 2004-2021 were only selected for the initial search. After removing the duplications, the inclusion and exclusion criteria 1 listed in Table 10 were applied resulting in 35 retrieved articles. Then 13 more articles were excluded by applying the exclusion criteria 2 and during the data extraction. 22 articles retained for the study from this search. The Prisma flow diagram followed in the process is shown in Figure 31.

Table 10: Inclusion and Exclusion Criteria

	Inclusion	**Exclusion**
Criterion 1	Original studies and Reviews	Not based on Sri Lanka
Criterion 2	Articles and Book chapters	General disaster preparedness/ not specific for Tsunamis
Criterion 3		Post- Tsunami/ Recovery stage

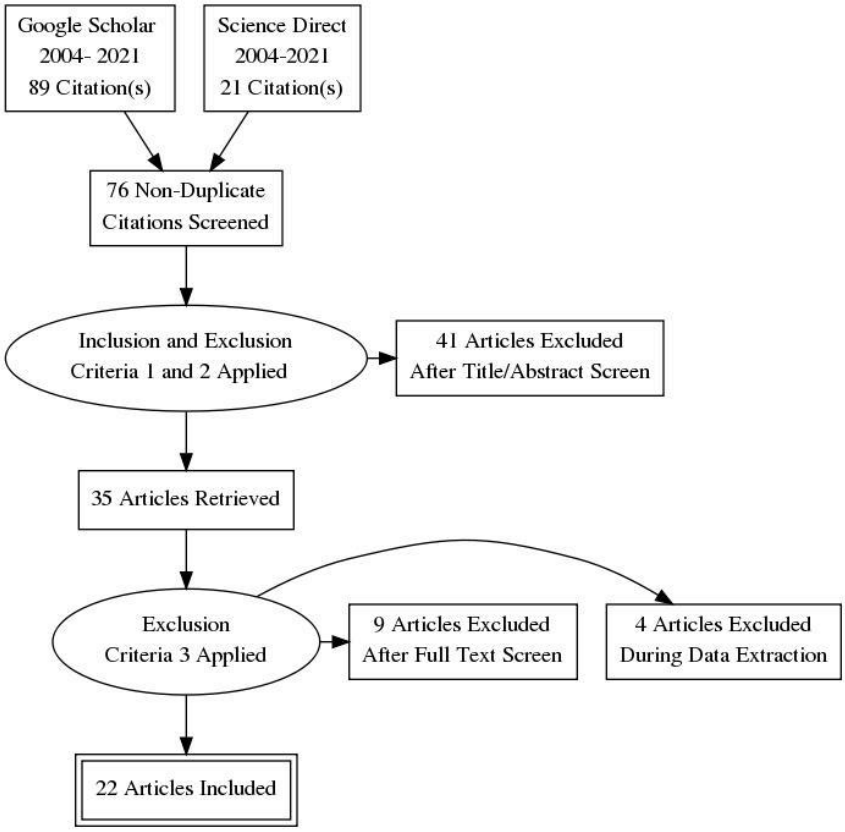


Figure 31: Prisma Flow Diagram of the Systematic Review

First, the feasible urban planning techniques and potential strategies to reduce Tsunami risk in Sri Lankan coastal cities were identified referring the 22 articles. These articles were based on research carried out in Sri Lanka, mostly by the local researchers to suggest the strategies for future urban planning in Sri Lanka in regard to Tsunami preparedness.

Key aspects discussed in the reviewed scholarly articles and the recommendations and feasible strategies to Sri Lanka suggested by them are listed in Table 11.

Table 11: Recommended strategies in literature to incorporate into urban planning in Sri Lanka

Key aspect	**Recommendation**	**Source**
Inundation modeling and vulnerability assessments	Understanding possible vulnerable areas of future tsunamis to prepare and implement disaster mitigation and management plans Use of dashboard tools for wave propagation modelling Inundation Modelling with primary considerations as inundation depth and recommended story heights	[56] [57]
Bathymetric assessments	Continuous Assessment of bathymetric changes that have taken place in near shore areas	[58]
Evacuation	Availability and functionality of the vertical and horizontal tsunami evacuation facilities with safe evacuation routes	[57]
Awareness	Increasing and monitoring continuous awareness of the exposed population	[59]
Design of buildings	Overall design guidelines providing advice on location, layout, orientation, structural configuration, geotechnical and other considerations. Detailed design guidelines leading to hydraulic and structural loads and geotechnical issues	[58]
Public Open Spaces (POS)	The locations of POS according to risk zonation Terrain quality and the Topographic characters guided allocation Determining the DRR use based on the location and size of POS Multipurpose uses of POS Networking of POS as a DRR Passage Network of public open spaces linked with green corridors	[60] [61]

The above aspects were grouped into 6 main parameters/indicators and were selected as the parameters defining Tsunami and multihazard preparedness in coastal cities.

1. Pre-Planning and Development
2. Capacity Building of human resources
3. Spatial and Infrastructure Planning
4. Emergency and Evacuation Planning
5. Structural and Nonstructural Interventions

2.4 Review of Local Urban Planning Frameworks

Six prevailing urban planning frameworks and related manuals in the country were studied to identify their focus areas and the current level of inclusion of tsunami and other coastal hazard preparedness and mitigation strategies in their guidelines Figure 32 shows the local frameworks referred.

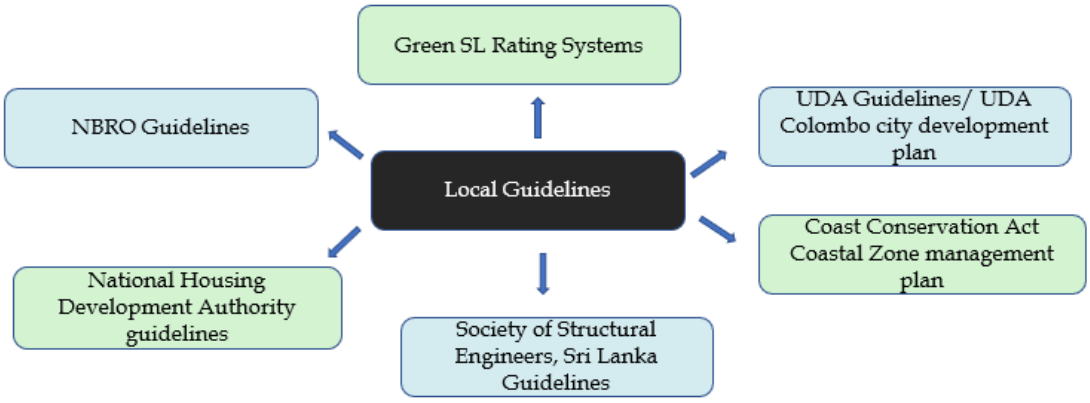


Figure 32: Sri Lankan frameworks for urban planning

2.4.1 Urban Development Authority (UDA) Frameworks and Guidelines

The Urban Development Authority Law, No. 41 of 1978 of the National State Assembly governs the Regulations made by the Minister of Urban Development and Housing and it recently underwent a revision, and the regulation will be cited as the Urban Development Authority Planning & Development Regulations 2020 henceforth. Even though it has introduced its own Green Rating System to assess buildings for the implementation of sustainable and green measures, neither the rating system nor the general guidelines include measures to reduce tsunami or coastal hazard risks.

The absence of any kind of disaster preparedness measure apart from the fire protection measures in the Urban Development Authority guidelines for city development is depicted in the Figure 33 where the aspects in red highlights the areas where Tsunami and multihazard preparedness measures could have been incorporated.

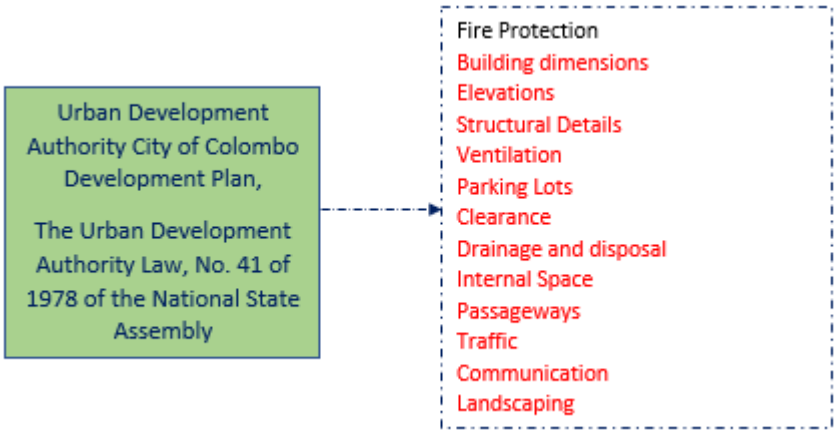


Figure 33: Gaps in integration of DRR aspects to Urban Development Authority guidelines

In its one guideline it provides reference from an NBRO guideline and states the following.

"The National Building Research Organization does not grant approval for any buildings to be constructed in this zone with a slope of 31 -45 degrees"

2.4.2 National Building and Research Organization (NBRO) Guidelines

As shown in Figure 34 some Tsunami resilient building planning aspects have been demonstrated in NBRO guidelines in terms of site selection, shape and orientation of buildings, design of the structure and also the external adjoining structures to the buildings.

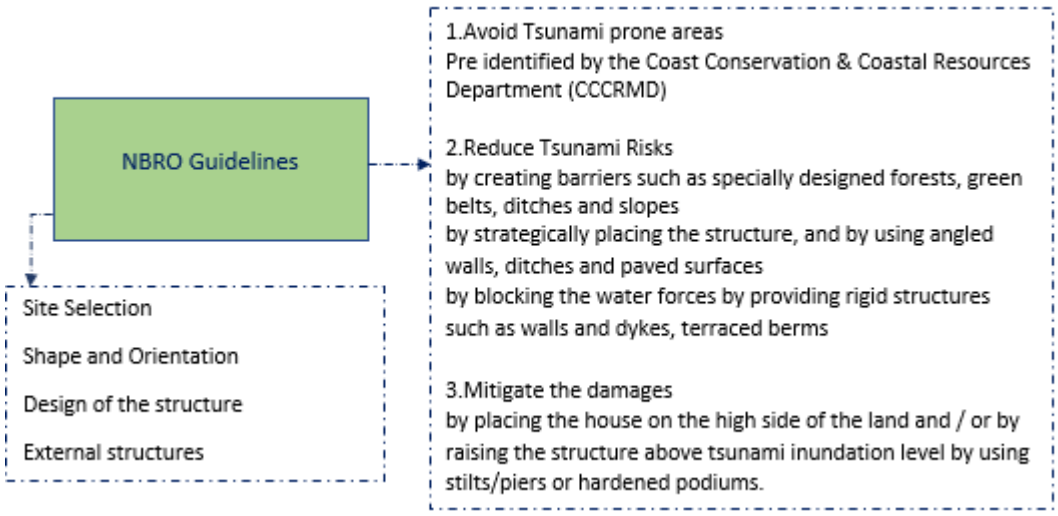
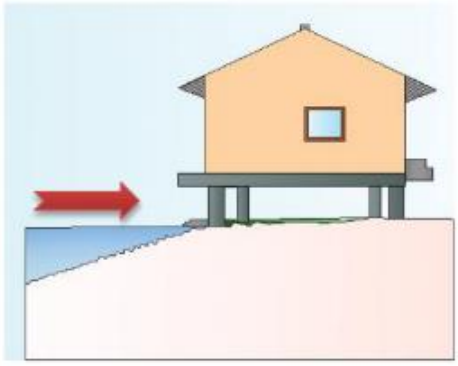


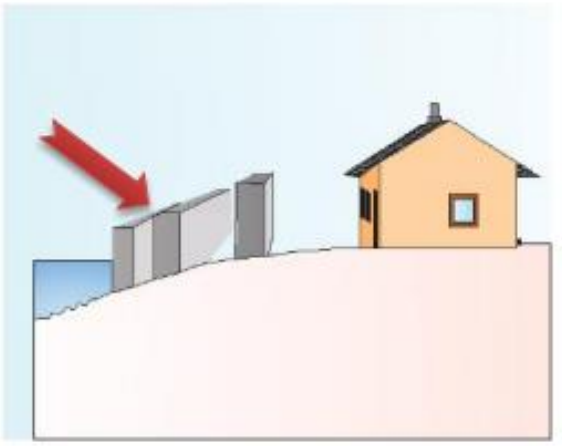
Figure 34: Tsunami and coastal hazard preparedness aspects in NBRO guidelines

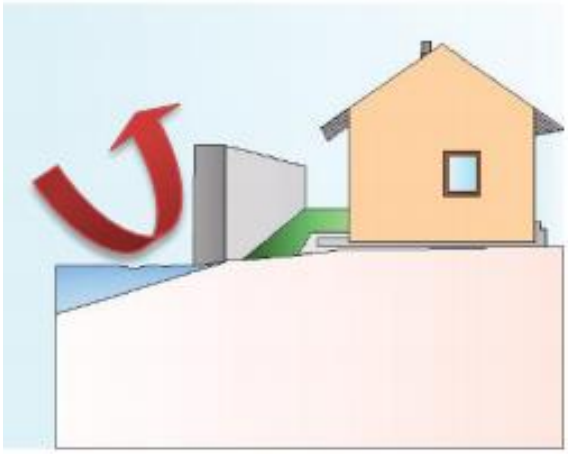
Table 12 summarizes the measures/ guidelines they recommend under the above 4 main aspects.

Table 12: Summary of NBRO guidelines for Tsunami and other hazard preparedness

Site Selection	• Buildings should be located to avoid the coastal reservation area and restricted zones • Locations near rivers and waterways, lagoons, and bays etc., connected to the sea and along which the tsunami waves could reach the land shall be avoided • The site should be such that the houses could be located on a high ground desirably well above the possible tsunami inundation level. If the ground is sloping towards the sea, locate the house on the higher side of the land. When siting on sufficiently high ground is not possible, the house may be constructed on stilts or on created high ground made up of thoroughly compacted earthen embankment.

	• Ground should have suitable bearing stratum to construct stable foundations and the sub-soils must not be prone to failure in bearing capacity that may be caused by sudden rise in pore water pressure in the soil.  Locate above the Inundation level
Shape and Orientation	• Use simple shapes • Orient the house with its shorter side facing the direction of tsunami waves as much as possible  Shapes desirable Shapes practical
Design of the Structure	• The design of tsunami resilient house shall be done on professional advice of a qualified engineer who should address various forces and expected conditions associated with tsunami currents and waves, water pressures, buoyancy, ground shaking due to earthquake or tremors, debris impact, scour, erosion, ground failure and fire. • A heavy steel framed structures - Ideal but costly and corrosive Therefore, confined concrete masonry structures are recommended. • If constructed on raised ground, embankments must be designed to streamline the flow of tsunami currents and all its sides shall be well protected against possible scour, erosion and being carried away by wave forces. • House on stilts/columns have the advantage that the underside can be used for non-occupancy purposes such as a garage or space where human activities are minimal.

	• If constructed on stilts/columns they shall be robust and adequately braced against overturning and properly anchored into the ground through a stable foundation or piles to prevent lifting. The columns shall be designed and constructed to withstand the seismic forces too. • If the house to be constructed on ground within reach of tsunami waves, provision shall be made to divert the water currents away from the house using barriers. Lower floor may be so designed to allow the water to flow freely across the house through wall openings placed in line with each other to minimize forces acting on the walls. • Use internal cross walls perpendicular to the walls facing the sea or the tsunami waves. • Floor slab shall be designed to withstand warping and lifting under buoyant pressures
	• Shallow foundations shall be founded on suitable bearing stratum but well below possible scour level. Possibilities of liquefaction shall also be taken into consideration in the design of foundation. • It is desirable to provide an apron around the house to minimize erosion and undermining of foundations  Slow down water currents using barriers

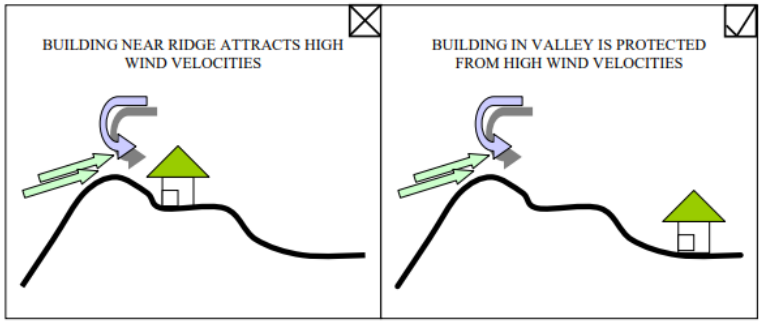
	 Block the water force
External Structures	• To prevent exterior structures such as boundary walls, water towers from damage or collapsing which can also produce waterborne debris, they shall be structurally strengthened and anchored to stable foundations. • Boundary walls- Brace in two directions with reinforced concrete columns and beams • Water Tanks- If elevated, construct on reinforced and braced concrete columns. Circular shape would be more suitable for ground tanks.

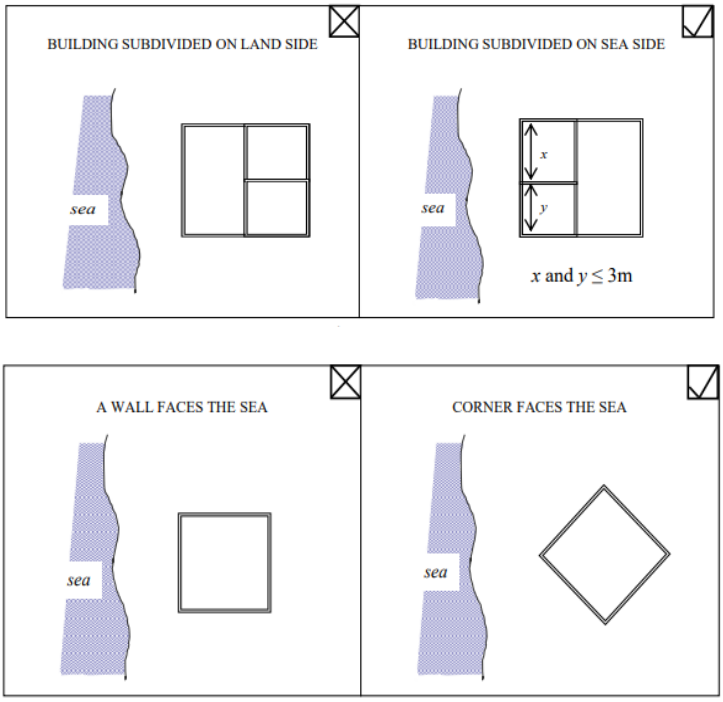
2.4.3 Guidelines of Society of Structural Engineers Sri Lanka

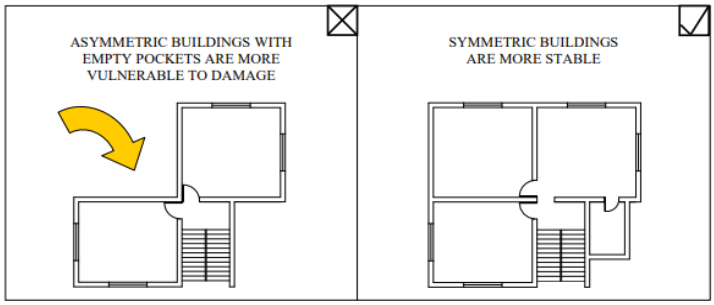
Guidelines for buildings at risk from natural disasters by Society of Structural Engineers Sri Lanka came about as a response to the tsunami of 26/12/2004 and as a cooperation to the reconstruction process. It discusses the following aspects shown in Table 13 regarding Tsunami resilient housing construction. According to the framework, buildings located within 500 m from the coastline or an elevation of 3m from the mean sea level (which is called as the "Coastal Zone") have to be designed adhering to the given guidelines; the above boundaries are generally mentioned as "1 km of the coastline or 5 m elevation from mean sea level" for the East Coast. However, the scope is limited to the structural measures for buildings.

Table 13: Highlights of Guidelines of SSESL for Tsunami and other coastal hazard preparedness

Design against natural disasters	• The introduction of steel reinforcement into the building envelope for buildings not to fall under gravity, buildings subject to cyclones, flooding and earthquakes must be prevented from being pushed sideways and lifted off upwards. • For resistance against cyclones and flooding, it is desirable to increase the weight of structures, contrary to the usual imperative to reduce weight for economic reasons.
General Principles	• The building must be held down to the foundation. Hence at least 4 reinforced concrete columns at the four corners of the building are required. The following are specified. ✓ Column cross section dimensions ✓ Reinforcement details ✓ Construction Techniques • Foundation types and details • Roof beam details • Roof band details • Lintel band details • The slope of the roof should be at least 22-30^{o}, to minimize wind uplift. • Ideal roofing material/sheets • Concrete grade selection
Siting of Buildings	• Buildings should not be constructed on the shore itself. • Buildings should not be constructed in areas that are below sea level, especially within the Coastal Zone. • Areas behind mounds or vegetation are preferred in order to provide natural shielding.

	  • The Coastal Zone may suffer from flooding due both to storm surges and tsunamis. Site selection should avoid areas likely to be submerged. It is desirable to locate the site such that it is at least 100 m from the shore (200 m on the East Coast) b. 3 m above Mean Sea Level. • The sites need to be close to the original settlement. It should preferably be within a distance of 1 km from the original settlement so as to facilitate the livelihoods of fishermen and the schooling of children. • Buildings should be located via stable foundations on soil strata having no susceptibility for liquefaction due to flooding.
Planning aspects	• The plinth area of each dwelling unit is specified • Wherever possible sea facing walls should be braced by cross walls, so that the length of unsupported wall does not exceed 3 m. • Large openings on the seaward side should be avoided. • For individual buildings, a circular or polygonal plan shape is preferred over rectangle or square plans, but from the viewpoint of functional efficiency a square plan form is desirable. • A symmetrical building about both axes with a compact plan-form is more stable than a zigzag plan, having empty pockets. • The buildings should be oriented in such a manner that the

	shorter span length of the wall faces the sea • The aspect ratio of the building (length to width ratio of the building) should not be greater than 3. • Ornamental architecture involving vertical or horizontal cantilever projections, fascias etc. should be avoided. • In the case of locating a group of buildings, a cluster arrangement should be chosen in preference to row type buildings, for resistance to cyclones; the opposite would be true for flood waters and tsunamis, which would be diverted through the gaps between rows. • Also, clear paths should be identified for evacuation to high ground or to a community building. • If possible, buildings should be constructed so that a corner rather than a wall faces the sea 

	
Walls	• Walls should be made as heavy as possible; if hollow blocks are used, they should be at least 200 mm thick, and if 100 mm thick walls are used, they should be of solid blockwork or brickwork. • Thermal insulation of walls • Rain protection of walls

Apart from the above some specifications on roofs, doors, openings, and foundations have been listed. However, the above guidelines are specifically for the construction of single-story buildings which may not be supported by structural design calculations. Also, guidelines mainly address the conventional building technology; except for the fact that underlying principles can be applied to any existing technology. Multi-story buildings can be erected after conducting structural engineering designs. With the aid of structural drawings any assessment of the building can be conducted in future.

2.4.4 Coastal Conservation Act and Coastal Zone Management Plan

Coast Conservation act, 1981 along with the coastal zone management plan only seems to bring out the nature-based solutions for the protection of coast minimizing the erosion and other issues in beaches where most of the measures indirectly contribute to Tsunami and coastal hazards prevention. (Figure 35)

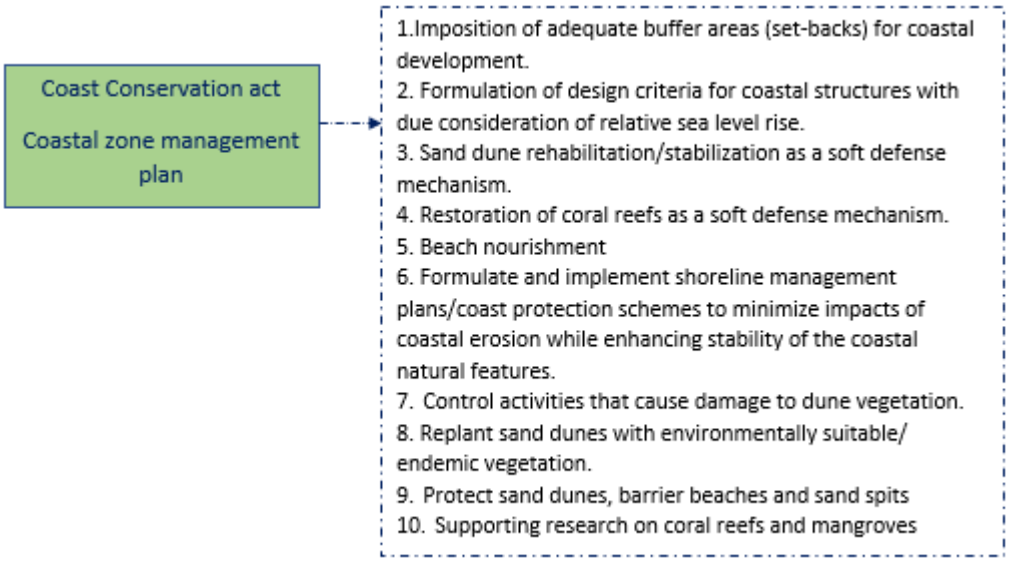


Figure 35: Tsunami and other coastal hazard prevention aspects highlighted in Coast Conservation Act

2.4.5 Guidelines of National Housing Development Authority, Sri Lanka

Guidelines for housing development in coastal Sri Lanka brings out statutory requirements and best practice guides to

- Planning of settlements
- Housing design
- Provision for services

For hazard preparedness in general.

Table 14 shows the buffer zone requirements imposed by the framework.

Table 14: Buffer zone requirements

Location	Activity	Permit required from	
		Director, CCD	Divisional Secretary
Coastal zone (Landward of setback line)	Dwelling houses	> 1,500 ft² (162m²)	< 1,500 ft² (162m²)
Coastal zone (Landward of setback line)	Extension to dwelling houses	> 1,500 ft² (162m²)	< 1,500 ft² (162m²)
Coastal zone (Landward of setback line)	Commercial structures	> 350 ft² (32.5m²)	< 350 ft² (32.5m²)
Coastal zone (Landward of setback line)	Other structures	-- Director, CCD only --	
Within setback Restricted area	Tsunami reconstruction	-- Director, CCD only --	
Within setback Restricted area	Temporary structures	-- Director, CCD only --	

Source: Modified from Table 8.1 of CZMP, 2004, p. 8-4.

This framework further specifies on the following aspects highlighted in Table 15 but seems to provide reference from the UDA guidelines instead of bringing out its own criteria as requirements.

Table 15: Highlights of Guidelines of National Housing Development Authority for Tsunami and other coastal hazard preparedness

Selection of Site	• The land should be at least 3m above the Mean High-Water Line.
Planning of Settlements	• General Settlement planning requirements by the UDA
Plot size and Coverage	• General Plot size requirements by the UDA
Provision for Roads	• General regulations by UDA based on the number of housing plots in a given sub-division.
Parking	• UDA Guidelines Recommended parking = 3 for every 3 housing units.
Means of Evacuation	• Evacuation paths and points should be considered when preparing layouts within the

	vulnerable areas. Evacuation paths should be opposite & perpendicular to the sea and clearly demarcated in the layout.
Spatial Aspects	• General UDA regulations for internal spaces
Structural Considerations	• British Standard Code of Practice – BSCP • Institute for Construction Training and Development - ICTAD specifications • For disaster prone areas (floods, cyclones, earthquakes, and tsunamis) • Best practices in material use
Post Tsunami Observation And Best social Practices Community centered planning	• Participatory approach – general introduction

2.4.6 GreenSL Rating Systems

Figure 36 shows the current level of inclusion of disaster risk reduction measures in the GreenSL rating systems. Both the GreenSL rating systems for Built Environment and Transportation Infrastructure lacks measures for prevention and preparedness for any kind of natural hazard while the GreenSL rating system for Sustainable Cities address few aspects for general disaster resilience. However, the integration of Tsunami and other multihazard (including the pandemics) preparedness into thee rating systems, is vital. Also, a separate rating system can be introduced for coastal zones if addition of Tsunami prevention measures to the general building and city tool might cause unnecessary point reduction in unaffected areas.

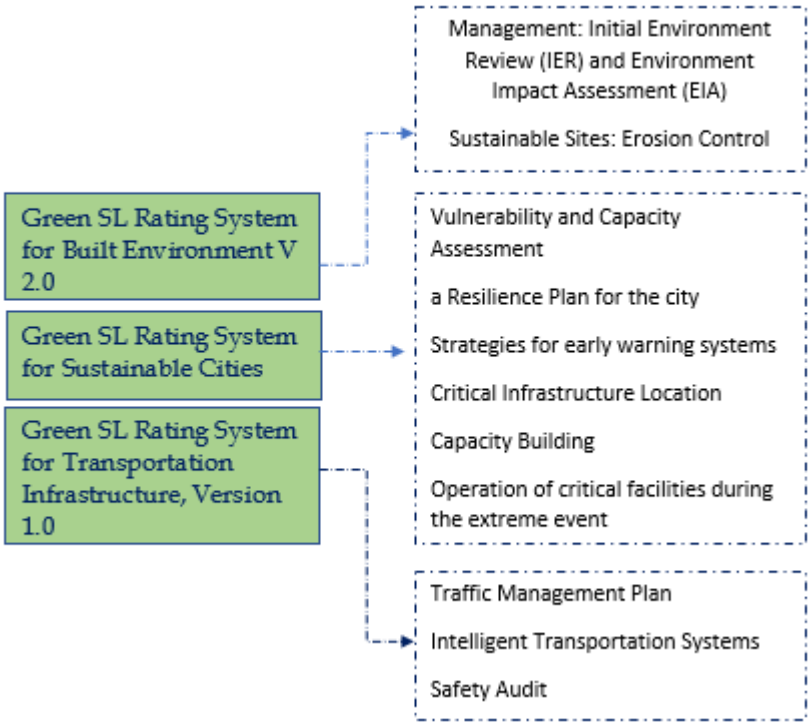


Figure 36: General Disaster Risk Reduction aspects in the GreenSL Rating systems

After Analyzing the local literature referred under section 2.3 and their considered aspects regarding Tsunami and multihazard preparedness in Tsunami prone areas, when moved on to analyze the consideration of above aspects to the actual planning context in Sri Lanka the following comparison shown in Table 16 can be reached.

Table 16: Comparison of aspects highlighted in research and actual planning policies

Aspects highlighted in Research	**Actual Frameworks/ Policies**
Modelling and Assessments	Not recommended
Spatial Planning for Disaster response	General Spatial Planning requirements by UDA and NHDA (not specified for disasters)
Land use planning for risk mitigation	General Spatial Planning requirements by UDA and NHDA (not specified for disasters)
Public awareness/ stakeholders	Participatory (community) approach recommended in NHDA Guidelines

	Sri Lanka National Disaster Management Plan does not recommend multi stakeholder engagement Coordination between different authorities is lacking. • Planning and policy making through DMC and some other organizations – government acts through coastal conservation dept. etc.) • Early warning through Meteorological Dept. • Enforcing and Response mechanisms through Local Authorities • Non-legally binding guidelines and manuals by several other parties
Design of buildings	Recommended in SSESL Guidelines /NBRO Guidelines No building code
Design of City Infrastructure	Not recommended in any
Vegetation and other soft measures	Specific plantation schemes not recommended in any
Protection of natural buffers	Coast Conservation Act
Buffer zones and legal compliance/ permits	Coast Conservation Act / UDA general guidelines Clearance from Costal Conservation Department and UDA/Local Authority (NBRO requirements are not legally binding for coastal districts Compliance required only for landslides)
Resilience Approaches (Build Back Better)	Sri Lanka National Disaster Management Policy (governed by Disaster Management Act No 13) has removed Build Back Better aspect in its final version (2014)
Multi-hazard Aspect	Only multihazard early warning is highlighted in National Disaster Management Plan (2017)

Urban planning frameworks shown in Table 17 confirms that some important aspects have been brushed aside in most of the local codes while the prominence have been given to the structural aspects of the preparedness measures. In green colour cells, the current

inclusion of measures is indicated as the darker color shows the deeper integration and the blank cells indicate the absence of any measure under the given aspect. In red colour are the major aspects neglected in the frameworks and aspects for improvements.

Table 17: Current level of integration of Tsunami and Multihazard Preparedness in Sri Lankan frameworks

Framework	Pre-planning and development	Capacity building of human resources	Structural and non-structural interventions	Spatial and Infrastructure Planning	Emergency and Evacuation Planning
Urban Development Authority (UDA) Guidelines			Building dimensions ,Elevations ,Structural Details, Parking Lots ,Clearance, Internal Space, Passageways		
NBRO Guidelines	Traffic, Communication and other facilities related measures				
Guidelines of Society of Structural Engineers Sri Lanka					
Coastal Conservation Act and Coastal Zone Management Plan					
Guidelines of National Housing Development Authority, Sri Lanka					
GreenSL Rating System for Cities					Operation of critical facilities during the extreme event

3 EXPERT OPINION SURVEY

A series of in-depth interviews were conducted with 12 experts from the related fields to compare and contrast the above findings from literature survey regarding the Sri Lankan present context. Interviews were conducted in the form of semi structured interviews. (Questionnaire is attached as Annexure 1)

Table 18 lists the experts involved in the survey and their expertise areas.

Table 18: Specialization Areas of Experts

Expert No:	**Specialized Areas**
1	Civil Engineering
2	Disaster Management
3	Structural Engineering, Disaster Management, Green building
4	Civil Engineering, Disaster Management, Sustainable Built Environment
5	Architecture, Town Planning
6	Structural Engineering
7	Architecture, Town Planning
8	Architecture, Town Planning
9	Architecture, Town Planning, Disaster Management
10	Town Planning, Building Services, Environmental Management
11	Town Planning, Architecture
12	Disaster Management

Interviews were conducted to explore systemic risk and cascading impacts, and the constraints and pathways to mainstreaming disaster risk reduction into urban planning at the national to local levels. These interviews were an opportunity to explore beyond the literature and allow additional concepts, themes, and areas of analysis to be discovered. The focus group in Sri Lanka was used to examine further and validate the findings from the interviews, while also providing an opportunity to clarify issues and ensure nothing significant was overlooked. Findings under each main parameter are listed below.

1. Pre-planning and Development
    - Legal requirements: buffer zones have been set by Coastal Conservation Department
    - Guidelines have been brought out under protection of nature-based measures in coastal Zone Management Plan
    - Structural guidelines are presented by SSESL and NBRO in their own manuals
    - Identification of potential hazards through mapping and land use planning are the essential elements of urban planning to mitigate Tsunami risk
    - Elevation, slope, and distance from the sea are the main parameters to be checked at a land suitability analysis
    - Coastal belt should not be isolated but designed and planned with resistive measures
    - Land scarcity, cost, and lack of expertise of Local Authorities are the barriers for proper land suitability and spatial planning
    - Public open spaces are an important element in urban planning and elevation and accessibility to the place should be mainly considered

2. Capacity Building of Human Resources
    - Policies should be prepared by the experts and public should be consulted in the process. (Physical and virtual platforms)
    - Information on previous hazards should be readily available to public. It's not currently happening.
    - Advanced planning and zoning (participatory) should be conducted with improved regulations for coastal zone activities and related industries
    - Sri Lanka lacks the synergy between policy development and enforcement. Enforcement mechanism is very weak
    - Education platforms which facilitate attitude development need to be increased.

3. Spatial and Infrastructure Planning

    - Coastal belt should not be isolated but designed and planned with resistive measures
    - Land scarcity, cost and lack of expertise of Local Authorities are the barriers for proper land suitability and spatial planning
    - Public open spaces are an important element in urban planning and elevation and accessibility to the place should be mainly considered.

4. Emergency and Evacuation Planning
    - Schools, religious places, and community centers should be planned in a higher elevation to cater for evacuation needs.
    - Indigenous knowledge can be incorporated to localized regulations in rural areas.

5. Structural and Non-Structural Interventions
    - Natural streams should be properly utilized, and drainage should be properly planned in order to reduce hazard risk.
    - Legal frameworks to protect beaches and coral reefs should be more stringent
    - Sri Lanka does not need elevated structures and coastal defense structures due to the less frequency of the event and the cost concerns
    - Sri Lanka needs to develop and implement a proper building code with Tsunami and other hazard resilient practices.

For the validation of interview results and to arrive at a consensus, six experts took part in a one and half hour focus group discussion, representing town and country planning, architecture, structural engineering, disaster management, landscape, and geospatial planning, building services, green buildings and infrastructure and environmental management fields. An audio recording of the focus group discussion was analyzed using content analysis. It enabled convergence of the status, good practices and gaps across focus groups and individual interviews, which enhanced trustworthiness of findings.

Findings from the systematic review were cross-referenced, triangulated, and contextualized with expert opinions to deepen the understanding on urban planning strategies in tsunami prone areas while maintaining the theoretical discussion, figuring the research gaps, and bottlenecks through observations from practice. Table 19 presents the gap analysis between global and local literature, current Sri Lankan frameworks and expert opinions.

Table 19: Gap Analysis between Literature, Actual Frameworks and the Expert Opinions

Theme	Level of integration/ Consideration		
	Global and Local Literature	Current frameworks	Expert Opinion
Preplanning and Development	Low	Low	Moderate
Capacity Building of Human Resources	High	Low	High
Spatial and infrastructure Planning	High	Low	High
Emergency and Evacuation Planning	Moderate	Low	Moderate
Structural and nonstructural interventions	Moderate	Low	Moderate

From the gap analysis the main bottlenecks in Sri Lanka for urban planning for Tsunami resilience were identified as shown in Figure 37.

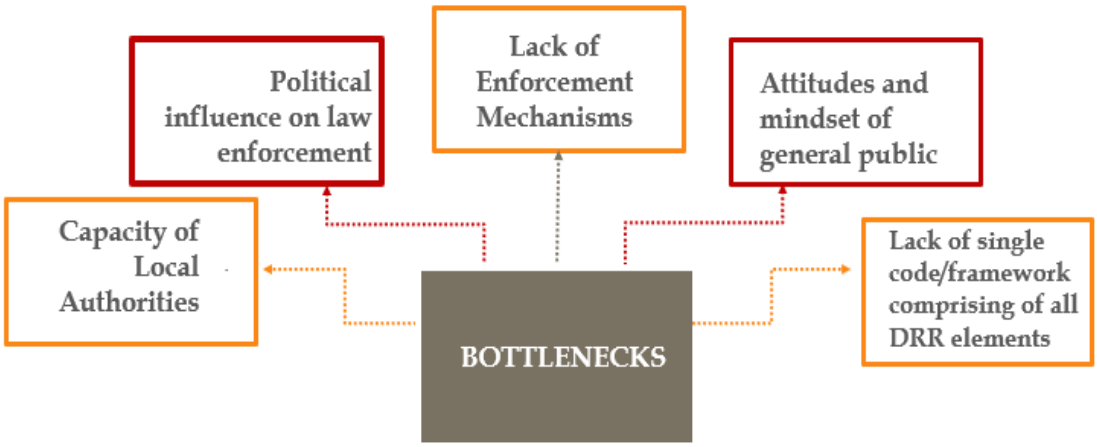


Figure 37: Bottlenecks for Urban Planning for Tsunami Resilience

Capacity of Local Authorities was doubted by several experts relating that as the cause for the ineffective execution of many Tsunamis related measures. For instance, geotechnical engineers, environmentalists and building services officers are required to carry out a proper land suitability analysis before permitting a construction, monitor disturbance to corals and other marine life and beach flora etc. Modern Sri Lankan governments are often condemned by the citizens due to unethical hindrances by the politicians against the enforcement of law. According to experts almost all coastal cities are experiencing disturbances to the execution of land use restrictions/buffer zone guidelines /barriers on certain illegal acts due to the local political leaders who dominate the power of law with their political supremacy. Moreover, Sri Lanka does not demonstrate proper enforcement mechanisms though there are considerable number of laws enacted. Most of the laws are limited to gazettes and books where they are not planned out, implemented, and monitored in the local authority level. In some areas public is not literate and educated enough to understand the long-term benefit of the measures and the risk generated from not following them. Also having a negative mindset towards technology driven efficient systems, more laws and regulations will restrict the growth of a city in terms of resilience. Based on interviews and literature it is well apparent that Sri Lanka has always failed to operate one single DRR code, where many different categories of resilience are addressed in different chapters of different manuals and frameworks by different parties. It will not bring all regulations together making it more difficult for the public to access and follow.

4 CRITERIA INCORPORATION FOR GREENSL RATING SYSTEM FOR SUSTAINABLE CITIES

Next, with the key validated findings from Step 02 and the internationally and locally recommended strategies for Tsunami risk reduction found in Step 01, new criteria development process was started. 4 Delphi surveys were used in order to review the developing criteria to be incorporated in the GreenSL Rating System for Sustainable Cities. The next set of Delphi surveys (4 more surveys) with the same expert committee was used to finalize and incorporate the criteria into the format of the GreenSL Rating System for Sustainable Cities. The steps followed in the incorporation of criteria to GreenSL Rating System for Sustainable Cities are shown in Figure 38.

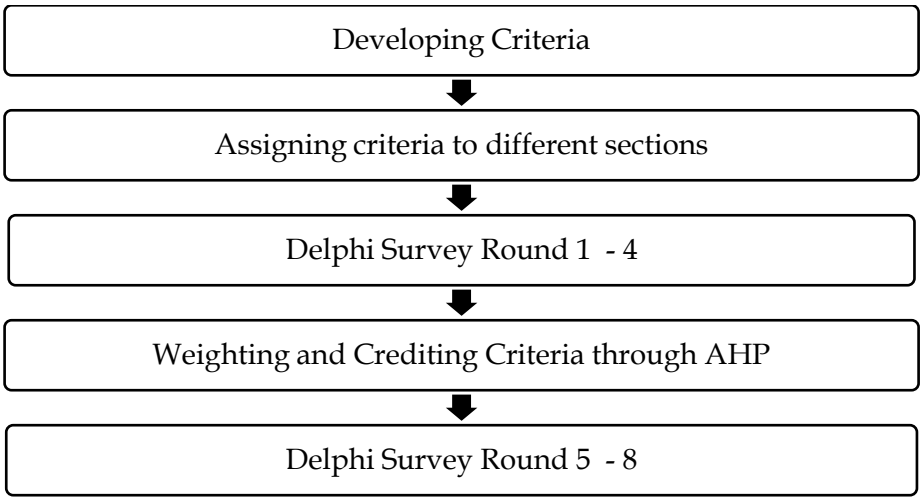


Figure 38: Steps of Incorporating criteria to GreenSL Rating System for Sustainable Cities

The GreenSL Rating System for Sustainable Cities comprises of 9 main categories of which 9 are pre-requisites and 53 are credits as shown in Figure 39.

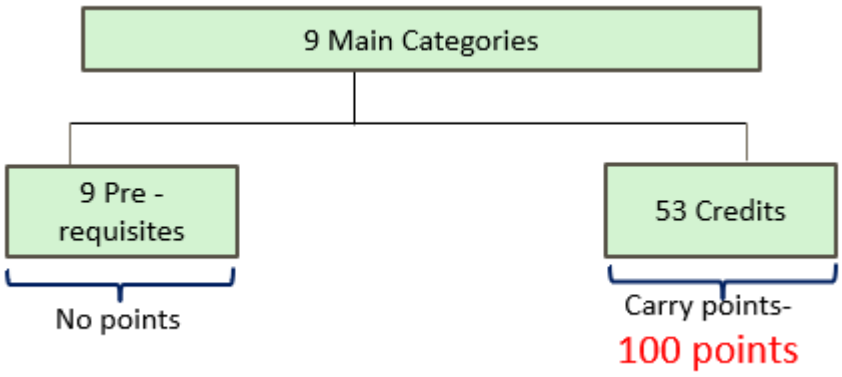


Figure 39: Composition of GreenSL Rating System for Sustainable Cities

According to the points obtained, the projects will be awarded rating as shown in Table 20.

Table 20: Rating of GreenSL Rating System for Sustainable Cities

Points	Rating
40-49	Certified Sustainable City
50-59	Sustainable City Silver
60-75	Sustainable City Gold
75 and above	Sustainable City Platinum

The 9 main categories are as follows.

1. Management
2. Ecology and Conservation
3. Infrastructure Management
4. Waste Management
5. Transport Facilities
6. Water Efficiency
7. Energy and Atmosphere
8. Social and Cultural Consciousness
9. Innovation

The scorecard with pre-requisites and credits is attached as Annexure 1 of this report.

4.1 Development of criteria

The Delphi surveys with the expert committee comprised of 8 members initially focused on developing new criteria. Following identifications and suggestions were made.

- Addition of Waste management Related criteria
- Changes in Submittals
- Watershed management
- Use of two manuals for residential units and commercial buildings
- Changes in submittals
- Utilization of maps
- Erosion prevention measures
- Removal of early warning related criteria
- Additions to submittals
- Funding allocation for DRR
- Incorporate Global Warming
- Facilities for shelters
- Deepening the integration of fire and other hazards
- Monitoring role of the local authorities
- Parking and traffic management criteria
- Road network planning for evacuation needs

After the 1st-4th surveys following new criteria were developed. (The new criteria incorporated Rating System is attached as Annexure 2 of this report.)

Table 21 depicts all newly developed criteria in red under the respective sections of the GreenSL Rating system for Sustainable Cities as “New Credit / New Pre-requisite”. In addition to that, minor and major additions to existing criteria are also listed as “Addition”.

Table 21: Newly developed Tsunami resilience criteria included in the GreenSL Rating system for Sustainable Cities

1.Management

Prerequisite/ Credit	**Requirement/Amendment**
Addition to PR 1 Green Building Accredited Professionals and Commitment	At least 1 of the above professionals should have the Disaster Risk Reduction/ Disaster Management Expertise. The disaster management specialist should participate all site visits and site assessment activities.
Addition to PR 2 Citizen Engagement	Local Information and details on prone natural hazards, risk and risk management strategies are incorporated into public awareness programs and are accessible to general public.
New Prerequisite 3 Emergency Preparedness Information and Instructions Manual	Develop an emergency preparedness information and instructions manual for apartment residents, homeowners, commercial and other buildings, including model emergency operating procedures and a building contact directory which can be used by city residents and commercial occupants in the city
Addition to PR4 Eco vision of the city	Submit extract of Policy Document or Development Plan / Master Plan / Project Report(s) highlighting the Eco-vision of the City as well as goals and implementation strategies for each of the aspects stated above.
Addition to Credit 1.1 Application of Appropriate Technologies and Information & Communications Technology (ICT) Integration	Deployment of ICT Tools to increase the efficiency of data flow in disaster response

Addition to Credit 1.2 Integrated Planning	When planning for new developments in the city the local authority should consult and check the compliance of guidelines recommended for respective potential hazards (landslides, Floods, Cyclones and Tsunamis) by • National Building Research Organization (NBRO) • National Housing Development Authority (NHDA) All developments in a coastal city should comply with the Coastal Conservation Act. (No 57 of 1981)

2.Ecology and Conservation

Prerequisite/ Credit	**Requirement/Amendment**
Addition to PR 1 Assess the existing ecosystem	Investigate the city's unique topographical, environmental, hydrological and other ecological features and produce reference in the form of maps. Identify the availability and protection techniques of sand dunes Identify the availability of mangroves and further development spaces in terms of more land utilization and improved landscaping techniques for Tsunami risk reduction. Where there is limited mangrove cover, the below -mentioned vegetation schemes should be implemented. Recommended species: Casuarina, Cocos, Pandanus, etc., Two layers of vegetation - odoratissimus and equis etifolia in the vertical direction (Pandanus odoratissimus is in the front rows)

Addition to Credit 2.1.2 Accessibility to Public Green and Open Spaces	Public open spaces should be designed to be used as safe evacuation places. For example, the open space network is used as evacuation points and the road network as evacuation rotes which will be linked with the public open spaces for improved access in case of emergency as a DRR passage. Also, public opens spaces are designed with a minimum of physical development to enable their use as a place for gathering in an emergency. Specific design features are introduced to increase the resilience for open public spaces to mitigate the effect from natural disasters, for example, barrier walls to regulate and slow down the waves from a tsunami.
Addition to Credit 2.2 Restore, Rehabilitate and Conserve Natural Resources	Submit a proposal for coral reef restoration / beach nourishment according to the need identified in the "Assess the existing ecosystem" credit - Formulate and implement shoreline management plans/coast protection schemes to minimize impacts of coastal erosion while enhancing stability of the coastal natural features - Proof of availability of legal procedures against sand mining.
Addition to Credit 2.4.1 Vulnerability and Capacity Assessment	A better mapping of a tsunami disaster assessment can be performed. The use of high spatial resolution satellite images and a high resolution of DEMs would also be useful in vulnerability mapping an assessment for a) potential for significant damage b) potential for high disruption c) potential for interactive and collateral damage Landslide Hazard Zonation Maps (NBRO), Flood Hazard Maps of the River Basins (Irrigation Department) The Map of Wind Loading Zones Sri Lanka (NBRO) can be used.

Addition to Credit 2.4.2 Develop a Resilience Plan	Evacuation centers, routes with Proper signage being available. Emergency pathways along the sidewalks should always have a backup power system to light the lighting systems along the evacuation routes during an emergency. Evacuation routes are developed as a part of public transportation systems for emergency management planning which leads to use Pedestrian Paths & Sidewalks as evacuation routes during emergencies and hazards. Early Warning Systems - Strategies for early warning systems and operation of critical facilities during the extreme event and post-event rehabilitation. Demonstrate at least one early warning system in practice. Develop standard operating procedures for traffic management during early warning and emergency situations along with the regular traffic management plan.

3. Infrastructure Management

Prerequisite/ Credit	**Requirement/Amendment**
New Credit 3.7 Disaster Prevention and Resilience	Identify the vulnerability of the road to the following hazards through susceptibility hazard and risk maps, morphology and past records and Implement preventive measures against them prioritizing upon vulnerability. - Landslides - Flood damage - Tsunami Risk
New Credit 3.7.1 Spatial Planning	A zoning overlay should be provided that restricts permitted land use/density in hazardous areas; (special hazard zones or sensitive open space protection zones) Especially The area where the tsunami hazard level is high should be used as open space. The development in the coastal areas should also be oriented rather towards non-settlement development with lower density. The density of land use should be tied to the hazard zoning code. Propose a development plan which abides by the UDA regulations and H&T Ordinance.
New Credit 3.7.2 Resilient Buildings and Infrastructure	A building code is more strictly applied especially for new buildings in the hazard zone. or When planning for new developments in the city the local authority should consult and check the compliance of guidelines recommended for respective potential hazards (landslides, Floods, Cyclones and Tsunamis) by National Building Research Organization (NBRO) National Housing Development Authority (NHDA) Society of Structural Engineers Sri Lanka All developments in a coastal city should comply with the Coastal Conservation Act. (No 57 of 1981) and Town and Country Planning Ordinance of Sri Lanka. Also, Identify the vulnerability of the roads to the following hazards through susceptibility hazard and risk maps, morphology and past records and Implement

	preventive measures against them prioritizing upon vulnerability for, •Landslides •Flood damage •Tsunami risk • Heavy winds
New Credit 3.7.3 Protective Structures and Barriers	Availability of structural barriers / coastal protection structures Eg: Revetments Sea walls Tsunami barriers any other structure
New Credit 3.8 Management and Monitoring Mechanism for Buildings	Regular monitoring and follow-ups are in place to ensure compliance with the set objectives and targets. Specially, carryout relevant structural health monitoring checks of the building structures in specific predetermined periodic time intervals (usually annually), depending on the location of the building, under the monitoring and targeting the resilience of the buildings to withstand against the natural and other hazards. These encompass aspects related to quality, cost and time, and disaster resilience properties and provide the opportunity to understand progress and, consequently, to take corrective actions where necessary. Monitoring and evaluation is also used to evaluate the success of the city resilience building efforts through performance indicators established within the city action plan and to measure their impacts. There are monitoring and evaluation tools to measure impact and success in place including a local level reporting system to convey the results and best practices and to identify corrective actions and revise the action plan based on feedback.

4. Waste Management

Prerequisite/ Credit	**Requirement/Amendment**
Amendment to Prerequisite 1	Comply the National Waste Management Policy
Addition to credit 4.2 Special Waste Streams Management	Take appropriate measures to safeguard hazardous waste including toxic waste collected and stored in all the buildings and infrastructure systems of flood prone zones by storing them in a flood proof area or above the elevation of the 50-year flood level which water can't be reached

5. Transport Facilities

Prerequisite/ Credit	**Requirement/Amendment**
Addition to credit 5.1 Transit Network	Emergency preparedness and post disaster instructions are displayed in all Transportation infrastructure facilities (transit shelters, bus and train terminals, bicycle parks and public transport vehicles etc.) for the awareness of occupants and passengers. Smart transportation networking is adopted for early warning, emergency management and to direct the community for evacuation routes. All transportation infrastructure facilities (transit shelters, bus and train terminals, bicycle parks and public transport vehicles etc.) should install reliable backup & emergency power sources and communication systems including Backup Fire & Life

	Safety Communication systems to be used during a hazard or an emergency. Choose reliable backup & emergency power sources such as Generators, back up batteries, and Renewable sources of energy such as Cogeneration & Solar during Blackouts together with a fire protection & detection system to improve resilience and efficiently mitigate in disaster situations. All transportation infrastructure facilities in flood zones should consider having a backup wireless fire communication system, and all transportation infrastructure facilities must have backup phone and data connections. Mandate the use of storage batteries with a life of at least eight hours to serve infrastructures' fire and life safety communication systems. Keep all transportation infrastructure facilities' and services' (transit shelters, bus and train terminals, bicycle parks, evacuation routes and public transport vehicles etc.) stairwells, hallways and emergency exits Lit during blackouts due to natural hazards using generators or other reliable energy sources such as solar or/and other renewable energy sources and provide portable emergency lighting by providing the occupants with hand-held lighting equivalent to 6-8 LED diodes in brightness for groups of occupants Emergency pathways and evacuation routes along the sidewalks should always have a backup power system to light the lighting systems along the evacuation routes during an emergency situation.
Addition to credit 5.2 Sidewalks and Pedestrian Facilities	Sidewalks should be connected to public open spaces and directed through evacuation routes
Addition to credit 5.4 Urban Traffic Management and Parking Management	Provision of public car parks and control roadside parking while avoiding impermeable parking areas as much as possible to increase the amount and rate of storm water infiltration and thereby reduce the risk of flooding. Develop standard operating procedures for traffic management during early warning and emergency situations along with the regular traffic management plan Develop a traffic signal system to be operated during early warning and emergency situations along with the regular traffic signal system.

6. Water Efficiency

Prerequisite/ Credit	**Requirement/Amendment**
Addition to PR 1 Water Quality	Comply to the Minimum Numbers of Toilets at Public Places and Institutions in Disaster Situations
Addition to Credit 6.5 Storm water Management	For a coastal city, periodically carry out an assessment for the requirement of beach nourishment in order to prevent erosion and sedimentation control. The use of soil bio engineering systems for erosion control

7. Energy and Atmosphere

Prerequisite/ Credit	**Requirement/Amendment**
Addition to PR 1 Enhanced Electricity Accessibility and Monitoring	All buildings and infrastructure facilities (specially in hazard prone areas) should install reliable backup & emergency power sources and communication systems including Backup Fire & Life Safety Communication systems.

8. Social, Cultural and Economic Achievements

Prerequisite/ Credit	**Requirement/Amendment**
Addition to PR 1 Demographic Assessment	A human rights-based approach is adopted, promoting and protecting all human rights, including ensuring equality (when each person is seen as equal in the eyes of the law with no discrimination based on their gender, race, religion, or sexuality, and social justice) to all citizens. Each person can exercise their rights within the society with the promotion of social justice, which ensures that everyone has physical security, education, healthcare, and employment. Subject Coastal cities to a Recovery Potentiality analysis (Socio-economic and Infrastructural)
Amendment to credit 8.1.2	Socio Economic development programs organized by the local authority discussing following aspects • Entrepreneurship opportunities within the locality and beyond • Disaster risk reduction strategies and creation of forums working groups to undertake programs to enhance the resilience from coastal hazards
Amendment to credit 8.2	Improvement of general literacy through basic and additional educational platforms Libraries ICT Centers Compulsory courses for children
Addition to Credit 8.4 Accessibility of Elderly and Persons with disability	Provide evacuation arrangements for persons with special needs • Blindness/ Deafness • Cognitive diseases • Pregnancy

New Credit 8.8 Engagement in Disaster risk reduction activities and planning process	Information and details on local risk, risk management strategies are incorporated into public awareness programs. Through the activation of Emergency Operations Centers (EOCs) at the respective levels of government, EMAs must coordinate an appropriate emergency response amongst all participating agencies

9. Innovation

Prerequisite/ Credit	**Requirement/Amendment**
New Credit 9.1.1 Innovation to address climate change and hazard risk	Introduce flood, earthquake and landslide warning systems and sensors in all major infrastructure facilities and services (multi stories residential and commercial buildings, critical infrastructures such as hospitals and schools) to detect the respective hazards and disseminate early warning alerts.
New Credit 9.1.2 Innovative interventions for attitude change towards resilience	Coherent approaches are in place to integrate disaster resilience for sustainable development. For example, there are novel platforms using the modern technology for built environment professionals and public in the city to get educated and ensure the resilience in every aspect when decision and policy making in their capacity

4.2 Scoring of Criteria through AHP

As discussed in Section 1, Analytical Hierarchical Process (AHP) was employed for the scoring of the criteria. The newly formed criteria were subjected to AHP in order to be weighted and scored.

AHP Model for the Problem

For the purpose of scoring the developed criteria for the GreenSL Rating System for Sustainable Cities an AHP Model was developed. It is shown in Figure 40. The problem was identified as "Urban Planning for Tsunami Resilience". Since all criteria were developed under 5 main parameters of Tsunami resilience, the same parameters were identified as the alternatives. To assess the alternatives, evaluation criteria were assumed as.

A- Practicality and feasibility of adaptation

B- Addressing of the multi-hazard aspect

C – Necessity and irreplaceability of the measure

Where it was assumed,

- C is 2 times as important as A and as 5 times important as B.
- A is as 3 times as important as B.

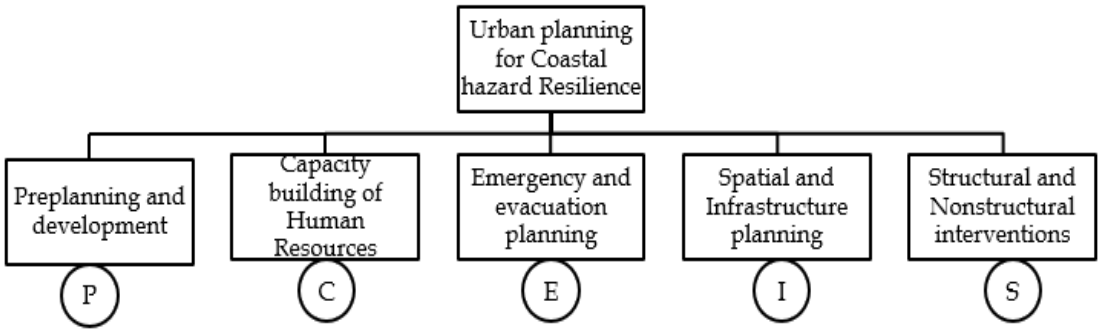


Figure 40: AHP Model for criteria scoring

Then a pairwise comparison was conducted between the above assumption criteria, A, B and C as shown in Figure 41.

	A	B	C
A	1	3	1/2
B	1/3	1	1/5
C	2	5	1

	A	B	C
A	1	3	0.5
B	0.33	1	0.2
C	2	5	1
	3.33	9	1.7

	A	B	C	Priority vector/Criteria weights
A	o.3003	0.3333	0.2941	0.3092
B	0.0991	0.1111	0.1176	0.1093
C	0.6006	0.5556	0.5882	0.5815

Figure 41: Pairwise Comparison on the evaluation criteria A, B, C based on the two assumptions

Received priority vectors for the criteria A, B and C were then used to obtain the Consistency Ratio (**λ** max). Figure 42 shows the calculation carried out in order to obtain the Consistency Ratio.

1	**3**	**0.5**	**0.3092**		0.9279		**0.3092**
0.33	1	0.2	0.1093	=	0.3276	= **λ** max	0.1093
2	5	1	0.5815		1.7464		0.5815

*Figure 42: Calculations to obtain Consistency Ratio (**λ** max) using the priority vectors*

$$\boldsymbol{\lambda}\ \text{max} = 3.0005$$

$$Consistency\ Index\ (CI) = \frac{\boldsymbol{\lambda}\ \text{max-}n}{n-1}$$

$$= 0.00025$$

$$Consistency\ Ratio\ (CR) = \frac{CI}{RI}$$

$$RI = 0.58$$

$$CR = 0.00043 < 0.1$$

Hence Consistency Ratio obtained satisfied the requirement, the assumptions/criteria were acceptable.

Then, the comparison matrix of the alternative options (P, C, E, I, S) was developed according to the above criteria. Options were quantified under each criterion as follows.

For criteria A- Practicality and feasibility of adaptation

Following assumptions were made.

C- capacity Building of human resources is 2 times as important as P - Preplanning and Development

E- Emergency and evacuation planning is as 2.5 times as important as P - Preplanning and Development

I - Spatial and Infrastructure planning is as 2 times as important as P - Preplanning and Development

S - Structural and Non-structural interventions is as 2.5 times as important as P - Preplanning and Development

E - Emergency and evacuation planning is as 1.25 times as important as C- capacity Building of human resources

I- Spatial and Infrastructure planning is of same importance as C- capacity Building of human resources

S- Structural and Non- structural interventions is as 1.25 times as important as C- capacity Building of human resources

E- Emergency and evacuation planning is as 1.25 times as important as I- Spatial and Infrastructure planning

E- Emergency and evacuation planning and S- Structural and Nonstructural interventions are of same importance

S- Structural and Non-structural interventions is as 1.25 times as important as I- Spatial and Infrastructure planning.

Above assumptions allowed obtaining the Comparison Matrix of the options/parameters as shown in Figure 43.

	P	C	E	I	S
P	1	0.5	0.4	0.5	0.4
C	2	1	1	1	0.8
E	2.5	1.25	1	1.25	1
I	2	1	1	1	0.8
S	3	1.25	1	1.25	1

Figure 43: Comparison Matrix for the parameters

Finally, with the obtained priorities from the comparison matrix, the priority vector was derived as shown in Figure 44. Parameter S- Structural and Non-structural interventions revealed to contain the highest priority while P - Preplanning and Development has obtained the lowest priority according to the vector.

	P	C	E	I	S	Priority Vector
P	0.1	0.1	0.1	0.1	0.099	0.0998
C	0.2	0.2	0.2	0.2	0.201	0.2002
E	0.2	0.2	0.3	0.2	0.251	0.2450
I	0.2	0.2	0.2	0.2	0.201	0.2002
S	0.3	0.2	0.2	0.3	0.261	0.2548

Figure 44: Priority Vector for the Main Parameters

This allowed weighing of each parameter as shown in Table 22.

Table 22: Derived Weightages for Main Parameters

Parameter	**Weightage**
P - Preplanning and Development	0.1
C- capacity Building of human resources	0.2
E - Emergency and evacuation planning	0.25
I- Spatial and Infrastructure planning	0.2
S- Structural and Non-structural interventions	0.25

Similar process was undertaken for the weighing of each newly developed credit under each main parameter. It should be noted that additions to existing credits, minor amendments and additions to submittals were not considered for scoring process. Newly developed credits and sub-credits were considered. Accordingly following structure of credits were considered for weighing.

P - Preplanning and Development – 3 new Credits
C- capacity Building of human resources – 3 new Credits
E - Emergency and evacuation planning – 3 new Credits
I- Spatial and Infrastructure planning – 3 new Credits
S- Structural and Non-structural interventions – 3 new Credits
A total of 20 additional points were dedicated for the newly developed criteria and the 20 points were decomposed to each credit based on the above obtained weightage.

This allocation of weightages and points is depicted in Figure 45.

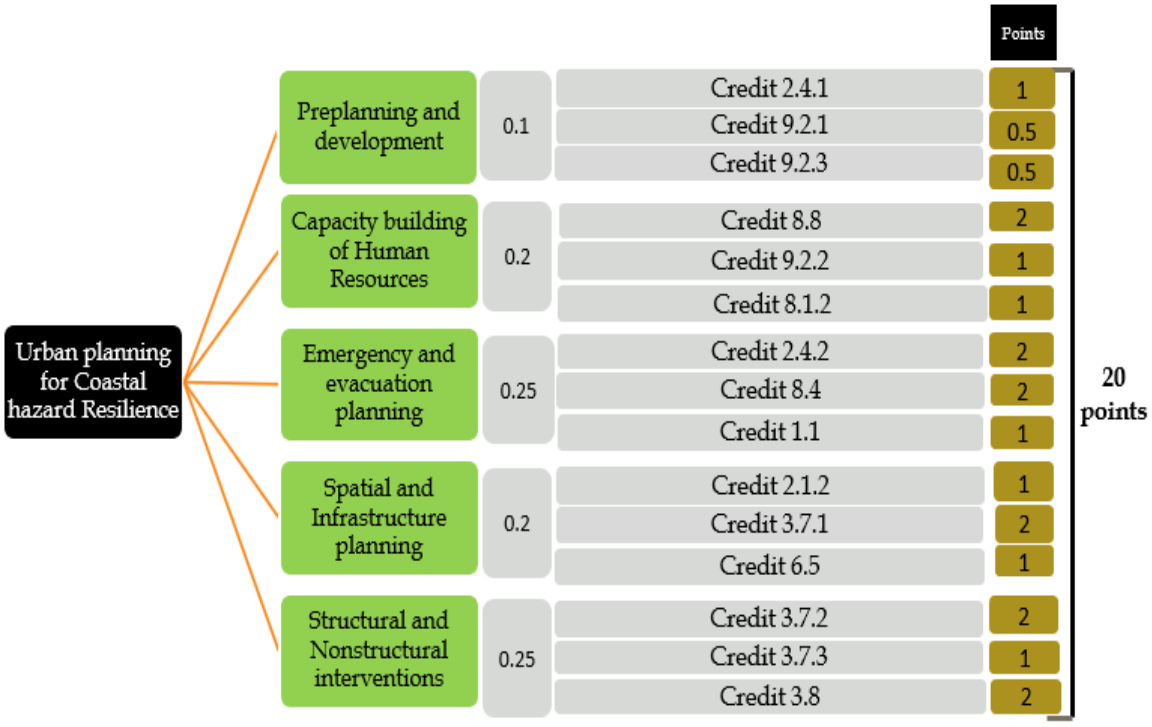


Figure 45: Point distrubution among the newly developed criteria

After the inclusion of new 20 points, the new rating system carries 120 points in total distributed among 53 credits as shown in Figure 46.

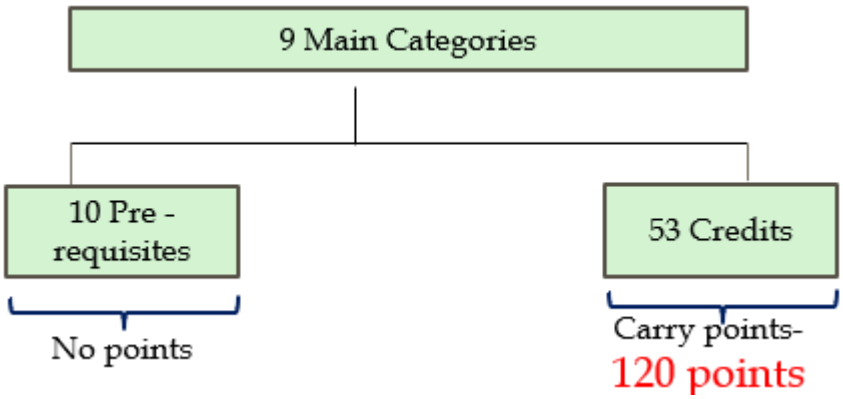


Figure 46: Final outlook of the GreenSL Rating System for Sustainable and Resilient Cities

New rating will be awarded as shown in Table 23.

Table 23: New Rating according to GreenSL Rating System for Sustainable and Resilient Cities

Points	Rating
40-49	Certified Sustainable and Resilient Coastal City
50-59	Sustainable and Resilient Coastal City Silver
60-75	Sustainable and Resilient Coastal City Gold
75 and above	Sustainable and Resilient Coastal City Platinum

For Coastal cities, GreenSL Rating System for Sustainable and Resilient Cities is recommended and for Non-Coastal cities GreenSL Rating System for Sustainable Cities can be accepted.

Finally, the modified GreenSL Rating System for Sustainable Cities with new Tsunami resilient criteria was employed to assess the current status of Panadura coastal city in terms of sustainable measures and Tsunami resilient measures.

The 5th- 8th surveys focused on confirming the obtained scores from AHP through their expertise and final incorporation to the tool. Following were the main activities conducted during this phase.

- Switching of credits among main categories
- New innovation criteria
- Educational events by the LAs and their scope
- Comparison of AHP resulted credits and expert opinions
- Allowing default credits for non-applicable hazards.
- Finalizing the crediting
- Final comments on the formatting of rating tool

5 VALIDATION OF THE GREENSL RATING SYSTEM FOR SUSTAINABLE AND RESILIENT CITIES

5.1 Selection of the city

Panadura urban council (Figure 47, Figure 48) was selected for the study. Panadura is one of the severely affected cities in Kalutara district and in Sri Lanka from the 2004 Indian Ocean Tsunami.

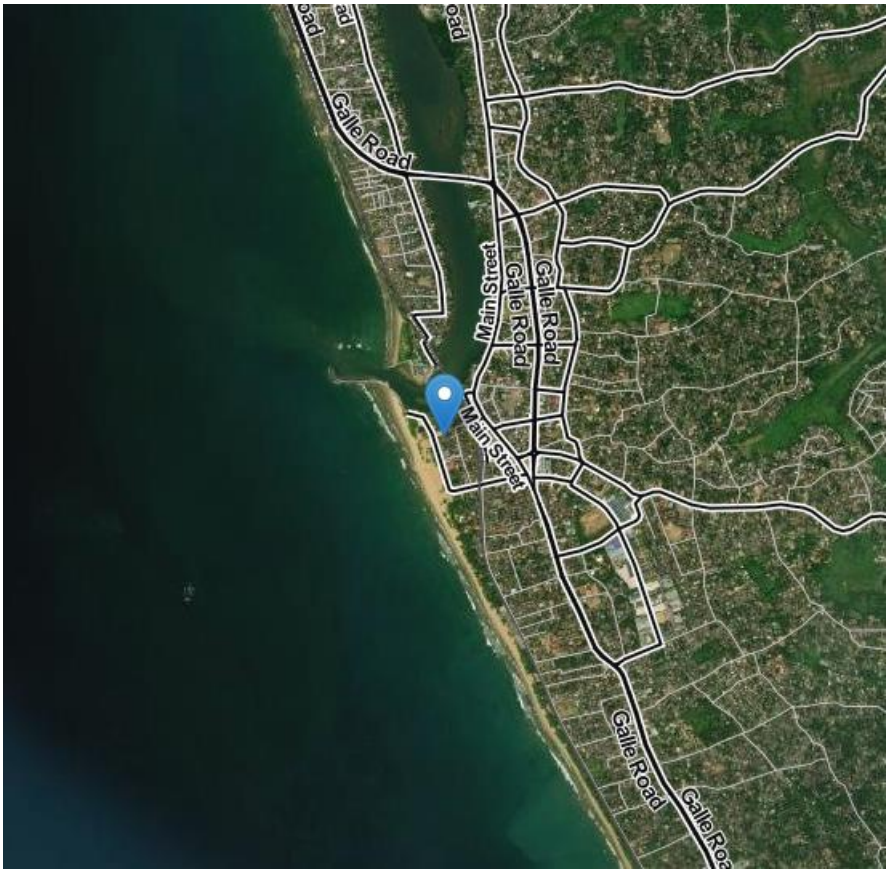


Figure 47: Panadura Urban Council (Google Earth,2022)

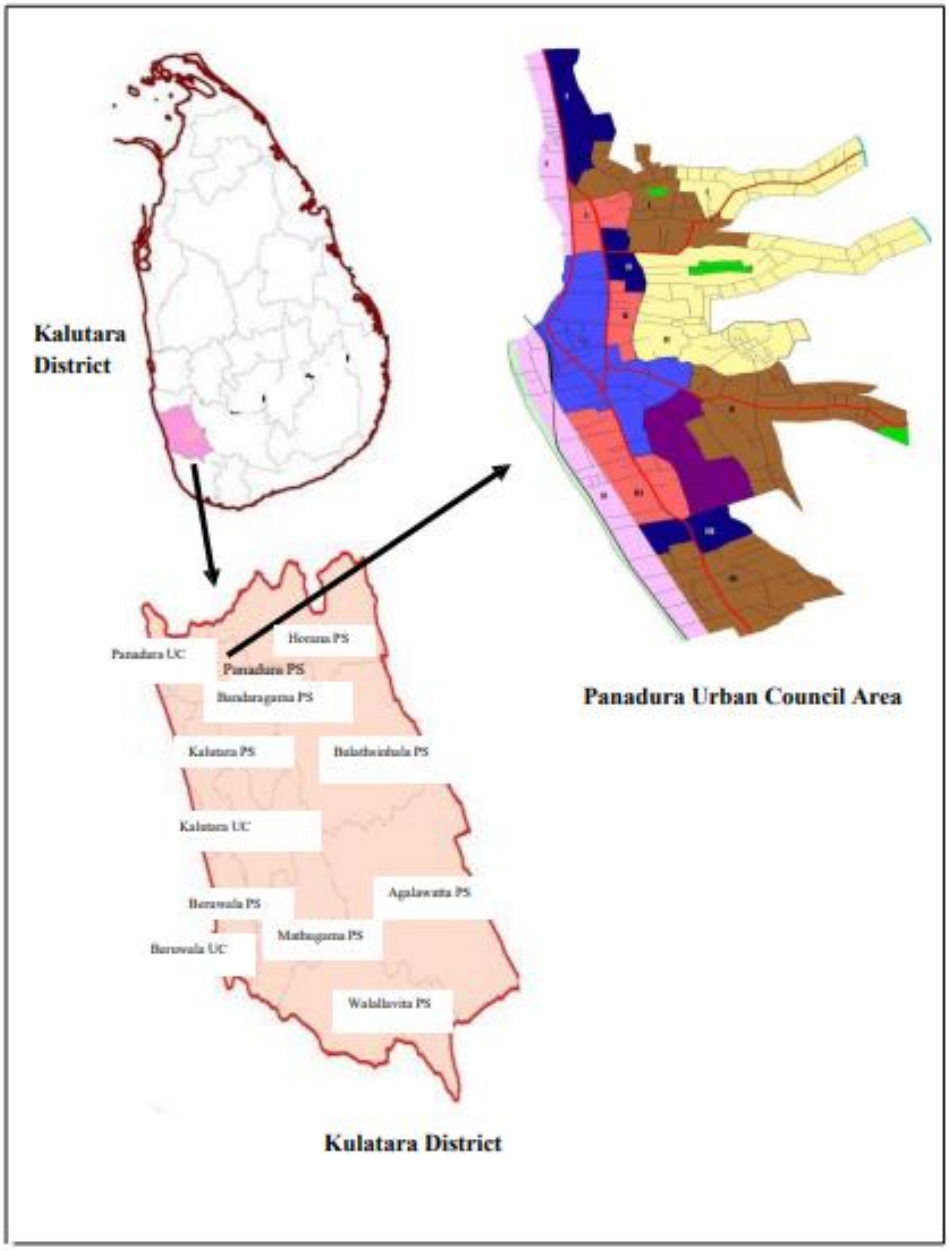


Figure 48: Location of Panadura Urban area

“Future disaster relief preparedness and response plan -2019” produced by the Divisional Secretariat Office, Panadura shown in Figure 49 states that Panadura area is prone to the following hazards.

1. Tsunami
2. Flash floods
3. Small landslides
4. Tornados and heavy winds
5. Saltwater intrusion

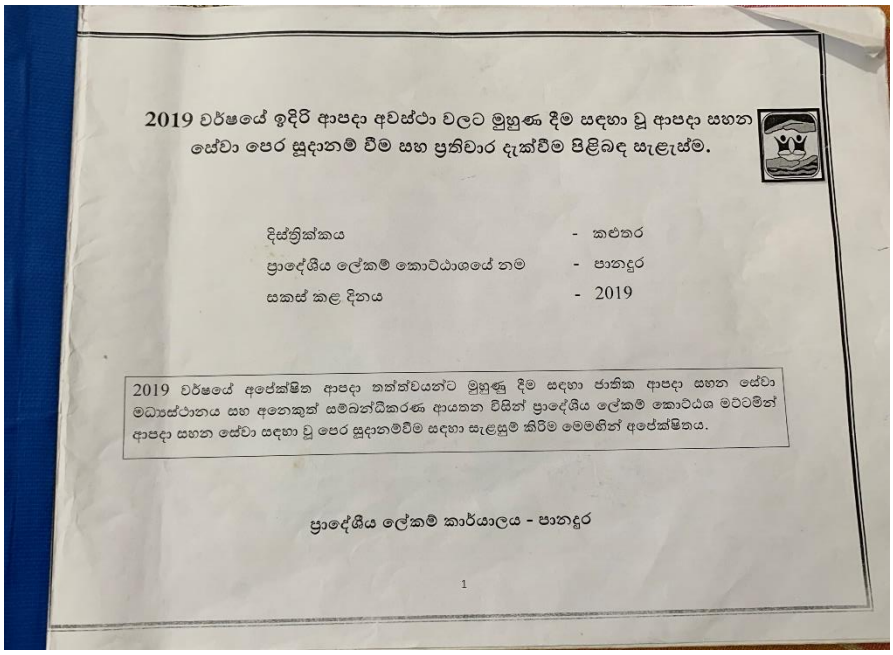


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Figure 49: Future disaster relief preparedness and response plan -2019

Accounting for nearly 75 deaths from 2004 Tsunami (Daily News, 27th December,2019) and the following damages to houses shown in Table 24, Panadura strikes to be an ideal city for this study.

Table 24: Damages to housing units in Panadura DS Division by 2004 Tsunami

DS Division	No of GN Divisions		No of census blocks in the affected GN divisions		No of housing units in the affected census			
	Total	Affected	Total	Affected	Before the disaster	Completely damaged	Partially damaged and cannot be used	Partially damaged and can be used
Panadura	72	17	143	58	3826	702	167	1206

Figure 50 shows the GN division and Road network of Panadura Urban Council and Figure 51 is the map of Tsunami affected GN divisions in Panadura.

Figure 50: GN Division and Road Network of Panadura Urban Council

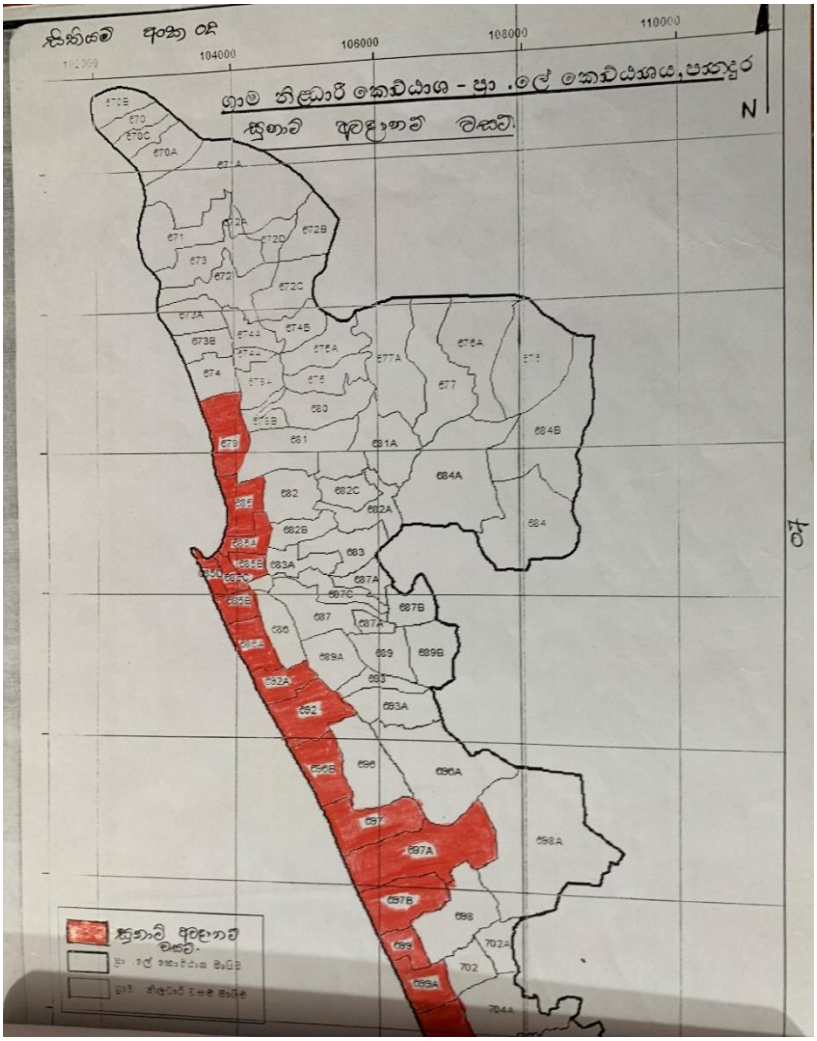

Figure 51: Tsunami affected GN Divisions in Panadura

It is evident from the map that all GN divisions along the coastline are vulnerable to Tsunamis where in some GN divisions even the internal areas away from the coastal belt seems no safer.

The National Physical Plan 2030 as shown in Figure 52 has identified Panadura City as an area of importance due to the following,

- ✓ A Main city
- ✓ A Metro Region
- ✓ A Fishery Harbor
- ✓ Included in the Main Road network
- ✓ Included in the Main Railway network

Also, Panadura has been identified as an Urban Centre in the Western Region Physical Structure Plan as shown in Figure 53.

Being situated along Colombo - Galle Road and connected with regular road network, Panadura provides access links to the North, Colombo -the main commercial city of Sri Lanka, Sri Jayawardenapura Kotte- the main capital city of Sri Lanka, down south and up to Rathnapura, through Colombo – Horana Road. Panadura has become a commercial center of the country too having the Modarawila Industrial zone and operating a fishery harbor greatly contributing to the fishery industry of the country. There are more than 200 fishery families living in the city. Panadura city is a hub for education, location for private and public sector banks and other commercial institutions.

The Pandura River, existing paddy fields and the marshy lands support to maintain the environmental equilibrium and the natural beauty of the area. Also, the coastal belt being boundary to the area is a valuable venue in considering the environmental characteristics of the area. Few cultural and archeological places and buildings were located within the Panadura urban area. There are few archeological places in Panadura including the place of Panadura debate and the Rankoth Viharaya could also be identified as cultural valuable place.

Figure 52: Sri Lanka in 2030; National Physical Plan 2030

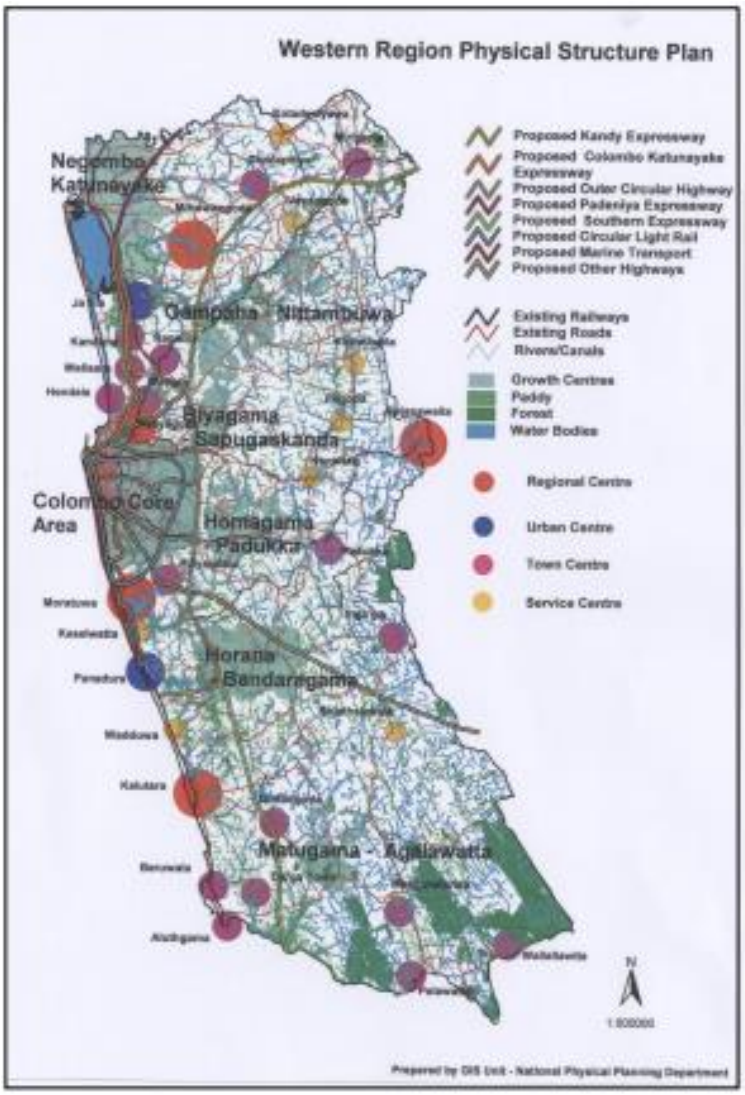

Figure 53: Western Region Physical Structure Plan

Panadura Urban Council was conducting the following programmes at the time of the study.

- Saubhagya Production Village Rural Development Programme 2021
- Saubhagya Dekma Rural Road Development Programme – 2021
- Fisheries Distress Payments
- Decentralized Budget Programme 2021 Panadura Divisional Secretary's Division

But the following major issues were identified in the city.

- ❖ Overcrowding, congested and unregulated development activities taking place at the town center
- ❖ Ribbon form of development along Galle Road and Khorana Road contributing to traffic congestion along these roads
- ❖ Underutilization of the lands in city center.
- ❖ Prevailing activities of the Public and Semipublic in unplanned way within the city.
- ❖ Unauthorized shanty structures on the beach front
- ❖ Declining of the old town center developed along the main street (Arthur V. Dias Mawatha)
- ❖ Congestion and overcrowding of Galle Road due to location of commercial establishments with no adequate vehicular parking spaces and passenger walkways.
- ❖ Beach area The Panadura beach area which was visually attractive seashore extending over 02 km from Wellaboda to Uyankele seem to have been neglected by the authorities. As a result, many unauthorized shanties and environmentally unfriendly activities have been taken place along the beach area. According to the Urban Council officials some arrangements are being made by the Coast Conservation Department in consultation with the Western Provincial Council to improve the environmental condition of this area.

After analyzing the above facts, it was evident that Panadura is a city of significance to the country's economy yet with prevailing issues in the context of sustainability and resilience. Therefore, it is ideal to assess the present condition of it paving the way for intelligent future development. Hence, Panadura Urban Council was selected as the study area for the validation of GreenSL rating System for Sustainable and Resilient Cities.

5.2 Validation Survey

A questionnaire was prepared in the following format in Table 25. The questionnaire was prepared in such a way that each question represents a pre-requisite/criterion in the rating system. Through this questionnaire, it was anticipated to check the compliance/ non-compliance of the relevant clause. (The questionnaire is attached as Annexure 3 of this report)

Table 25: Structure of validation questionnaire

Main Category	No of Total Questions	Questions on Green Measures	Questions on Resilience Measures
Management	10	5	5
Ecology and Conservation	10	5	5
Infrastructure Management	12	8	4
Waste Management	5	4	1
Transport Facilities	8	4	4
Water Efficiency	14	11	3
Energy and Atmosphere	5	3	2
Social, Cultural and Economic Achievements	12	9	3
Innovation	4	1	3
	80	**50**	**30**

The questionnaire was presented to 14 officials attached to following organizations/sections. 7 officials for each aspect (green and resilient)

- Panadura Urban Council
- Divisional Secretariat Office, Panadura
  - Disaster Management office
  - Beach protection office
  - Environment office
  - Resource Management office
- Coast conservation Department- Area office- Modara

The respondents answered Yes/No to Compliance of each clause from which a basic judgement could be made on the prevalence of each measure presented in the rating system. If the majority of the 7 respondents provided the answer “YES”, that measure was accepted as implemented in the city.

5.3 Analysis of Results

The summary of responses for the questionnaire is shown in Table 26.

Table 26: Summary of responses of survey

		Green Concepts		Resilience Concepts		Implemented (YES)/ Not Implemented (NO)
		Yes	No	Yes	No	
Management	question 1.1	0	7			NO
	question 1.2			5	2	YES
	question 1.3	5	2			YES
	question 1.4			0	7	NO
	question 1.5			2	5	NO
	question 1.6			0	7	NO
	question 1.7	4	3			YES
	question 1.8	1	6			NO
	question 1.9			2	5	NO
	question 1.10	1	6			NO
Ecology and Conservation	question 2.1	0	7			NO
	question 2.2	0	7			NO
	question 2.3			0	7	NO
	question 2.4			7	0	YES
	question 2.5	0	7			NO
	question 2.6			5	2	YES
	question 2.7	0	7			NO
	question 2.8			4	3	YES
	question 2.9			1	6	NO
	question 2.10	5	2			YES
Infrastructure Management	question 3.1	5	2			YES
	question 3.2	0	7			NO
	question 3.3	7	0			YES
	question 3.4	0	7			NO
	question 3.5	5	2			YES
	question 3.6	0	7			NO
	question 3.7	0	7			NO
	question 3.8			0	7	NO

	question 3.9	4	3			YES
	question 3.10			7	0	YES
	question 3.11			0	7	NO
	question 3.12			0	7	NO
Waste Management	question 4.1	4	3			YES
	question 4.2	0	7			NO
	question 4.3	0	7			NO
	question 4.4			0	7	NO
	question 4.5	0	7			NO
Transport Facilities	question 5.1	2	5			NO
	question 5.2			2	5	NO
	question 5.3			4	3	YES
	question 5.4	1	6			NO
	question 5.5			0	7	NO
	question 5.6	0	7			NO
	question 5.7	0	7			NO
	question 5.8			0	7	NO
Water Efficiency	question 6.1	7	0			YES
	question 6.2	3	4			NO
	question 6.3			0	7	NO
	question 6.4	7	0			YES
	question 6.5	5	2			YES
	question 6.6			3	4	NO
	question 6.7	5	2			YES
	question 6.8	0	7			NO
	question 6.9	0	7			NO
	question 6.10	0	7			NO
	question 6.11	2	5			NO
	question 6.12			4	3	YES
	question 6.13	0	7			NO
	question 6.14	0	7			NO
Energy and Atmosphere	question 7.1	7	0			YES
	question 7.2			0	7	NO
	question 7.3	0	7			NO
	question 7.4			0	7	NO
	question 7.5	0	7			YES

Social, cultural and Economic Achievements	question 8.1	7	0			YES
	question 8.2	0	7			NO
	question 8.3	5	2			YES
	question 8.4			0	7	NO
	question 8.5	1	6			NO
	question 8.6	0	7			NO
	question 8.7			4	3	YES
	question 8.8			3	4	NO
	question 8.9	0	7			NO
	question 8.10	0	7			NO
	question 8.11	0	7			NO
	question 8.12	2	5			NO
Innovation	question 9.1			0	7	NO
	question 9.2			0	7	NO
	question 9.3			0	7	NO
	question 9.4	0	7			NO

Then, for each category, a percentage implementation level was obtained as shown in Table 27.

Table 27: Percentage Implementation of green and resilience measures in each main category

	Green	**Resilience**
Management	40%	20%
Ecology and Conservation	20%	40%
Infrastructure Management	37.50%	25%
Waste Management	25%	0%
Transport Facilities	0%	25%
Water Efficiency	36%	33%
Energy and Atmosphere	33.33%	0%
Social, cultural, and Economic Achievements	22.22%	33.33%
Innovation	0%	0%

6 Discussion

The global literature survey reflected different Tsunami preparedness measures which can be categorized in to five main parameters. When referring to local research centered around the same subject, it was observed that many researchers have been highlighting some of the above global measures to the Sri Lankan context. But the actual frameworks showcased a dramatic difference between the ideal guidelines suggested by research and the considered aspects in the law and policy frameworks. From the expert interview results it is even evident that some of the laws and policies are not enforced at the local authority level. All experts have unanimously agreed on the reasons behind lack of implementation of measures in Sri Lanka. Political influences, lack of capacity of local authority officials, weak enforcement mechanisms, public attitude towards resilience and less integration between different individual building and other codes top the list. Therefore, while strengthening the existing frameworks and policies it can be argued that it is effective to incorporate such measures to rating systems in order to provide an incentive to stakeholders. It will lead to increased tendency of local authorities and the connected parties to commit towards making their city not only green but resilient.

The 9 main categories of GreenSL Rating System for Sustainable Cities depicted an inclusive framework of greening criteria. But all categories showed lack of implementation of Tsunami or disaster resilience measures. Therefore, confining to the scope of this research, Tsunami preparedness measure were prepared and incorporated appropriately to each category. The 8 expert interviews shed much light on amending the globally practiced criteria to Sri Lankan context. Instead of intuitive methods, Analytical Hierarchical Process was identified as the best way to weigh and score the newly developed criteria maintaining the rationality and consistency. Though a rating system for all hazards ideally suit the requirement, it can be argued that when one city is taking the assessment it is tedious to go through all hazard criteria which are irrelevant to the selected city. As a solution, points for non-applicable criteria can be proposed to establish inclusive tool for the whole country. This research, on the other hand brings out a model rating system for single type of hazards which is only applicable to coastal regions. However, considering the significance of coastal cities to Sri Lanka in terms of economy, population, and infrastructure density adaptation of this rating system for all regions in the country and applying exemption points for other regions where necessary can be identified as a better alternative option. On that grounds preparation of the GreenSL Rating System for Sustainable and Resilience Cities through this research can be justified. Nevertheless, it is necessary to find out the practicality of the incorporated criteria by validating the rating system through an application to a city. A surface level validation could be achieved by evaluating Panadura city through surveys to local authority officials. More stringent and effective evaluation could be a project of greater level which surpass the scope of the

study. It can be recommended when launching the rating system for actual practice. The results obtained from the validation of this study could be used to understand the current level of implementation of both green and resilience measures in a typical coastal city of Sri Lanka.

Figure 54 shows the implementation levels of green and resilience measures under each main category.

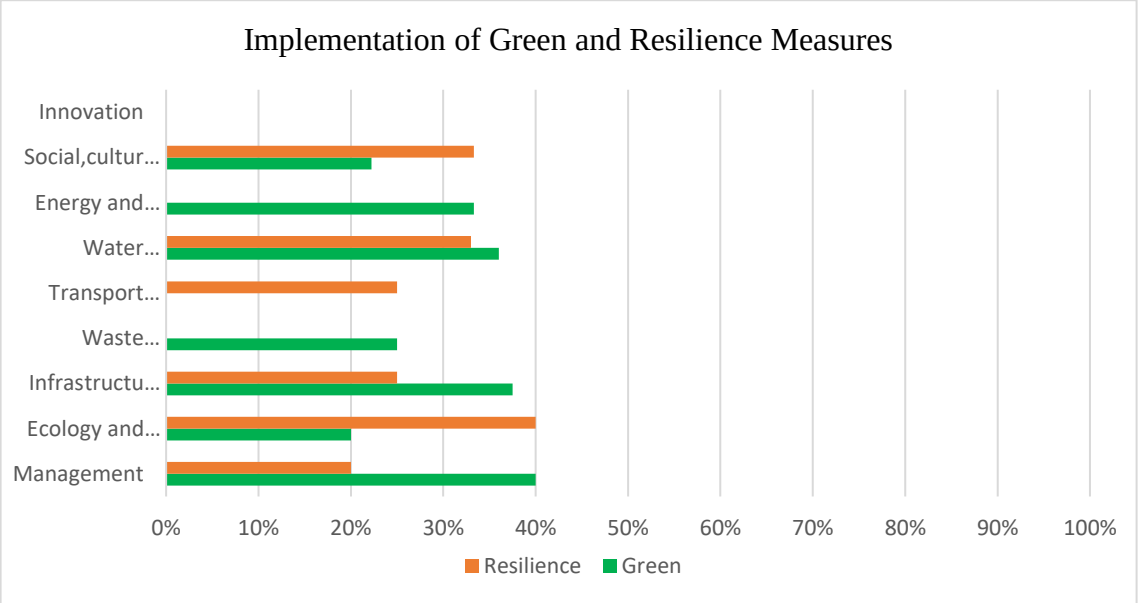

Figure 54: Implementation levels of green and resilience measures in the Panadura City

It is well evident that any of the main categories have not been implemented beyond 40% of the ideal. In the water efficiency category both green and resilience measures have been implemented in approximately equal levels whereas other categories show different levels of implementation. It is alarming that in the waste management category no measure of resilience has been implemented. Also, no green measures prevail under the category of Transport facilities. It is visible that in the Management and Infrastructure Management categories less focus have been given to Resilience measures when compared to green measures. Due to the overall below average implementation levels, not surprisingly the city has failed to score in the Innovation category.

7 Conclusion and Recommendations

The study intended to identify the main parameters and derived measures to increase Tsunami hazard preparedness in the coastal cities in Sri Lanka and incorporate them into the GreenSL Rating System for Sustainable Cities. The resulted rating system containing scored measures for sustainability and resilience was tested using an application of a city. Through the literature survey, parameters of Tsunami resilience in coastal cities were identified as,

- Pre-Planning and Development
- Capacity Building of human resources
- Spatial and Infrastructure Planning
- Emergency and Evacuation Planning
- Structural and Nonstructural Interventions

The gap analysis revealed that,

- Local and global literature have greatly highlighted measures related to “Capacity Building of Human Resources” and “Spatial and Infrastructure Planning” for Tsunami resilience in Sri Lanka.
- Local and global literature have moderately highlighted measures related to “Emergency and Evacuation Planning” and “Structural and Nonstructural Interventions”.
- Judgement of experts from disaster management, civil engineering, architecture, and town planning fields is also in accordance with the above observation.
- Current frameworks in Sri Lanka, especially the Urban Development Authority Guidelines and Coastal Conservation Act seriously lack the incorporation of measures relate to all five parameters.

The GreenSL rating System for Sustainable and Resilient Cities carrying 20 points for resilience measures was introduced for the rating of coastal cities.

Non- coastal cities are accepted to be rated using the existing GreenSL rating System for Sustainable Cities. However, the relevance of many general disaster management and resilience measures to any disaster scenario, the employment of the `new rating system is encouraged to benchmark the resilience of a city. If a non-coastal city claims the adaptation of new Sustainable and Resilience Rating system, the Tsunami related criteria will be exempted.

The city of Panadura subjected to a surface-level validation of the GreenSL rating System for Sustainable and Resilient Cities depicted that its incorporation of sustainable and resilience measures is below 50% of the recommended. Hence, the city fails to achieve the minimum certified level offered by the rating system.

These obtained results highlight the necessity of launching and practicing similar rating systems in near future. This validation survey could be used as a feasibility study to investigate the actual context and progress towards better evaluations and adapting this rating system in future.

However, the adaptation of new GreenSL rating System for Sustainable and Resilient Cities is still restricted until a pilot city is fully assessed for the GreenSL certification. Therefore, a deeper validation is recommended for the rating system.

A Life Cycle Analysis of all suggested measures, especially those involve construction material should be undertaken to accurately bring out the advantage towards suitability/resilience and to avoid contradictions between the same.

More inclusive and common rating system can be developed in future where all hazard types are addressed, and possible exemption clauses are well specified.

The cost factor of implementing the suggested measures should be analyzed through an actual pilot study for a city.

Also undoubtedly, adequacy of resilience measures incorporated should be constantly updated with the new tendencies and climate change implications observed worldwide.

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Annexure 1

7.1.1 Expert Interview Questionnaire

Introduction

This questionnaire consists of 36 questions related to Tsunami and other multi-hazard preparedness in Tsunami prone cities in Sri Lanka under the following 6 sections.

1. General
2. Spatial and Infrastructure Planning
3. Involvement of Key stakeholders
4. Resilience Approaches
5. Hard Engineering Measures
6. Soft Engineering and Nature Based Measures

Please note that the information obtained from the interviews will be solely used for research purposes and the information of the interviewees will not be revealed under any circumstance.

Expert's Details

What is your expertise area? Select all appropriate answers.

☐ Civil Engineering
☐ Architecture
☐ Country and City Planning
☐ Disaster Management
☐ Health Sector
☐ Other Click or tap here to enter text.

1. General

1.1 In your opinion what is /are the essential elements/indicators of urban planning for tsunami and other multi hazard preparedness in a coastal city? (List the most crucial 3 items)

☐ Identification of the potential hazard and the effects (regards to exact locations, likelihood of getting affected, severity of damage)
☐ Subjection to continuous vulnerability assessments
☐ Early warning mechanisms
☐ Tsunami and other hazard resilient structures
☐ Land use planning to reduce hazard risk
☐ Evacuation planning
☐ Awareness/education and capacity building of human resources

☐ Protection and strengthening of nature-based solutions
☐ Availability and facilities of critical infrastructure
☐ Other ……

1.2 Is the cooperation from local government and NGOs adequate for urban planning for Tsunami and other multihazards?

If No, how can it be enhanced?
Click or tap here to enter text.

1.3 According to your knowledge what is/are the most underperformed action related to urban planning for Tsunami and other multihazard preparedness in Sri Lanka?

☐ Tsunami Evacuation Drills and other means of preparing public for hazards
☐ Maintenance, upgrading and monitoring of Early warning systems
☐ Legal framework and actions to protect nature-based solutions
☐ Regular hazard mapping
☐ Regular vulnerability assessments
☐ Regulating land use planning
☐ Erection of more hazard resilient structures
☐ Planning for platforms to educate public
Other:

1.4 According to your point of view, what resources Sri Lanka lacks the most to implement Tsunami preparedness measures in coastal city planning?

1.5 Do the planners adhere with guidelines, regulations and policies imposed by the local government?

1.6 Should a Tsunami preparedness manual be mandatory for buildings and infrastructure in a Tsunami prone area?

1.7 Are there enough seismic and sea level monitoring facilities available in Sri Lanka?

2. Spatial and Infrastructure Planning

2.1 What are the unique topographical features that reduce the Tsunami risk?

☐ Rising Terrains
☐ Steep Narrow Bays
☐ Ditches
☐ Berms
☐ Dykes
Other:

2.2 What are the most important parameters to be considered and checked during land suitability analysis and planning building lots in the coastal belt?

	1	2	3	4	5
Land slope	☐	☐	☐	☐	☐
Elevation	☐	☐	☐	☐	☐
Soil Texture	☐	☐	☐	☐	☐
Distance from the sea	☐	☐	☐	☐	☐
Building Orientation	☐	☐	☐	☐	☐
Building Shape	☐	☐	☐	☐	☐
Spacing	☐	☐	☐	☐	☐
Normal Flood depth	☐	☐	☐	☐	☐
Brownfield/ redeveloped	☐	☐	☐	☐	☐

Other: Specify Click or tap here to enter text.

2.3 What are the barriers encountered in conducting proper land suitability analysis before erecting buildings?

Click or tap here to enter text.

2.4 What should be the ideal study area (distance from the sea) for Tsunami Hazard mapping?

☐ 100m
☐ 200m
☐ 500 m
☐ 1 km

2.5 Do you recommend coastal belt isolation in urban planning for Tsunami and other multihazard preparedness than finding alternative measures?

What are the reasons for your recommendation?

Click or tap here to enter text.

2.6 Do coastal belt recreational activities have an impact of the malfunctioning of any Tsunami / other hazards prevention measures?

If yes, how this can be tackled?

Click or tap here to enter text.

2.7 Is inundation modelling taking place in coastal city planning?

2.8 What are the important aspects that should be considered in spatial planning for evacuation?

2.9 What are the concerns/aspects to be considered in planning open public spaces in coastal cities? Rank

☐ Shape and other features of the open space
☐ Elevation of the selected land
☐ Easy accessibility to the place
☐ Area of one open space
☐ Number of open spaces
Other:

3. Involvement of Key Stakeholder groups

3.1 Do the public get to involve in urban planning and related policy development processes?

If the public involvement is required in planning, what are the ways and platforms?

3.2 Are the case study information and local knowledge sources related to Tsunami and other multi hazards easily accessible for public in Sri Lanka?

If no, suggest ways to effectively utilize local knowledge and case study information to enhance public and other stakeholder engagement in urban planning?
Click or tap here to enter text.

3.3 Are there negatively affected industries due to buffer zone and other guidelines used in urban planning?

If yes, how to tackle the economic crisis arising during Tsunami and other multihazards?
Click or tap here to enter text.

3.4 Does education levels, literacy and other similar factors of public have an effect on their involvement in urban planning?

3.5 Do early warning mechanisms play a vital role in urban planning for tsunami and other multi hazards?

If yes, what are the most effective and community friendly early warning mechanisms that can be incorporated in urban planning?

4.Resilience Approaches

4.1 What are the resilience thinking approaches that can be applicable to Sri Lankan urban planning which practiced internationally?

4.2 Does Sri Lankan urban planning in coastal cities and the guidelines and policy frameworks used reflect the "learning from lessons of past incidents" approach?

If No, what causes hinder it?

Click or tap here to enter text.

4.3 Are the Sri Lankan costal cities aligning and practicing "Build Back Better" approach?

What improvements do you suggest for better urban planning with above approach?

5. Hard Engineering Measures

5.1 Should Tsunami resilient construction measures be integrated in building codes? Is it practiced in Sri Lanka?

5.2 What are the coastal protection structures that are most effective?

☐ Seawalls

☐ Engineered Tsunami barriers and gates

☐ Levees

Other: specify Click or tap here to enter text.

5.3 Is Sri Lanka less focusing on structural measures (elevated structures etc.) in urban planning compared to other Tsunami prone countries?

If yes, what can be the reasons?

Click or tap here to enter text.

5.4 What are the special aspects to be focused in planning critical infrastructures in coastal cities?

5.5 What are the Tsunami resistive building materials recommended in planning guidelines?

Most Resistive →

	1	2	3	4	5
Concrete	☐	☐	☐	☐	☐
Wood	☐	☐	☐	☐	☐
Bricks	☐	☐	☐	☐	☐
Fly ash blocks	☐	☐	☐	☐	☐

Other: Specify Click or tap here to enter text.

5.6 What are the buildings and infrastructure in a city that can be used as evacuation shelters during a hazard emergency?

5.7 Are there examples for fire-proof zones/ fire break belts in coastal cities in Sri Lanka?

5.8 What are the additional structural / architectural features that should be planned in buildings and infrastructure to cater for pandemic needs?

Click or tap here to enter text.

6. Soft and Nature based Measures

6.1 What are the soft Engineering and nature-based measures recommended for urban planning in Tsunami prone areas?

6.2 What are the limitations of implementing nature-based solutions as a part of urban planning in Sri Lanka?

Click or tap here to enter text.

6.3 Can indigenous knowledge be incorporated to urban planning against tsunami and other multihazard resilience

If yes, List some examples?

Annexure 2

GREEN$^{SL®}$ RATING SYSTEM FOR SUSTAINABLE AND RESILIENT CITIES

Version 1.0

Green Building Council of Sri Lanka

'Committed Leadership in Sustainability'

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PREFACE FROM GREEN BUILDING COUNCIL OF SRI LANKA

The natural environment together with our economy, health and productivity are immensely affected by the performance of the built environment. According to United Nations, habitat, cities consume 78 per cent of the world's energy and produce more than 60 per cent of greenhouse gas emissions even if they account for less than 2 per cent of the Earth's surface.

The Green Cities Rating System of Green Building Council of Sri Lanka (GBCSL) offers the valuable opportunity to respond positively to one of the greatest challenges of the day. It is a voluntary scheme where urban designers, engineers and city dwellers can achieve recognition as a 'Green City' together with governance for the city they are residing.

History shows how our forefathers built great cities, irrigation systems and religious monuments that coexisted with nature and yet provided a sustainable economy and lifestyle to the citizens. This initiative of the GBCSL is another humble step towards taking our society to that glorious past which we are still proud of as Sri Lankans.

We believe our effort will make zero-energy cities by the year 2050.

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FOREWORD

When considering the current urbanization trend in the world, it is amazing that, over four billion people around the world, approximately more than 50% of the global population, live in cities. That number is still fast growing, as individuals and families continue migrating to urban areas for various reasons, mainly seeking better livelihoods. It is noteworthy that in East Asia and the Pacific alone, cities house 1.2 billion people, almost equal to the total population of India. With the assumption that urban population would be doubling its current size in the next 30 years, it is estimated that, nearly 70 out of 100 people in the world will live in cities, by 2050.

However, the speed and scale of urbanization brings tremendous challenges. It is obvious that, widening income gaps, worsening pollution, aging buildings and bridges are all indicating signs that today's cities are struggling to keep up with city inhabitants' growing dreams for a sustainable and prosperous future. In addition, climate change further complicates the urbanization challenge. Some studies reveled that, by 2030, climate change and natural disasters may cost cities over US $300 billion each year, and push nearly 80 million more urban residents into poverty. The impact of COVID-19 will be most devastating in poor and densely populated urban areas, especially for the people living in informal settlements and slums worldwide, where overcrowding also makes it difficult to follow recommended measures such as social distancing and self-isolation.

At the same time, it is a fact that cities have become the world's major growth engine, generating more than 80% of the global GDP, while helping hundreds of millions of people to lift themselves out of extreme poverty. In addition, cities are also our greatest opportunity where innovation happens, wealth generation accelerates and efficiency gains are achievable. And as the world becomes increasingly urban and no way of returning back, we will never get an opportunity to select the correct path and make our cities resilient and sustainable, if we do not do it today.

The researchers found that, all these strengths and weaknesses of urbanization have attributed to the current situation where cities have become the main source for most of the climate change catastrophes, as they account for more than 70 percent of global

greenhouse gas emissions and two-thirds of the world's energy use. With the understanding of this situation and as a result of the global commitment to making urbanization right, we can see that the 'Sustainable City Concept' has become a reality today. It is praiseworthy that a broader consensus among all stakeholders has been reached to make cities inclusive, safe, resilient, and sustainable for all, and to revitalize their existence to achieve the Sustainable Development Goals set out by the United Nations. This situation drives the Green Building Councils around the world to formulate Green City Rating Systems, identifying norms and standards required to measure and evaluate the environmental performances of cities to certify them as Green and Sustainable Cities.

The Green Building Council of Sri Lanka (GBCSL), being the fully-pledged green promoting and endorsing organization, has formulated and introduced the 'GREENSL Rating System for Sustainable Cities' to respond positively to the greatest challenge of the day for making our cities inclusive, safe, resilient, and sustainable. It is a voluntary scheme where urban planners, architects, designers, engineers and city dwellers can achieve recognition as a 'Green City' together with the local government authorities, they are residing. This is a kind of repetition in our history as our forefathers built great cities, irrigation systems and religious monuments that co-existed with nature and yet provided a sustainable economy and lifestyle to the citizens. This initiative of the GBCSL is another step forward in taking our society to that glorious past, which we are still proud of as Sri Lankans.

The Green City Concept seeks at promoting an eco-friendly city that balances social, economic, and environmental dimensions, as well as good urban governance as its foundation. Also, one of the main concerns which need to be stressed upon is optimal and efficient use of natural resources. In this context, emerging cities have the opportunity to set a strong eco-vision that can be transformed into a long-term plan from day one itself. The rating system shall enable the development authorities and developers to apply green concepts and planning principles, so as to reduce environmental impacts that are measurable, and to improve the overall quality of life.

Prof. Ranjith
Dissanayake
Chairman
Green Building Council of Sri Lanka

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ACKNOWLEDGEMENTS

The GREENSL® Rating System for Sustainable Cities, Version 1.0 has been made possible only through the efforts of many dedicated volunteers, committee members and others in the GBCSL community. The drafting was managed and implemented by GBCSL staff and consultants and included with reviews and suggestions by the GBCSL Core Committee and many members. Expert guidance was provided by the GBCSL Director Archt. Plnr. Piyal Silva.

The GBCSL acknowledge the support of Archt. Plnr. Piyal Silva, Mr. Lionel Nawagamuwa, Ms.
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We mention with gratitude the expert committee members for their expertise and reviews in perfecting the draft.

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- Ms. Samandhi Fernando
- Ms. Dilini Abeywardhana

GREENSL® RATING SYSTEM FOR SUSTAINABLE and RESILIENT CITIES POINT ALLOCATION

120 POINTS AVAILABLE

Criteria		Existed Points	Newly added Points
1.0 Management	**4 Points available**		
Prerequisite 1	Green Building Accredited Professionals and Commitment	Required	
Prerequisite 2	Citizen Engagement	Required	
Prerequisite 3	Eco vision of the city	Required	
Credit 1.1	Application of Appropriate Technologies and Information & Communications Technology (ICT) Integration	1 Point	1
Credit 1.2	Integrated Planning	2 Points	
Credit 1.3	Recognize GREEN^{SL} rated built environment	1 Point	
2.0 Ecology and Conservation	**19 Points available**		
Prerequisite 1	Assess the Existing Ecosystem	Required	
Credit 2.1	Existence of Green Coverage & Accessibility to Public Green Spaces		
Credit 2.1.1	Existence of Green Coverage	2 Points	
Credit 2.1.2	Accessibility to Public Green and Open Spaces	3 Points	1
Credit 2.2	Restore, Rehabilitate and Conserve Natural Resources	4 points	
Credit 2.3	Reduce Heat Island Effect		
Credit 2.3.1	Reduce Heat Island Effect- Roads	2 points	
Credit 2.3.2	Reduce Heat Island Effect- Roof areas and vertical facades	2 points	
Credit 2.4	Resilience Planning		
Credit 2.4.1	Vulnerability and Capacity Assessment	2 Points	1
Credit 2.4.2	Develop a Resilience Plan	2 Points	2
Credit 2.5	Encourage Re-Generation of Environmentally Degraded Areas	2 Point	
3.0 Infrastructure Management	**6 Points available**		
Credit 3.1	Light Pollution Reduction	1 Point	
Credit 3.2	Noise Pollution reduction	1 Point	
Credit 3.3	Visual Pollution reduction	1 Point	
Credit 3.4	Air Pollution Reduction	1 Points	
Credit 3.5	Material Recovery	1 Point	
Credit 3.6	Preserve Archeological Sites and Heritage Buildings	1 Point	
Credit 3.7	Disaster Resilience in Infrastructure		
Credit 3.7.1	Resilient Spatial Planning		2

Credit 3.7.2	Resilient Buildings and Infrastructure		2
Credit 3.7.3	Protective Structures and Barriers		1
Credit 3.8	Management and Monitoring Mechanism for Buildings		2
4.0 Waste Management		**5 Points available**	
Prerequisite 1	Solid Waste Management Plan of the City	Required	
Prerequisite 2	Assess the Nature & Volume of Solid Waste	Required	
Credit 4.1	Waste Performance Score	3 Points	
Credit 4.2	Special Waste Streams Management	2 Points	
Credit 4.3	Smart Waste Management Systems	1 Point	
5.0 Transportation Facilities	**20 Points available**		
Credit 5.1	Transit Network	6 Points	
Credit 5.2	Sidewalks and Pedestrian Facilities	3 Points	
Credit 5.3	Bicycle Lanes and Cycling Facilities	2 Points	
Credit 5.4	Urban Traffic Management and Parking Management	4 Points	
Credit 5.5	Travel Demand Management (TDM)	2 Points	
Credit 5.6	Transit Oriented Development (TOD)	2 Point	
Credit 5.7	Alternative Energy Driven Vehicles	1 Point	
6.0 Water Efficiency	**18 Points available**		
Prerequisite 1	Water Quality	Required	
Credit 6.1	Water conservation	3 Points	
Credit 6.2	Innovative Treatment and Transmission of water	2 Points	
Credit 6.3	Water System Performance	2 Points	
Credit 6.4	Rainwater Harvesting	3 Points	
Credit 6.5	Storm water Management	2 Points	1
Credit 6.6	Wastewater Management		
Credit 6.6.1	Wastewater Treatment	3 Points	
Credit 6.6.2	Re-use treated wastewater	3 Points	
7.0 Energy and Atmosphere		**9 Points available**	
Prerequisite 1	Enhanced Electricity Accessibility and Monitoring	Required	
Credit 7.1	Energy Audit	3 Points	
Credit 7.2	Encourage to Use of Renewable Energy	2 Points	
Credit 7.3	Greenhouse Gas Emissions Management	4 Points	
8.0 Social, Cultural and Economic Achievements		**17 Points available**	
Prerequisite 1	Demographic Assessment	Required	
Credit 8.1	Social Housing Initiatives & Social Initiatives		
Credit 8.1.1	Housing Initiatives	2 Points	
Credit 8.1.2	Social Initiatives	1 Point	1
Credit 8.2	Quality of Life Performance	6 Points	
Credit 8.3	Affordable Housing	1 Point	
Credit 8.4	Accessibility of Elderly and Persons with disability	1 Point	1
Credit 8.5	Implementing Circular Economic Practices	2 Point	
Credit 8.6	Recognize Cooperate Social Responsibility (CSR) with sustainability focus	1 Point	
Credit 8.7	Promotion of Sustainable Products & Services		
Credit 8.7.1	Promotion of Sustainable Local Products & Services and Sustainable Consumption Habits	2 Point	
Credit 8.7.2	Undertaking training /education & research on sustainable	1 Point	

	product & services		
Credit 8.8	Community Engagement in Disaster risk reduction activities and planning process		2
9.0 Innovation		**2 Points available**	
Credit 9.1	Exemplary performance	2 Points	
Credit 9.2	Innovation in Resilience		
Credit 9.2.1	Innovation to address climate change and hazard risk		1
Credit 9.2.2	Innovative interventions for attitude change towards resilience		1
Credit 9.2.3	Integrate Global warming Impact to all estimates		1

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INTRODUCTION TO GREEN BUILDING COUNCIL OF SRI LANKA (GBCSL)

Going green is no strange concept to us Sri Lankans, having a proud history of great civilizations with structures and monuments together with irrigation systems that impress the entire world even today. The balanced lifestyle and coexistence with nature, which is provided to the human society, is the ultimate goal of GBCSL's endeavor.

The GBCSL came into existence as a result of an emerging trend towards applying the greener concepts for built environment and now expand its interests on applying green concepts for construction materials, transport infrastructure and for cities.

The GBCSL launched in November 2009 as a non-profit organization is committed to develop a sustainable building industry for Sri Lanka by encouraging the adoption of green building practices. It is uniquely supported by both industries and government institutions across the country.

The GBCSL is now granted with "Emerging Member Status" by the World Green Building Council, which represents about 80 countries ranging from developed to developing nations world-wide.

Currently Prof. Ranjith Dissanayake leads the GBCSL as the chairperson while the board comprises of expert academic advisors and industrial agents.

Board Members

- **Prof. Ranjith Dissanayake (Chairman)**

Senior Professor at the Department of Civil Engineering, University of Peradeniya, Sri Lanka

- **Prof. Priyan Mendis (Founder Chairman)**

Professor at the Department of Civil and Environmental Engineering, University of Melbourne, Australia

- **Eng. Shiromal Fernando (Vice Chairman)**

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Committees of the Council

- Green Environmental Rating System & Life Cycle Assessment
- Transport Infrastructure in Built Environment
- Education & Training
- Awareness & Publicity
- International Relations
- Membership
- Volunteer Force

Institutions that have taken leadership in establishing GBCSL

- Sri Lanka Standards Institute (SLSI)
- Sri Lanka Institute of Architects
- The Institution of Engineers Sri Lanka
- Society of Structural Engineers Sri Lanka
- National Construction Association of Sri Lanka
- Institute of Quantity Surveyors of Sri Lanka
- National Academy of Sciences Sri Lanka
- Sri Lanka Institute of Nanotechnology
- Institute of Town Planners Sri Lanka
- Department of Civil Engineering, Department of Mechanical Engineering and Faculty of Architecture - University of Moratuwa
- Department of Civil Engineering - University of Peradeniya
- Department of Civil & Environmental Engineering - University of Melbourne

VISION OF GREEN BUILDING COUNCIL OF SRI LANKA

Our Vision is to transform the construction industry in Sri Lanka with traditional building practices and fully adopt sustainability as the means by which our environment flourishes, the economy prospers and society grows to ensure the future wellbeing of our motherland.

MISSION OF GREEN BUILDING COUNCIL OF SRI LANKA

The Mission is to develop the sustainability of the built environment by transforming the way it is planned, designed, constructed, maintained and operated and drive the adoption of green building practices through market- based solutions while helping to forge a new partnership between government, industry and other stakeholders.

INTRODUCTION TO GREEN$^{SL®}$ RATING SYSTEM FOR SUSTAINABLE CITIES TOOL

A Sustainable City can be defined as a city which shows high environmental performance relative to established benchmarks in terms of; quality of environmental assets (air, water, land/soil and biodiversity), efficient use of resources (water, energy, land and materials) while maximizing the economic and social co-benefits and considering its context (population size, socio-economic structure and geographical and climate characteristics). Most of the developing countries are now following this concept towards mitigating and adapting to, risks deriving from the global scale disaster, climate change.

The current world population of 7.7 billion, expected to reach 8.6 billion in 2030 and 9.8 billion in 2050 residing more people in urban areas than in rural areas. Almost 90% of this population growth happening in Asia and Africa. It is impossible to neglect the fact that there are no non-urbanized developed countries as the cities contribute over 80% of the global GDP being the major economic and financial hubs. (Cheshmehzangi, 2016). “The Status of Sri Lankan Cities 2018” Report by UN-Habitat reveals that the main have expanded rapidly over the past two decades at a rate of 6.42% per year and the new estimate for the urbanization in Sri Lanka is around 42%.

This trend will continue to grow as people migrate from rural areas to urban areas for better employment opportunities and standard of living. Also, Urban Sprawl has been identified as a major issue related to urban development because it increases the cost of service provision while causing major issues for environmental sustainability such as climate change, pollution, congestion and substandard living conditions. The onset of COVID-19 pandemic is an eye opener on the extent of environmental degradation that has taken place and the need to take urgent measures for the protection of environment and maintain environmental sustainability.

Therefore, in this context, one of the solutions that can be given is the concept of

‘Sustainable Cities’ where the growing urbanization is encouraged to embrace sustainable urban development principles into city planning framework while supporting to achieve SDGs (Sustainable Development Goals) stated by United Nations by 2030.

Thus, Green Building Council of Sri Lanka has developed a Sustainable City Rating tool to assess the cities according to the developed framework where these Green cities will balance social, economic and environmental dimensions based on a good urban governance as its foundation. Urban Planners, Urban Designers, Architects and Engineers can work together with local administration and communities to ensure that integrated planning and design can create a city based on sustainable planning principles to minimize the negative impacts on environment while improving the overall quality of city living.

Sustainable Cities Rating System of the Green Building Council of Sri Lanka is developed as a tool to recognize and promote sustainable urban development practices by establishing a bench mark for a sustainable city profile in Sri Lankan context.

The rating system is aimed at local government sector for developing and managing existing and new cities or for private sector investors and public-private partnerships, engaged in developing new urban centers in Sri Lanka.

The main feature of the rating system is the focus on community participation and the requirement to broad base the green initiatives for wider public participation in order to achieve the recognition.

Attributes Considered When Developing Sustainable Cities Rating Tool

Overall rating system is developed within a broad framework in order to achieve the following attributes considered as important to long term sustainability.

- Enhanced Livability
- Environmental Responsibility
- Economic Prosperity
- Social Inclusion
- Innovation & Design Excellence
- Strong Leadership & Commitment

Main Segments of the Rating System

The rating system recognizes the city profile under the following nine (09) segments and evaluates the impact of the initiatives undertaken against each segment based on the detailed guide lines stipulated:

1. Management
2. Ecology and Conservation
3. Infrastructure Management
4. Waste Management
5. Transportation Facilities
6. Water Efficiency
7. Energy and Atmosphere
8. Social, Culture and Economic Achievements
9. Innovation

The Rating System

- The rating system identifies points to be allocated (out of 100) under each of the nine segments of the sustainable city profile and each segment is expanded to include number of sub segments identified as cre3dits to cover a wider ambit of sustainable action or green initiatives.
- The system also focuses on the macro issues in the urban environment while recognizing the important micro features contributing to improving the overall quality of the urban environment all initiatives will be evaluated in this context.
- One of the main objectives of the rating system is to act as a catalyst for stimulating and attracting community participation to achieve environmental sustainability. Therefore, it is expected that the majority of the initiatives undertaken are focus on wider public participation and voluntary action.
- The rating system is based on a continuous assessment spanning a period of two years. Therefore, performance of the strategies and interventions to achieve sustainability under stated segments will be periodically assessed.

Ratings Offered

Pre requisites

Each segment in the points system identifies pre requisites that needs to be complied with, in order to qualify for points under the respective segments.

The point system

The points allocated under each segment is clearly indicated and guidelines are provided to meet the requirements and claim points under each segment. For clarity each segment is divided into number of sub segments identified as credits the point's allocation and the expected output under each sub segment (credit) are specified in the system.

Rating offered

In the point system following ratings are offered

Points	Rating Offered
40-49	Certified Sustainable and Resilient Coastal City
50-59	Sustainable and Resilient Coastal City Silver
60-75	Sustainable and Resilient Coastal City Gold
75 and above	Sustainable and Resilient Coastal City Platinum

Interim Rating

On submission of an application for rating, GBCSL shall commence processing of the application and shall provide guidelines to follow up on the procedure.

After six months an evaluation will be undertaken and GBCSL shall award 'emerging green city' status if satisfactory follow up action has been taken to achieve the stated sustainability targets.

At the end of one year, a further evaluation shall be undertaken and if satisfactory progress has been made a ‘provisional rating’ shall be assigned.

The final award shall be made on submission of a compliance report and a request for the award, claiming points as per the point system stipulated. (A guideline for the preparation of the report shall be provided by the GBCSL).

An independent evaluation by an expert panel appointed by GBCSL shall be undertaken on receipt of the compliance report. Subsequently a final evaluation shall be undertaken by a jury appointed by the council and recommendation made to the GBCSL for an award based on the recommendation. The applicant shall be given an opportunity present and justify the claim to the jury who will also visit the subject city before the determination of the rating.

Categorization of Cities for Rating

In-order to encourage sustainable urbanization at different scales, the rating shall be offered under three categories based on the number of inhabitants in each city:

Small City - 5,000 or more inhibitants

Medium City - 50,000 or more inhibitants

Large City- 150,000 or more inhabitants

The population thresholds were decided based on the population statistics related to existing urban centers in Sri Lanka. This will be periodically reviewed by the councils and the threshold will be adjusted. In order to ensure that the rating is assigned to urban centers, a minimum density of 60 persons per hectare is required within the identified city area for which rating is requested.

GLOSSARY

- **City**

A large and densely populated urban settlement

- **Green City**

A Green City is a city which shows high environmental performance relative to established benchmarks in terms of;

i) quality of environmental assets (air, water, land/soil and biodiversity)

ii) efficient use of resources (water, energy, land and materials)

iii) mitigating, and adapting to, risks deriving from climate change

while maximizing the economic and social co-benefits and considering its context (population size, socio-economic structure and geographical and climate characteristics)

- **Ecosystem**

An ecosystem is a community of living organisms and their physical environment that interact as a functional unit.

- **Green Space**

A patch of vegetated land for predominantly recreational use. It may include assets of different scales from green roofs or pocket gardens to large urban parks.

- **Green Infrastructure**

A strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services It is present in both rural and urban settings. In urban areas, many different features may be part of the green infrastructure (e.g. parks, gardens, grassy verges, green walls or green roofs) as far as they are part of an interconnected network and are delivering multiple ecosystem services. These green urban elements (or blue if aquatic ecosystems are

concerned) may be found within the city and in its peri- urban area.

- **Green Building**

Green building is a holistic concept that starts with the understanding that the built environment can have profound effects, both positive and negative, on the natural environment, as well as the people who inhabit buildings every day. Green building is an effort to amplify the positive and mitigate the negative of these effects throughout the entire life cycle of a building.

- **Landscape**

The traits, patterns and structure of a specific geographic area, including its biological composition, its physical environment and its anthropogenic or social patterns. An area where interacting ecosystems are grouped and repeated in a similar form

- **Land use**

Land use describes the social and economic purposes for which land is managed (e.g. housing, intensive agriculture or transport). It comprises all the activities undertaken in a certain land-cover type

- **Landfill**

Landfill is engineered depression in the ground into which waste is put.

- **Urban Sprawl**

The unplanned and uncontrolled growth of urban areas into the surrounding countryside. Urban sprawl is the physical pattern of low-density expansion of large urban areas under market conditions into the surrounding agricultural areas. Development is patchy, scattered and strung out, with a tendency to discontinuity because it leap-frogs over some areas, leaving agricultural enclaves.

- **Urban Heat Island Effect**

The urban heat island is a microclimatic phenomenon that occurs in

urban areas, and results in a tendency to be hotter than its surroundings. It consists in a significant increasing of the temperature in the urban area respect to the surrounding peri- urban and rural neighborhoods.

- **Urban Resilience**

The ability of a city as a socio-ecological-infrastructural system and its component parts to absorb and recover from shocks whilst retaining the essential same functions and identity, to adjust to stresses and learn from them to reorganize and develop, and to transform in order to adapt to social- economic and environmental changes, which involves framing resource management according to resource availability within this system over different temporal and spatial scales

- **Sustainable Mobility**

The ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future

- **Smart power grid system**

Interconnected grid with;

1. Distributed, regional and central generation
2. Hybrids (multiple means) of power generation at each scale
3. Smart sensors in buildings for efficient use
4. Smart technologies to designate critical areas during power losses
5. New generation batteries and other storage technologies

- **Environmentally Degradation**

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution.

- **Light Pollution**

Waste light from building sites that produces glare, is directed upward to the sky, or is directed off the site. Waste light does not increase nighttime safety, utility, or security and needlessly consumes energy.

- **Noise pollution**

Unwanted or excessive sound that can have deleterious effects on human health and environmental quality.

- **Visual pollution**

Visual pollution is an aesthetic issue, referring to the impacts of pollution that impair one's ability to enjoy a vista or view.

- **Travel Demand Management (TDM)**

A collection of strategies designed to reduce automobile trips and associated roadways congestion and parking demand by redistributing travel to alternative modes, times and routes

- **Transit Oriented Development (TOD)**

Transit-oriented development is a mixed-use residential and commercial area designed to maximize access to public, and often incorporates features to encourage transit ridership. A TOD neighborhood typically has a center with a transit station or stop (train station, metro station, tram stop, or bus stop), surrounded by relatively high-density development with progressively lower-density development spreading outward from the center.

- **Renewable Energy**

Renewable energy is a source that is, within a short time frame relative to the earth's natural cycles; sustainable, and include non-carbon technologies such as solar energy, hydropower, and wind, as well as carbon-neutral technologies such as biomass. Renewable energy resources capture their energy from natural energy sources, such as sunlight, wind, hydropower, biogas and geothermal heat that are self-replenishing (as opposed to non-renewable energy sources, e.g., oil, gas and coal, that can be used only one time).

- **Greenhouse Gases**

Any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and reradiating it back to Earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapor are the most important greenhouse gases. (To a lesser extent, surface-level ozone, nitrous oxides, and fluorinated gases also trap infrared radiation.)

- **Social Housing**

Housing provided for people on low incomes or with particular needs by government agencies or non-profit organizations.

- **Circular Economy**

An economic system aimed at eliminating waste and the continual use of resources. Circular systems employ reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system, minimizing the use of resource inputs and the creation of waste, pollution and carbon emissions.

- **Supply chain**

A network between a company and its suppliers to produce and distribute a specific product to the final buyer. This network includes different activities, people, entities, information, and resources. The supply chain also represents the steps it takes to get the product or service from its original state to the customer.

- **Sustainable consumption**

Sustainable consumption is the use of material products, energy and immaterial services in such a way that their use minimizes impacts on the environment, so that human needs can be met not only in the present but also for future generations.

- **Vulnerability**

Vulnerability is the degree to which a system is susceptible to and unable to cope with the adverse effects of injury, damage or harm (Source: IPPC. Methodological and Technological issues in technology transfer). This term normally refers to climate change effects. In this sense, urban vulnerability depends on the character, magnitude, and rate of climate change events and, on the other hand, on the city's sensitivity and adaptive capacity to them.

GREEN$^{SL®}$ RATING SYSTEM FOR SUSTAINABLE CITIES

Version 1.0

MANAGEMENT

1.0 MANAGEMENT

Prerequisite 1: Green Building Accredited Professionals and Commitment

Required

Intent

Support and encourage the involvement of GBCSL Accredited Professionals in the implementation of green initiatives in Sustainable Cities.

Requirement

At least two principal participants of the Sustainable Cities Implementation Team shall be GBCSL Accredited Professionals.

AND

Form an interdisciplinary team with at least one professional from each category is stated as below. However, those 3 professionals should have a reasonable knowledge about the other areas as well.

- Category 1
  - Urban Planner
  - Architect / Urban Designer
  - Ecologist/Landscape Architect
- Category 2
  - Civil Engineer
  - Mechanical, Electrical and Plumbing (MEP) Engineer
  - Quantity Surveyor / Valuer
  - Sustainability Consultant
- Category 3
  - Financial Specialist/ Urban Economist
  - Real Estate Specialist
  - Management Specialist

At least 1 of the above professionals should have the Disaster Risk Reduction/ Disaster Management Expertise.

Any other experts or stakeholders can be included as relevant to the city or community.

Potential Technologies and Strategies

The Accredited Green Building Professional must be engaged in the Green City assessment process from the initial planning stage to the completion of the final assessment.

1. The Accredited Green Building Professional should;

- Attend all planning and evaluation meetings of the proposed green city project
- Participate site visits and site assessment activities
- Prepare progress reports and forward preliminary submission to the GBCSL using the Preliminary Submission Format
- Prepare all necessary documentation for the final submissions to the Evaluation Panel with the assistance of all the other professionals engage in the green city assessment process.

2. disaster management specialist should participate all site visits and site assessment activities.

Submittals

1. List of interdisciplinary team

2. Site visit/ site assessment records

Prerequisite 2: Citizen Engagement

Required

Intent

Encourage citizen-based development process, thereby improving government-citizen interface.

Requirements

A public/community consultation mechanism to ensure public/community participation should be available. Participation of a Community Based Organization (CBO) or a Community Interest Group (CIG) shall be acceptable if a formal understanding of their role in the process is established and *a community embedded urban planning and designing process is in place that makes use of local, indigenous knowledge in identifying hazard prone areas, and the strengths and weaknesses of the area in terms of disaster risk and local disaster risk management strategies.*

Local Information and details on previous natural hazards, risk and risk management strategies are incorporated into public awareness programs and should be easily accessible to general public.

In order to make the process inclusive from the inception, applicant shall engage a Community Based Organization (CBO) or a Community Interest Group (CIG) to work hand in hand with the community to involve them in the process and ensure that commitment and responsibility to achieve and maintain sustainability and disaster resilience is generated within the community.

Submission Requirements

- Submit a written consent document from the community organization clearly identifying their commitment, responsibility and agreement for the initiative.
- Provide evidence of the CBO/CIG for their community involvement programs held in the city or held for the city.
- Narrative describing the community engagement techniques
- Agenda/Report on monthly/annual awareness programmes, mock drills of

emergency response scenarios conducted to public on disaster preparedness

Prerequisite 3: Emergency Preparedness Information and Instructions Manual

Intent

To make sure every building in the city is well prepared, equipped and ready for a emergency response situation arising from potential natural hazards.

Required

Case 1

For public buildings and private commercial buildings (Buildings fall into Category A and B of Urban Development Authority General Regulation Ex: public buildings, hotels, banks, hospitals, shopping malls, grocery malls)

Develop an emergency preparedness information and instructions manual including model emergency operating procedures and a building contact directory which can be used before or at a time of a disaster.

Emergency Preparedness Information and Instructions Manual should include the following sections,

- *Introduction to the manual*
- *Applicable Vulnerable hazards and scenarios*
- *Critical Operational Functions, Systems, and Supplies*
- *Roles and Responsibilities during a hazard or an emergency*
- *Coordinating/Integrating during a hazard or an emergency*
- *Evacuation plan (routes, Shelters and stakeholder involvement, etc) including evacuation of disable and people with special health needs during an emergency*
- *Building contact & safety directory including all emergency contacts*

• *Model emergency operating procedures*

• *Training and Education*

• *Recourses and references*

Case 2

For all residential buildings in the city

Develop a common emergency preparedness information and instructions manual including model emergency operating procedures written in native language which can be used before or at a time of a disaster.

Emergency Preparedness Information and Instructions Manual should include the following sections,

• *Introduction to the manual*

• *Applicable Vulnerable hazards and scenarios*

• *Identification of people with special needs*

• *Roles and Responsibilities of family members during a hazard or an emergency*

• *Coordinating/Integrating during a hazard or an emergency*

• *Evacuation plan (routes, Shelters and stakeholder involvement, etc.) developed by the city authorities including evacuation of disable and people with special health needs during an emergency*

• *all emergency contacts of relevant authorities and assisting agencies*

• *Model emergency operating procedures with examples in simple language*

• *Recourses and references*

Submittals

Emergency Preparedness Manuals for Cases 1 and 2 and compliance check form/report issued from the local authority

Prerequisite 4: Eco Vision of the City

Required

Intent

Encourage the city to recognize the areas in the city that are poor in environmental performance and develop a proposal demonstrating the city's vision in encompassing principles of sustainability, thereby enabling the city to prioritize in terms of infrastructure upgrade and policy reforms.

Requirement

Examine and report the city's significantly problematic areas in terms of poor performance in environment, social and economic domains. Based on that, develop a holistic Eco vision of the city to ensure environmental sustainability and disaster resilience. The Eco vision should include measurable goals to achieve sustainability and resilience in the following aspects:

- Land Use Planning
- Green Cover and Open Spaces
- Sustainable Mobility
- Solid Waste Management
- Water Efficiency
- Energy Efficiency
- Green Buildings/Infrastructure
- Community Participation
- Management of natural streams
- City Landscaping

The Eco-vision should reflect the city's milestones towards sustainability and Resilience.

Submission Requirements

- Brief review report on the city's problematic areas, areas that need to be improved
- Submit extract of Policy Document or Development Plan / Master Plan / Project Report(s) highlighting the Eco-vision of the City as well as goals and implementation strategies for each of the aspects stated above.

Credit 1.1 Application of Appropriate Technologies and Information & Communications Technology (ICT) Integration

1 Point

Intent

To encourage application of appropriate technologies and the use of innovative ICT applications thereby minimizing the negative impacts on environment, to improve the overall performance of the city and support disaster response mechanisms.

Requirements

Encourage to incorporate some of the following technological applications appropriate to the city plan to ensure a better performance.

- On/off automatic controls for street lighting
- Smart metering for water supply at consumer level
- City dashboard system for real time performance tracking for infrastructure facilities such as power, water, waste, transport, air quality, etc.
- Smart power grid system
- Real time travel response
- Smart irrigation system for city landscape
- Automatic vehicle location and tracking
- Any other ICT applications contributing to environmental performance of the city
- Deployment of ICT Tools to increase the efficiency of data flow in disaster response
- Online platforms specifically designed for the public of the city to provide suggestions and feedback in the planning process of new developments and infrastructure changes in the city.

Submission Requirements

- Submit extract of development plan, master plan, project report, highlighting list of all technological and ICT applications planned or proposed within the city area including the time line.
- Provide links to the online platforms available for public consultation
- Provide a narrative on technologies, applications and the management plan.

Credit 1.2: Integrated Planning

2 Points

Intent

Intent is to ensure the high-performance and cost-effective outcomes through interrelationships between the city and its community.

Requirement

The work plan to achieve the rating within a span of reasonable time should be prepared with milestones established to achieve sustainability. It is recommended that the work plan is prepared considering the segments in the rating system covering all important activities identified.

An input schedule should also be prepared identifying the inputs of the professionals in the team, together with details of community participation and stakeholder inputs supplementing the work plan with clear timeline to cover within the agreed period.

The existence of routine budget allocations as assistance to support activities that can reduce the risk of damage caused by coastal hazards is also recommended.

Potential Technologies and Strategies

Conduct regular meetings with the integrated project team to review project status, introduce new team members to project goals, discuss problems, formulate solutions, review responsibilities, and identify the next steps. The main principle of green city design is essentially about urban design efforts by creating an environment that ensures ecological functions of the city as an eco-system.

Submission Requirements

1. Submit a report including city development proposals with showing evidence of integration of different aspects and key stakeholders.

2. Compliance reports/clearance from the local authority regulations

(integrated with NBRO/NHDA) and Coastal Conservation Department for new developments in the city.

3. Approved budget for Disaster Risk Reduction activities and proof(bills) of expenditure from the same.

Credit 1.3: Recognize GREENSL® Rated Built Environment

1 Point

Intent

Intent is to recognize GREEN^{SL} rated Built Environment in the city that under assessment.

Requirements

Existing Buildings: Register for green certification of existing buildings above 4000 square feet that are owned and/or operated by the local government or another governmental authority under the Green^{SL} rating system for existing buildings certification system.
Points are awarded as per Table 1;

New Buildings: Influence all new constructions undertaken by the City Council or the community to achieve Green^{SL} rating system for built environment certification system.

Table 1: Points allocated for number of GREEN certified buildings

Category	Number of buildings registered or certified under the GREEN$^{SL®}$rating system	Points
Small City	≥1	1
Medium City	≥3	
Large City	≥5	

****** To get this point in addition to having above mentioned number of green buildings, the city council should recognize these as green buildings.

Potential Technologies and Strategies

Follow the guidelines in Green^{SL} Rating System for Built environment version 2 and Green^{SL} Rating System for Existing Buildings.

Submission Requirements

- Submit a report including total number of green rated buildings

within the city with relevant certification documents.

- Evidence of recognizing the GREEN certified buildings in the city by the city council.

ECOLOGY AND PRESERVATION

2.0 ECOLOGY AND CONSERVATION

Required

Intent

Prerequisite 1: Assess the Existing Ecosystem

To assess existing ecosystem conditions and services provided by ecosystems, built landscapes, and other open spaces to guide the city development along with conservation, restoration and rehabilitation efforts.

Requirements

- Investigate the city's unique topographical, environmental, biodiversity, hydrological and other ecological features and produce reference in the form of maps.
- Identify the availability and protection techniques of sand dunes
- Identify the availability of mangroves and further development spaces in terms of more land utilization and improved landscaping techniques for Tsunami risk reduction.
- Assess the existing beach condition and requirement of any beach nourishment
- Where there is limited mangrove cover, the below -mentioned vegetation schemes can be implemented.
  Recommended species: Casuarina, Cocos, Pandanus, etc.,
  Two layers of vegetation - odoratissimus and equis etifolia in the vertical direction
  where Pandanus odoratissimus is in the front rows)

Potential Technologies and Strategies

Green city implementation team should begin by collecting a wide range of information such as topography, soils, vegetation and habitats, hydrology and aquatic ecosystems data. The assessment should demonstrate the relationships between the features and topics listed above and how these features influenced the city development. Some information are available in following websites.

- https://www.survey.gov.lk/
- http://www.agrimin.gov.lk/web/
- http://www.disastermin.gov.lk/web/
- https://www.iucn.org/

Submittals

- Submit map (s) in the city area by illustrating key details such as topography, soil type, land use, vegetation, hydrology and aquatic ecosystems, sources of pollution and degraded ecosystems. Composite maps in this regard is preferred.
- Submit a list of threaten species (flora and fauna) within the city.
- Submit the report of the beach assessment with suggested remedial measures
- Submit the current arrangement and improvement plan of coastal mangroves/ vegetation schemes.

Credit 2.1: City Spatial planning

5 Points

Credit 2.1.1: Existence of Green Coverage

2 Points

Intent

Increase the green coverage of the city to enhance the environmental performance and to develop the human wellbeing.

Note: Green space is defined as land that is partly or fully covered with trees, shrubs, grass or other vegetation. This includes urban parks, trails and community gardens including roof top or vertical gardens.

Requirements

Provide easily accessible green coverage. Points are awarded as per Table 2;

Table 2: Points allocated for green coverage

Urban green space per capita	Points
12.0 m^2	1
15.0 m^2	2

Potential technologies and strategies

Should assess available green space in the city and decide whether to add more green spaces to the city or conserve the available space. City planners and design professionals have to find ways to incorporate accessible green-spaces to city such as; green roofs, green walls, parks and reserves, sporting fields, riparian areas like stream and river banks, greenways and trails, community gardens, street trees (nature stripe along roadsides) and nature conservation areas. Also, any program to increase green cover through tree planting campaigns, cleaning and greening of reservations, community action for protection of green areas with integration of public activities for better surveillance are some of the actions qualify for this point.

Submission Requirements

- Provide a map marking City's significant green cover and open spaces
- Tree inventory of the city
- Submit the per capita ratio of trees calculation and the method of calculation

7.1.2 Credit 2.1.2: Accessibility for Public to Green and Open Spaces

3 Points

Intent

Encourage easy accessibility for public to green and open spaces thereby enabling such spaces to be used by majority of the population, making a city healthy and livable and also facilitating effective evacuation during disaster response scenario.

Note:

Public green spaces include parks, botanical gardens, and riparian areas along water bodies.

Open Spaces include public playgrounds, multi-open space (median), sports complex etc. This shall not include areas under water.

Public access restricted areas will not be considered

Requirements

For public green/open space accessibility, points are awarded

as per below. if

- Less than 25% of City's developed area is located within 400 m of total public green space/open spaces; 1 point
- Between 25% - 40% of City's developed area is located within 400 m of total public green space/open spaces; 2 point
- More than 40% of City's developed area is located within 400 m of

total public green space/open spaces; 3 points

UDA General Regulation part1 and Town and Country Planning ordinance where the parcel of land or site to be sub divided exceeds 1.0 hectare, and area of not less than 10 per centum of the land or site, excluding street shall be reserved for community and recreation and open space uses in appropriate locations expect in the following instances:

in residential land sub divisions, if the minimum land parcel of the sub division is not less than 1012 sq.m (40 perches) and the development is limited to two housing units per lot the land may be sub divided without reserving 10% of the land for open space uses but subject to the condition that in the event of further sub divisions or constructions of more than two housing units per lot, the developer should deposit the market value of 10% of the land so sub divided or developed to the authority

Open /space around buildings

Public open spaces should be linked with green corridors and should be designed to be used as safe evacuation places. For example, the open space network is used as evacuation points and the road network as evacuation rotes which will be linked with the public open spaces for improved access in case of emergency as a DRR passage. *Also,* public opens spaces are designed with a minimum of physical development to enable their use as a place for gathering in an emergency. *Specific design features are introduced to increase the resilience for open public spaces to mitigate the effect from natural disasters, for example, barrier walls to regulate and slow down the waves from a tsunami.*

Submission Requirements

- Provide map marking City's significant public green spaces and open spaces.
  Demarcate the developed area that lies beyond 400 m of the green/open spaces.
  Emergency evacuation map and procedures

Credit 2.2: Restore, Rehabilitate and Conserve Natural Resources

3 Points

Intent

To preserve and restore the natural resources within the city or community. By adopting existing environmental regulations and using native plants to suit local environmental conditions.

Requirements

- Submit a document indicating the strategies taken so far by the city council to restore/rehabilitate and conserve existing natural resources.
- Submit a natural resources conservation and restoring plan based on the study carried out under Prerequisite: Assess the Existing Ecosystem
- Submit a proposal for coral reef restoration / beach nourishment according to the need identified in the “Assess the existing ecosystem” credit
- Formulate and implement shoreline management plans/coast protection schemes to minimize impacts of coastal erosion while enhancing stability of the coastal natural features
- Proof of availability of legal procedures against sand mining.

Credit 2.3: Reduce Heat Island Effect

3 Points

Intent

Mitigate urban heat islands to improve the microclimate.

Credit 2.3.1 Reduce Heat Island Effect- Roads

2 Points
Requirements

For Carriage-way and Service Roads

- Have an inventory of shaded carriage-way and service roads.
- Provide one or a combination of the following measures for carriage-way and service (arterial, sub-arterial, collector and local roads):
  - Shade from tree cover
  - Cool pavements
  - Or a combination

Table 3: Points allocated for percentage of shaded areas or cool pavements

Percentage of shaded areas or cool pavements from total road areas of carriage - way/ service roads	Points
≥ 20%	1
≥ 30%	2

Note: Cool pavements are defined as reflective pavements that help lower surface temperatures and reduce the amount of heat absorbed into the pavement. The Solar Reflective Index (SRI) value of cool pavements shall be at least 29 (and not higher than 64) (Source: Reducing Urban Heat Islands: Compendium of Strategies for Cool Pavements, U.S EPA, 2009).

Submission Requirements

- Identify responsible maintenance agencies and their methodology of maintenance.
- Detailed plan which is clearly indicating the shaded pavements, trees and shrubs.
- Submit the calculation and the methodology.

Credit 2.3.2 Reduce Heat Island Effect- Roof and Vertical Facades

2 Points
Requirements

For exposed roof areas and vertical facades (external) of all buildings

- Establish a policy to incentivize buildings that use high reflective roofing material (or) vegetation (or) combination, to cover the exposed roof areas. Points are awarded as Table 4;

Table 4: Points allocated for percentage of vegetated roofs, high reflective roofing material or combination

Percentage of vegetated roofs, high reflective roofing material or combination over total exposed roof area and vertical green gardens	Points
≥ 25%	1
≥ 50%	2

Submission Requirements

- Submit the SRI calculation and the methodology.
- Submit extractions of local development regulations/mandates/policies encouraging the incorporations of vegetated roofs /high reflectance roofing materials
- Submit extractions of local development regulations/mandates/policies encouraging the incorporations of vertical green elements /high reflectance walling materials and finishing materials.

Credit 2.4: Resilience Planning

4 Points

Intent

To strengthen the resilience of communities to climate change risks, natural hazards and extreme events.

Credit 2.4.1 Vulnerability and Capacity Assessment

2 Points

Requirements

Identify the local environmental context and conduct a vulnerability and capacity assessment for climate change risks, natural hazards and extreme events such as; landslides, tsunamis, floods, wildfires, earthquakes, cyclones, storms, disease epidemics and so forth.

Potential Technologies and Strategies

- Vulnerability and Capacity Assessment – Assess the most exposed and affected sections of the city and community for above mentioned risks.
- Adaptation and Mitigation Goals - Set goals based on the vulnerability and capacity assessment
- Usage, upgrading and connecting with the zonal warning systems of the following hazard maps or having self-developed hazard maps for the city
  - Landslide Hazard Zonation Maps (NBRO)
  - Flood Hazard Maps of the River Basins (Irrigation Department)
  - The Map of Wind Loading Zones Sri Lanka (NBRO)

  Ex: Utilization scheme;
  an assessment for
  a) potential for significant damage,
  b) potential for high disruption, and
  c) potential for interactive and collateral damage

- Fire hazard mitigation and response strategies

Submittals

- Vulnerability and capacity assessment report of the city for Tsunami, heavy winds and floods.
- Self-developed Maps or Reference Maps from above sources with their utilization scheme
- Reference Documents for Fire hazard mitigation strategies for the city

Credit 2.4.2 Develop a Resilience Plan

2 Points

Requirements

Develop a Resilience Plan for the City or community

Potential Technologies and Strategies for Resilience Plan

The plan should meet at least seven of the following requirements:

- Climate Adaptation and Mitigation Strategies - Adaptation and mitigation strategies to meet the goals identified under Vulnerability and Capacity Assessment above
- Fundamental Emergency Planning and Preparedness - Access to basic needs, first aid, emergency supplies, water, food communication, temporary shelter.
- **Subject Coastal cities to a Recovery Potentiality analysis (Socio-economic and Infrastructural) based on** socio economic - Demographic structure, economic Power, self-sufficiency, health facilities, institutional robustness, social integrity, public security, Infrastructural-Alternative roads and bridges, temporary housing, lifelines
- Evacuation centers, routes with Proper signage being available
- Emergency pathways along the sidewalks should always have a backup power system to light the lighting systems along the evacuation routes during an emergency situation.
- Evacuation routes are developed as a part of public transportation systems for emergency management planning which leads to use Pedestrian Paths & Sidewalks as evacuation routes during emergencies and hazards.

- Early Warning Systems - Strategies for early warning systems and operation of critical facilities during the extreme event and post-event rehabilitation. Demonstrate at least one early warning system in practice.

- Develop standard operating procedures for traffic management during early warning and emergency situations along with the regular traffic management plan.

- Critical Infrastructure Location - Map and reduce over time any critical infrastructure that is located in designated high-risk areas.
- Access to preparedness information, emergency communication tools
- Policy Intervention - Incorporate building structure resilience strategy to withstand the potential damage due to natural hazards in the building regulations.
- Capacity Building - Design awareness programs to educate different stakeholders (at least one at community level and one at internal administrative level) about hazard management. Plan for implementation the programs at regular intervals for at least one year. The programs should have the provision for revisions after stakeholders' feedback.
- Regular First Aid training, Evacuation Training and Victim search and rescue training

Submission Requirements

- Provide statistics/data on the natural hazards the city has undergone in the last 50 years and areas that were most affected by the hazard
- Provide risk assessment of area by probability of occurrence and impact
- Identify zones which would be most affected in future
- Provide extracts of development regulations/policies/ public awareness efforts that facilitates for resilience from the identified hazards
- Provide evacuation maps and proof of signage displayed
- SOP or plans for traffic management during emergency response
- Proof for operation checks for early warning systems
- Proof of public awareness programmes and evacuation drills

Credit 2.5: Encourage Re-Generation of Environmentally Degraded Areas

2 Points

Intent

Restore or habilitate and use environmentally degraded areas in the City for future development to reduce demand for virgin land.

Note:

Environmentally degraded areas are areas previously used for industrial or commercial purposes with known or unknown pollution including soil, water or air contamination due to hazardous waste etc. These areas still have potential for redevelopment or other economic opportunities.

Requirements

- Map all the environmentally degraded areas within the city.
- Identify and prepare programs to improve & integrate environmentally degraded areas and Institute a policy to allocate future developments in environmentally degraded areas

Submission Requirements

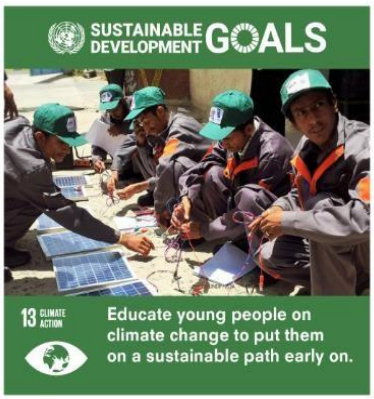
- Provide a map indicating all identified areas which are identified as environmentally degraded.
- Measures taken to re-generate identified degraded land.
- Evidence of mandates/policies/ development regulations directing /encouraging future development towards using degraded land.

Considered Sustainable Development Goal in the Criteria

Under Ecology and Preservation, the following Sustainable Development Goals set out by the UN are taken into consideration in this rating system.

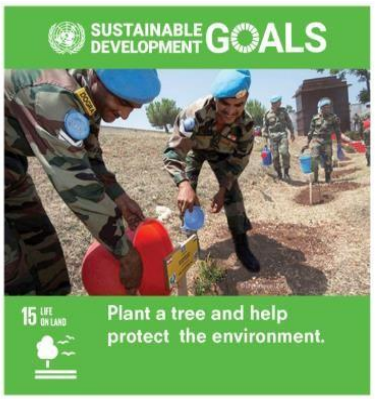
- UN SDG 11 Sustainable cities and communities,
  - UN SDG 13 Climate action, UN SDG 14 Life below Water
  - UN SDG 14 Life Below Water
  - UN SDG 15 Life on Land

Goal 11: Sustainable Cities and Communities



Goal 13: Climate Action

Goal 14: Life Below Water



Goal 15: Life on Land

INFRASTRUCTURE MANAGEMENT

3.0 INFRASTRUCTURE MANAGEMENT

Credit 3.1: Light Pollution Reduction

1 Point

Intent

To minimize and manage ambient light levels to protect public health and the integrity of ecological systems and increase the night sky access and improve nighttime visibility.

Requirements

- Prerequisite: Relevant utility agency should have proper maintenance (during its entire life cycle) plan for street light system.
- LED lamps for public space light systems which proper maintains under any authority.
  Demonstrate increased use of LED lighting load for public space light system (Ex: public parks, bus stands, market etc.) The points are awarded as Table 5;

Table 5: Points allocated for increased use of LED lighting load

Installed LED lighting load (kW) / Total lighting load (kW)	Points
≥ 30%	1

OR

- Solar lighting (or similar renewable source) for public space light system which maintains under relevant utility agency.
  Demonstrate increased use of installed solar lighting load for public space light system (Ex: public parks, bus stands, market etc.). The points are awarded as Table 6;

Table 6: *Points allocation for increased use of solar powered lighting load*

Solar powered lighting load (kW) / Total lighting load (kW)	Points
≥ 2.5%	1

Submission Requirements

- Number of public space light system installed (including type, capacity, operating system (manually or photocell controlled)
- Public space light requirement.
- Calculations/evidence to prove above lighting loads.

Credit 3.2: Noise Pollution Reduction

1 Point

Intent

To minimize and maintain the noise level standards as specified in environmental law

Requirements

The noise levels should comply with the National Environmental (Noise Control) Regulations No. 1 of 1996.

Table 7: Maximum Permissible Noise Levels at Boundaries in LAeq'T

Area	LAeq'T	
	Day time	Night Time
Low Noise	55	45
Medium Noise	63*	50
High Noise	70	60
Silent Zone	50	45

*Provided that the noise level should not exceed 60 dB (A) inside existing houses, during day time.

In specific cases, the noise levels should comply with the schedule II, III, IV, V, VI, VII, and VIII of the regulations.

Note:

"LAeq 'T' means the equivalent continuous, A- weighted sound pressure determined over a time interval T(in dB).

"Low noise area" means an area located within any Pradeshiya Sabaha area.

"Medium noise area" means an area located within any Municipal Council or Urban Council area.

"High noise area" means any export processing zone established by the Board of Investment or industrial estate approved under part IV C of the National Environmental Act.

"Day time" from 06.00 hours to 18.00 hrs,

Potential Technologies and Strategies

Incompatible land uses

- Implement zoning controls and other land use policies to limit or avoid the proximity of noisy and noise-sensitive uses.

Construction

- Noise pollution levels and standards should be issued with the construction permission.
- Local authority should monitor the site condition regularly.
- Local authority should request the noise level log reports from the contractors considering the complexity of site.

Traffic Noise

- Local authority should obtain noise level report in key locations in roads quarterly from authorized institution of laboratory and testing services.
- Evidence for proper license with relevant authorities in mitigating traffic noise.

Machinery and Equipment

- Ensure the noise levels of machinery and equipment installed in buildings are subject to the prevailing regulation.
- Implement and enforce noise standards for loud machinery equipment and can restrict on the use, location, or timing of specific equipment or activities to protect health and sleep.
- Adopt building standards to require quite interiors.

Entertainment

- Permit and monitors outdoor public events and entertainment venues which are requiring building insulation and limiting hours of operation.

Noise Reduction by Soft and Hard Landscape

- Soft landscape – Refers to the lighter elements of a Landscape design like soil, plants, flower or even color combination.

- Hard Landscape - Refers to the heavy elements of a Landscape design like stone, rocks or driveways.

Submission Requirement

- Evidence of having a procedure and a mechanism by local authority for public complains on noise levels and local authority actions on that.
- Report submit by the contractors on ambient noise levels and noise levels during construction/operation stages.

Credit 3.3: Visual Pollution Reduction

1 Point

Intent

To maintain vistas towards city character

Requirements

Identify visually polluted hotspots and provide an implementation plan to mitigate vision pollution.

Potential Technologies and Strategies

- Local Authority should provide facilities for digital advertisement facilities, however only in specific locations with reference to a standard/code of practice.
- Poster advertisements should be allowed only on local authority approved spaces and penalty system should be enforced.

Submission Requirements

- Execution plan with measures to mitigate visual pollution of the city.

Credit 3.4: Air Pollution Reduction

1 Point

Intent

To monitor and maintain air quality level to a safe level for human health.

Requirements

- Monitoring system for air pollution controls for factories and industrial activities.
- Local authority should obtain air quality monitoring report in critical areas from a competent authority of laboratory and testing services for the previous six-month period.

Submission Requirements

- Report of air quality monitoring.
- Actions plans to mitigate the air pollution if it’s higher than the safe level

Credit 3.5: Material Recovery

1 Point

Intent

To encourage material recovery towards a circular economy through 7R system

Requirements

Option 1: Extended Producer Responsibility

Collection centers must be provided within the boundary and must be equipped with facilities to collect and store the waste products pertaining to the Extended Producer Responsibility (EPR) Policy in order to transfer these to the manufacturers. Collection centers must be within or outside the city boundary and may be operated by the municipality or other organizations such as Producer Responsibility Organizations (PRO).

AND

Mandate a Manufacturers or Producer's Extended Producer Responsibility (EPR) policy for companies within the city's jurisdiction to encourage refurbishment, remanufacturing and recycling. Policy should meet all of the following requirements:

- Address (i) Electronics and Electrical Equipment (EEE) and (ii) packaging or metal cans.
- Include specific guidelines regarding channelization, collection centers, storage, transportation, environmentally sound dismantling, recycling and refurbishment.
- Mandate companies to collect and recover minimum of 60% of the total annual waste generated.

OR

Option 2: Non-recyclable Waste Generation Reporting

- Conduct a waste stream audit for all non-recyclable waste generated within the city, by either weight or volume.
- Based on the waste stream study, identify and list top five major contributing waste producers.
- Report major contribution based on source and total weight or volume of waste generated.

- Local Authority must initiate a dialogue with identified producers to take appropriate measures for the safe collection, storage and recycling/reuse to take back product into their system.

Submission Requirements

- Extended producer responsible policy should be submitted for all the industries within the city area.
- Waste stream audit report, calculations on quantity (by weight or volume) of non-recyclable waste generated within the city.
- Document describing the major producers and the measures identified for safe collection, storage shipment, recycling/reuse to take back product into their system.

Credit 3.6: Preserve Archeological Sites, Heritage Buildings and Cultural Landscapes

1 Point

Intent

To preserve historic buildings, structures and sites and focus growth and rehabilitation through adaptive reuse and conservation.

Requirements

Historic Preservation

This option is applicable to cities or communities with at least one recognizes historic building, contributing building in a historic district, or cultural landscape within the city or community boundary.

Develop an inventory of designated and eligible historic structure(s) and site(s). Consider historic buildings that are outside the city or community boundary but may be impacted by development.

Adopt a policy for alteration (rehabilitation, preservation or restoration) of any historic building or a contributing building in a historic district to ensure that following requirements are met:
Approval in the form of a certificate of appropriateness from Department of Archeology for any exterior alterations or additions for building subject to local review.
Approval in the form of a certificate of appropriateness for alteration from the Department of Archeology in case of buildings subject to national review

Potential Technologies and Strategies

Avoid development activities on archeologically sensitive areas. All development should conform to the respective heritage policies, laws and regulations such as;

- Antiquities ordinance
- Central cultural fund act
- Galle heritage foundation act
- Urban development authorities act etc.
- International protocols such as Convention Concerning the Protection of the World's Cultural and Natural Heritage by UNESCO

Submission Requirements

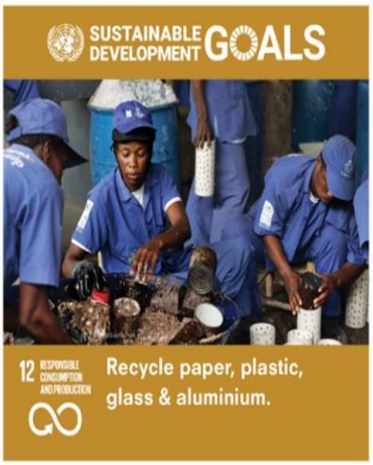
- Submit a summary report including all the information requiring in requirement section

Considered Sustainable Development Goal in the Criteria

Under Infrastructure Management, the following Sustainable Development Goals (SDGs) set out by the United Nations have been taken into consideration.

- SDG 9 - Industry, Innovation & Infrastructure
- SDG 12 - Responsible Consumption & Production
- SDG 15 - Life on Land

Goal 9: Industry, Innovation, and Infrastructure



Goal 12: Responsible Consumption and Production

Goal 15: Life on Land

Credit 3.7: Disaster Resilience in Infrastructure

Intent

To minimize the risk from potential geophysical and Hydro-meteorological hazards through implementing preventive and mitigatory measures in city infrastructure

Credit 3.7.1 Resilient Spatial Planning

A zoning overlay should be provided that restricts permitted land use/density in hazardous areas; (special hazard zones or sensitive open space protection zones)

Especially The area where the tsunami hazard level is high should be used as open space. The development in the coastal areas should also be oriented rather towards non-settlement development with lower density. The density of land use should be tied to the hazard zoning code.

Prepare a development plan which abides by the UDA regulations and H&T Ordinance.

Submittals

The development plan for the city and compliance to UDA and H&T ordinance
Arrangement of public open spaces (drawings)

Credit 3.7.2 Resilient buildings and infrastructure

A building code is more strictly applied especially for new buildings in the hazard zone.

or

When planning for new developments in the city the local authority should consult and check the compliance of guidelines recommended for respective potential hazards (landslides, Floods, Cyclones and Tsunamis) by

- National Building Research Organization (NBRO)
- National Housing Development Authority (NHDA)
- Society of Structural Engineers Sri Lanka, IESL

All developments in a coastal city should comply with the Coastal Conservation Act. (No 57 of 1981) and Town and Country Planning Ordinance of Sri Lanka.

Also, Identify the vulnerability of the roads to the following hazards through susceptibility hazard and risk maps, morphology and past records and Implement preventive measures against them prioritizing upon vulnerability

- Landslides
- Flood damage
- Tsunami risk
- Heavy winds

Submittals

- Submit a report including city development proposals with showing evidence of integration of different aspects and key stakeholders.
- Compliance reports/clearance from the local authority regulations (integrated with NBRO/NHDA) and Coastal Conservation Department for new developments in the city.
- Report consisting identified vulnerabilities and action plan for disaster risk reduction in the proposed new infrastructures

Credit 3.7.3 Protective structures and barriers

Availability of structural barriers / coastal protection/defense structures

Eg: Revetments
Sea walls
Tsunami barriers
any other structure

Submittals

Pictures and the operations schedule of any coastal defense structure available.

Credit 3.8: Management and Monitoring Mechanism for Buildings

1 Point

Intent

To ensure the resistance of buildings in the city towards potential natural hazards

Require

ments

Regular monitoring and follow-ups are in place to ensure compliance with the set objectives and targets. Specially, carryout relevant structural health monitoring checks of the building structures in specific predetermined periodic time intervals (usually annually), depending on the location of the building, under the monitoring and targeting the resilience of the buildings to withstand against the natural and other hazards.

These encompass aspects related to quality, cost and time, and disaster resilience properties and provide the opportunity to understand progress and, consequently, to take corrective actions where necessary. Monitoring and evaluation is also used to evaluate the success of the city resilience building efforts through performance indicators established within the city action plan and to measure their impacts. There are monitoring and evaluation tools to measure impact and success in place including a local level reporting system (a dedicated local authority officer) to convey the results and best practices and to identify corrective actions and revise the action plan based on feedback.

Submittals

- SOP for structural health monitoring requirements for buildings
- Compliance forms/ checklists used in such building assessments
- Building Maintenance Procedure

WASTE MANAGEMENT

4.0 WASTE MANAGEMENT

Prerequisite 1: Solid Waste Management Plan of the City

Required

Intent

Intent is to encourage and recognize developing of a proper plan for managing solid waste of the city to ensure a clean and healthy atmosphere.

Minimize disposal of waste in landfills by proper segregation of waste at source and utilize solid waste as a potential resource thereby encouraging a clean and healthy city and promote reduce, reuse, recycle and recovery principals in waste management with other appropriate technologies.

Requirements

- Provide an integrated solid waste management plan for the city.
- Comply the National waste management Policy

Submission Requirements

- Integrated solid waste management plan of the city

Prerequisite 2: Assess the Nature & Volume of Solid Waste

Required

Intent

To support sustainable waste management and move towards net zero waste.

Requirements

- Document the assumptions for differing diurnal and seasonal population if varying numbers are used to arrive at waste generation per capita.
- Identify the sources of waste generation

Submission Requirements

- Identified waste catchment area of the City
- Results of waste audits with weight per capita per day
- Total units (residential/commercial/industrial/institutional/other) within the area and population
- Zone map marked the waste collected area
- Number of units (residential/commercial/industrial/institutional/other) waste collected by local authority.

Credit 4.1: Waste Performance Score

1 Point

Intent

To examine City's waste performance, i.e.; generation, resource consumption, waste efficiency against waste performance of benchmarking communities/cities.

Note:

Municipal solid waste must include waste generation from all sectors within the city or community including but not limited to residential, institutional, commercial, other sectors and open spaces.

Construction and demolition waste are not included under this credit. Exclude land clearing debris, soil and landscaping materials.

Requirements

Conduct a waste audit and measure the total weight of waste (in lbs., kg, or tons) that is generated, and the total weight that is diverted from landfills or incineration for a minimum period of the most recent calendar year.

- Municipal solid waste generated (in metric tons per year per capita)
- Total municipal solid waste is collected by the local authority or any other organization
- Municipal solid waste diverted (% of total generated)/ recycled by the local authority or any other organization

The Waste Performance Score rates the resource consumption and resource use efficiency of the city (waste generated and diverted) against the consumption and efficiency of comparable cities or communities.

The score is a value from 1-100 based on the cities' total weight of waste generated and the total weight of waste diverted from landfills and incineration facilities.

Performance Score Calculation

To calculate the Waste Performance Score, following data is required:

- Municipal solid waste generated (quantity and quality)
- Municipal solid waste collected by the local authority or any other organization.

- Municipal solid waste diverted by the local authority or any other organization and citizens by themselves (quantity and quality)
- Total population of the city

The waste generated is converted into an average daily waste generated per occupant, using Equation 1.

Equation 1.

Average daily waste generated = (waste generated / # days associated with waste total) / occupancy

The waste diverted is converted into a daily waste not diverted per occupant, using Equation 2.

Equation 2

Daily waste not diverted per occupant = (waste diverted / # days associated with waste total) / occupancy

The daily not diverted waste is calculated using Equation 3.

Equation 3

Daily not diverted waste per occupant = daily waste generated per occupant– daily waste diverted per occupant

The project's calculated average daily waste generated per occupant AND average daily waste not diverted per occupant are input into the waste scoring function to calculate the waste performance score.

Submission Requirements

- Results of Municipal waste performance
- Extractions of expected potential measures to mitigate waste generation and adopt a waste management policy for the city

Credit 4.2: Special Waste Streams Management

2 Points

Intent

To separate Biomedical, Hazardous waste and recyclable wastes and divert special waste streams from landfill to incinerators. Encourage to recover and recycle reusable only non-infection, non-hazardous materials.

Requirements

Measure and report the total weight of waste generated under special waste streams and the total waste diverted from landfill to incineration. Submit a report including data for one full calendar or fiscal year.

Report data for each of following special waste streams:

- Waste generated through special waste streams (quantity per year)
- Waste diverted (percentage diverted)
- The sources which generate biomedical and hazardous waste

Report the ongoing special waste management measures and propose sustainable waste management strategies for the special waste streams.

Special wastes are defined as non-municipal solid waste generated within the city or community, including industrial waste, agricultural, bio-medical waste, hazardous waste or any other as specific to the city.

Take appropriate measures to safeguard hazardous waste including toxic waste collected and stored in all the buildings and infrastructure systems of flood prone zones by storing them in a flood proof area or above the elevation of the 50-year flood level which water can't be reached

Table 8: Points allocated for Reduced percentage of special waste

Reduced percentage of special waste (2010 as the base year)	Points
≤ 2.5%	1
≤ 5%	2

Submission Requirements

- Submit statistics of City's special waste (of hospitals/industries/manufacturers), weightage and point sources
- City regulations on proper segregation and handling of special waste and exact procedure.
- Extractions of policies/mandates/regulations that manages to reduce/divert special waste from land fills

Credit 4.3: Smart Waste Management System

1 Point

Intent

Intent is to improve operational efficiency of the waste management system.

Requirements

Provide smart waste management systems using any or both of the following to handle a minimum of 20% of the waste generated within the city.

Option 1- Pneumatic Transport Systems

- Loading Stations – Public areas and private property with pneumatic transport system will have hatches, called loading stations where the waste will enter the Automatic Waste Collection System (AWCS) pipe network. At this station, a minimum of two pipes one for compostable and another for recyclable waste will run underground.

- Transport Network – Underground transport network with appropriate diameters and protective coatings (e.g. 3-layer PE coating). PVC conduits containing both the compressed air conduits and system communication control cables will run parallel to the waste pipes.

- Central Waste Handling Facility – At central waste handling facility all pipes will transfer waste for compacting and automated software will direct the compacted waste to the proper container, from there to be trucked for recycling.

AND/OR

Option 2 - Smart Bins and Route Optimization

- Sensor Bins – Ultrasonic sensors installed in municipal bins to guide fill level of waste and a communication system will transfer this information to the cloud for further processing and analysis.
- Sensor Bins with Radio Frequency Identification (RFID) technology for e-waste: Electronic waste bins installed with ultrasonic sensors and RFID technology to automatically identify and track tags attached to products. The tags containing electrically stored information will exchange information between cloud and trucks

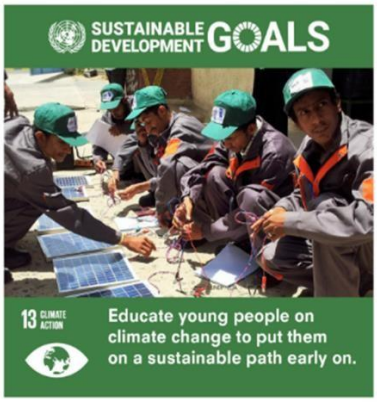
for disposal or directly for the waste bins where the information from each bin is conveyed to the cloud and product recycling can be eased.

- Route Optimization – Information analyzed at the cloud will be processed further and sent to waste vehicle operators to optimize the fleet routing for waste collection.

Considered Sustainable Development Goal in the Criteria

Under the Waste Management Criteria, the following Sustainable Development Goals (SDGs) set out by the United Nations have been taken into consideration.

- SDG 13 – Climate Action
- SDG 14 – Life Below Water
- SDG 15 - Life on Land



Goal 13: Climate Action

Goal 14: Life Below Water

Goal 15: Life on Land

TRANSPORTATION FACILITIES

5.0 TRANSPORTATION FACILITIES

Credit 5.1: Transit Networks

6 points

Intent

To encourage the use of public transportation through well integrated transit network

Requirements

Local authorities are encouraged to play a positive role in the public transport supply, operation, infrastructure provision and maintenance, promote inter-modality by close coordination with the transport service providers and citizen.

Points are awarded as below,

- Record keeping and liaising with public transport related institutions (2 points)

  Map showing public transit routes, transit stations, intermodal transfer facilities and tabulated information on route time tables, fare structures, etc. - 1 point

  Evidence of the involvement of the local authority in liaising with transport authorities and public transport facility improvement – 1 point

- City-wide coverage of Public Transits and modal share (3 points)

  Percentage of developed area of the city covered by public transport access (within 500m walking from a rail transit station, and 300m from a bus route)

  ≥ 50% in Central Business District (CBD) – 1 point

  ≥ 20% outside the CBD – 1 point

  Peak hour public transport modal share in the city (estimated) > 65% - 1 point

- Improvement of public transit facilities and usage since the base year

  (1 point) Improvement of peak-hour public transport modal share in 5 years > 1% (1 point)

  Increase the percentage use of public transport in the city as compared to the total transport, taken 2012 as the base year.

Emergency preparedness procedure and post disaster instructions and the evacuation plan are displayed in all

Transportation
infrastructure facilities (transit shelters, bus and train terminals, bicycle parks and public transport vehicles etc.) for the awareness of occupants and passengers.

Smart transportation networking is adopted for early warning, emergency management and to direct the community for evacuation routes.

All transportation infrastructure facilities (transit shelters, bus and train terminals, bicycle parks and public transport vehicles etc.) should install reliable backup & emergency power sources and communication systems including Backup Fire & Life Safety Communication systems to be used during a hazard or an emergency situation. Choose reliable backup & emergency power sources such as Generators, back up batteries, and Renewable sources of energy such as Cogeneration & Solar during Blackouts together with a fire protection & detection system to improve resilience and efficiently mitigate in disaster situations. All transportation infrastructure facilities in flood zones should consider having a backup wireless fire communication system, and all transportation infrastructure facilities must have backup phone and data connections. Mandate the use of storage batteries with a life of at least eight hours to serve infrastructures' fire and life safety communication systems.

Keep all transportation infrastructure facilities' and services' (transit shelters, bus and train
terminals, bicycle parks, evacuation routes and public transport vehicles etc.) stairwells, hallways and emergency exits Lit during blackouts due to natural hazards using generators or other reliable energy sources such as solar or/and other renewable energy sources and provide portable emergency lighting by providing the occupants with hand-held lighting equivalent to 6-8 LED diodes in brightness for groups of occupants

Emergency pathways and evacuation routes along the sidewalks should always have a backup power system to light the lighting systems along the evacuation routes during an emergency situation.

Potential Technologies and Strategies

Promotion of public transit patronage, starting from public bus and rail services to more specialized public transits, by frequent revision of transit routes and frequencies to match demand variation and by facilitating intermodal transfer through appropriate spatial, temporal and operational measures of modal integration.

Submission Requirements

- Submit Public transport network plan of the city as described above with tabulated data and evidence of involvement in public transport facility upgrading, interaction with transport authorities
- Submit the public transit coverage maps of the CBD and local authority limits separately, showing the developed areas and areas served by public transport as explained above. Show the detailed estimation of the peak-hour public transport modal share
- Submit calculations of the estimation of modal shares in base year and current year

Credit 5.2: Sidewalks and Pedestrian Facilities

6 points

Intent

To encourage walking as a mode of transportation for citizens by providing continuous and designated pedestrian network

Requirements

The local authorities are to play a positive role in the provision and maintenance of safe and well-connected walking network, with proper surfacing, separation from motorized traffic, shading, drainage, lighting, rest areas etc. Sidewalks are to be provided with sufficient width to accommodate the pedestrian flows at the respective areas.

Points are awarded as below,

- City map showing the pedestrian sidewalks and other pedestrian facilities-1 point

  All pedestrian facilities (pedestrian crossings, signals etc.) and locations of major trip generators, attractors and transport terminals served by the pedestrian network supplemented by the physical details (such as width, pavement type, shading etc.) of the sidewalk and pedestrian links in tabular form

- Providing sufficiently wide sidewalks in the CBD-1 point

  Provision of continuous, hard surfaced sidewalks of minimum 1.5m width on either side of the road

  OR

  provision of continuous, hard surfaced sidewalks of minimum 2.0m width on one side of the road for over 60% of the motorable roads in the city center

- Providing adequate safety for pedestrians-1 point

  Provision of adequate pedestrian safety measures at all major pedestrian crossings (including push-button operated signals, grade-separated crossings, speed tables etc.), proper usage of markings and signage where necessary, and especially at locations where vulnerable road users are expected (schools, hospitals), evidence of conducting safety awareness programs at schools etc. liaising with traffic police

  Side walks should be connected to public open spaces and directed through evacuation routes

Potential Technologies and Strategies

Improvement of pedestrian safety by spatial and temporal separation of pedestrian movements from motorable traffic using dedicated pedestrian spaces and paths, grade separation or signalization at shared spaces to avoid conflicts; improvement of visibility, markings and signage to direct road users; introducing pedestrian paths to shorten the access and increase public convenience in reaching destinations.

Submission Requirements

- Submit city road network plan indicating all sidewalks, designated pedestrian pathways and alleyways, pedestrian crossings, supplemented with physical details of pedestrian links in tabular form.
- Submit evidence of safety improvements carried out, safety programs conducted and liaising with traffic police in safety improvements during the past two years

Credit 5.3: Bicycle Lanes and Cycling Facilities

6 points

Intent

Encourage comfortable cycling experience by providing continuous and designated bicycle
lane network, thereby promoting public safety and health

Requirements

Ensure adequate and safe cycling facilities are provided to cover major trip generators and attractors, transport terminals etc. and providing sufficient bicycle parking facilities at appropriate locations. Coverage of the network and the providing necessary safety requirements are considered important.

Points are awarded as below,

- City map showing the Bicycle lanes and other cycling facilities-1 point
  All cycling facilities (crossings, signals etc.) and locations of major trip generators, attractors and transport terminals served by the cycling network supplemented by the physical details (such as width, pavement type, shading etc.) of the bicycle lanes in tabular form

- Safety Measures related to Bicycle lanes-1 point
  Provision of necessary safety measures (such as curb lowering, signals, separation from motorway as well as pedestrian paths, lighting, markings and signage etc.), evidence of the local government taking active role in rider awareness and education in schools etc. and liaising with traffic police

Potential Technologies and Strategies

Provision of cycling facilities to improve safety of cyclists and other road users by spatial and temporal separation of bicycle movements from motorable and pedestrian traffic; provision of lighting, visibility, pavement, shelter, proper markings and signage along cycle paths and at bicycle parks; policy interventions to encourage cycling

Submission Requirements

- Submit city road network plan indicating all bicycle lanes (both along roadways and otherwise), designated cycling facilities such as proper pavement, drainage, lighting, shading, crossings, parking, supplemented with physical details of bicycle links in tabular form.
- Submit evidence of safety improvements carried out, safety programs conducted and liaising with traffic police in safety improvements during the past two years with respect to cyclists

Credit 5.4: Urban Traffic Management and Parking Management

4 points

Intent

To address urban traffic congestion and safety issues through the implementation of appropriate traffic management policy.

Requirement

Promote local authorities to actively involved in the traffic data acquisition, maintaining, using data in the selection of appropriate traffic management techniques that can best address the local urban transport issues by coordinating and liaising with relevant public institutions, starting from the basic and simpler traffic management options, to develop in to advanced and more environmental-friendly traffic management options.

Parking management, as part of general traffic management, has to aim at minimizing roadside parking, encourage building developers to provide and maintain their parking requirements inside the premises, and promoting development of public off-street car parks near major locations with higher parking demands, such as hospitals, offices etc.

Points are awarded as below,

- Record keeping of the city traffic management systems – 1 point

  All locations with traffic and parking management implementation to be shown on a map of the city which is supplemented with necessary physical and operational information in a tabular form, evidence of frequent review of management options with the help of a multi-disciplinary committee that includes representations from traffic police, RDA, PRDA, transport authorities, local authority, business community, citizen groups and other stakeholders.

- Traffic data collection and maintenance– 1 point

  Periodic and continuous collection of traffic data and maintenance of traffic database (using data from different studies carried out by third party institutions)

- Implementation of advanced traffic management systems– 1 point

  Evidence of city-wide implementation of more advanced traffic management techniques described above.

- Parking Inventory of the city and frequent upgrading– 1 point

  Keeping an inventory of parking supply of the city; roadside, off-street (public and private) with operational information and demand data (if any). Evidence of the direct involvement of the local authority in developing parking facilities of the city through proper implementation of building regulations and special parking facility development projects.

  Provision of public car parks and control road side parking while avoiding impermeable parking areas as much as possible to increase the amount and rate of storm water infiltration and thereby reduce the risk of flooding.

  Develop standard operating procedures for traffic management during early warning and emergency situations along with the regular traffic management plan.

  Develop a traffic signal system to be operated during early warning and emergency situations along with the regular traffic signal system.

Potential Technologies and Strategies

- Consider following areas when developing traffic management system,
- Minimize the need of travel by incorporating transportation in land use planning Safety improvement at junctions and intersections with shared right-of-way (manual control, roundabouts, signalizing, signalized roundabouts, grade separation).
- Circulatory improvements (directional restrictions, turning restrictions, one-way streets)
- Bus lanes, pedestrianized streets
- Parking restraints (by location, by type of vehicles, time of day, day of week, by duration) and parking fares (traffic wardens, parking meters)
- Optimizing road space (parking restrictions, reversible lanes)
- More advanced management systems (count-down signals, demand-responsive signals, coordinated signals along a route, area-wide traffic control (ATC), real-time traffic information systems, real-time parking information systems, ERP etc.)

Submission Requirements

- Submit city road network plan indicating all locations with traffic and parking management implementation, supplemented with physical and operational details of traffic and parking management in tabular form.
- Submit the parking inventory of the city
- Safety procedures of parking- including fire hazard
- Submit evidence of the involvement of the local authority in the frequent interactions with other institutions in carrying out, traffic management reviews and liaising with traffic police, RDA etc.

Credit 5.5: Travel Demand Management (TDM)

2 points

Intent

To reduce the peak-hour traffic demand through the implementation of travel demand management policies

Requirement

Points are awarded as follows;

Evidence of local authority taking leading role in the study and implementation of TDM techniques

- Strategies covering more than one category and more than three strategies – 1 point

OR

- Strategies covering more than two categories and more than four strategies – 2 points

Potential Technologies and Strategies

- Reducing demand to travel (mixed land-use, work-from-home, telecommuting, e- shopping, online meetings)
- Reducing frequency of travel (four-day-work-week)
- Reducing travel distances (land-use readjustment, compact cities, smart cities, mixed land-use)
- Readjusting time of travel (staggered working hours, flexible work hours)
- Reducing number of vehicles (HOV promotion, carpooling, ride sharing)

Submission Requirements

Evidence of the involvement of local authorities in TDM implementation during the past 5 years

Credit 5.6: Transit Oriented Development (TOD)

2 points

Intent

To improve the implementation of TOD policies to encourage public transit as well as development of land use near transit stations

Requirement

To encourage the local government institutions to play a leading role in the promotion of transit-oriented development in the city, coordinating with the relevant agencies and land- use planning with due consideration of the transit facilities

Points are awarded as follows;

Evidence of local authority taking leading role in the study and implementation of TOD techniques

- At least two interventions by the local authority implemented already and evidence of continued involvement – 1 point

OR

- At least four interventions by the local authority implemented already and evidence of continued involvement – 2 points

Potential Technologies and Strategies

Involvement of the local authorities either in direct participation or by promoting private sector, in residential and office / shopping developments within walking distance of the transit stations. Promotion of private developers may be recognizing TOD as a positive contribution at the approval process for development permits. Strengthening feeder services to and from the transit stations to cover major trip generators and attractors.

Submission Requirements

Evidence of the involvement of local authorities in TOD promotion during the past 5 years

Credit 5.7: Alternative Energy Driven Vehicles

1 point

Intent

Intent is to reduce pollution by promoting alternatives to vehicles driven using fossil fuel.

Requirement

Points are awarded for;

Provide Electric Vehicle charging Facilities at minimum of two public parking places. Clearly identify and reserve these bays for the sole use by plug-in electric vehicles. Demonstrate that the combined number of private and public electric vehicle charging stations exceed 1 per 10,000 residents

Potential Technologies and Strategies

Encourage the use of vehicles powered by electricity, solar and other renewable energy sources and fuels by providing dedicated service facilities and infrastructure support.

Submission Requirements

- An inventory of facilities in the city for vehicles powered by alternative energy shown in the form of a map and details in tabular form
- Evidence of the involvement of local authorities in promoting the use of vehicles powered by alternative energy during the past 5 years

Considered Sustainable Development Goal in the Transport Facility Criteria

Following Sustainable Development Goals have been taken into consideration under Transportation Facility Criteria.

- UN SDG 9 Industry, Innovation & Infrastructure

Goal 9: Industry, Innovation, and Infrastructure

WATER EFFICIENCY

7.0 WATER EFFICIENCY

Prerequisite 1: Water Quality and Wastewater Management

Required

Intent

(i) to provide all citizens with equitable access to clean drinking water that confirms NWS&DB standards;

(ii) Sustainable wastewater management; and

(iii) Applying reverse engineering techniques to the modified hydrological cycle for sustainable water resource management

Requirement

Water supply systems and sewerages serving the city or community must meet the following requirements:

Water and Sanitation Access

Case 1- 100% coverage of all buildings by water supply schemes and sewerages either by centralized or decentralized systems. This case also covers proper sanitary facilities including the disposal systems (e.g. septic tanks) that confirm SLS standards.

Case 2 – Provide a road map for cities which have not achieved 100% coverage of all buildings by water supply schemes and sewerages either by centralized or decentralized systems within five years of certification. This case also covers proper sanitary facilities including the disposal systems that confirm SLS standards.

And

Comply to the Minimum Numbers of Toilets at Public Places and Institutions of UDA and H&T ordinance regulations

Provide 25% extra sanitary facilities with adequate water supply to evacuation centers/assembly areas used in a disaster response scenario.

Institution	Short term	Long term
Market areas	1 toilet to 50 stalls	1 toilet to 20 stalls
Hospitals/medical centres	1 toilet to 20 beds or 50 out-patients	1 toilet to 10 beds or 20 out-patients
Feeding centres	1 toilet to 50 adults 1 toilet to 20 children	1 toilet to 20 adults 1 toilet to 10 children
Reception/transit centres	1 toilet per 50 people 3:1 female to male	
Schools	1 toilet to 30 girls 1 toilet to 60 boys	1 toilet to 30 girls 1 toilet to 60 boys
Offices		1 toilet to 20 staff

Drinking Water Quality

Demonstrate compliance with NWS&DB Drinking Water Standards for the previous or the reporting year.

Treated Wastewater Quality

The effluents of centralized or decentralized sewerages must comply with CEA standards, and in case of septic tanks, the SLS standards.

Storm water Quality

Adopt a policy to maintain the sediment load (or the dominant contaminant) of storm water generated from construction and/or industrial sites not be 10% more than the pre disturbance scenario, whilst ensuring it will be equal or less than the pre disturbance scenario within two years. Pre disturbance scenario may be arrived via actual measurements an/or by referring a relevant baseline case.

Monitor the quality of storm water discharged from all types of land uses and ensure compliance with an internationally accepted standard (e.g. USEPA) after two years.

Potential Technologies and Strategies

Water and Sanitation Access

Requirement can be met by ground water extraction if it is permitted by law.

Drinking Water Quality

- Provide the following data for each water supply facility:
  - Frequency of water quality testing of effluent (quarterly, monthly, bi- monthly, etc.)
  - Water quality parameters
- Report on enforcement actions taken in case of non-compliance with NWS&DB water quality standards, under the following categories:
  - Violation of testing frequency
  - Violation in water quality parameter threshold

Treated Wastewater Quality

- Provide the following data for each wastewater treatment facility:
  - Frequency of testing treated wastewater (quarterly, monthly, bi-monthly, etc.)
  - Water quality testing parameters
- Report on enforcement actions taken in case of non-compliance with the CEA standards for effluents, under the following categories:
  - Violation of testing frequency
  - Violation in water quality

parameter threshold All sewerages must

follow CEA standards on effluents.

Submission Requirements

- Drinking water quality report(s) from NWS&DB or in case of decentralized systems from a CEA registered laboratory for number of cases as agreed by GBCSL.
- Number and Locations of public toilets in the city

Cedit 6.1: Water conservation

Intent

To have sustainable water management system by reducing water use and demand as a means to conserve water in the city.

Requirement

Have a policy in place to ensure that the water consumption for the most the dominant land use (if it is > 75% of the total land) or the two dominant land uses do not exceed the following baseline criteria (baseline loading rates for other land uses should be taken from standards and internationally accepted sources such as SLS, USEPA); Points are awarded as Table 10;

Table 9: Baseline criteria

Land Use	Baseline
Residential facilities	120 L per day per capita
Day schools	50 L per day per capita
Hotels/Hospitals	200 L per bed
Office	0.48 L/s/day
Cinema	0.25 L/s/day

Table 10: Points allocated for reduction of consumption over baseline criteria

Percentage reduction of consumption over baseline criteria	Points
10%	1
20%	2
25%	3

Potential Technologies and Strategies

- Adopt and implementation of a water conservation policy for the city
- Public awareness about water scarcity and conservation
- Rain water harvesting
- Wastewater reuse and recycle
- Use of water efficient fixtures

Credit 6.2: Innovative Treatment and Transmission of water

Required

Intent

To supply water through innovative treatment and transmission using renewable energy.

Requirements

Reduce 25% of non-renewable energy consumption in water transmission by using renewable energy including solar, wind, low impact hydro and biomass or any other innovative strategy for transmission water (1 point).

Reduce 50% of non-renewable energy consumption in water transmission by using renewable energy including solar wind, low impact hydro biomass or any other innovation strategy for transmission water (2 points).

Potential Technologies and Strategies

- Solar (PV or thermal) and/or wind pumping
- Renewable energy driven water treatment
- Use of hybrid energy systems

In addition to the use of alternative onsite sources of water, use high efficiency fixtures. (e.g. water closets and urinals), Dry fixtures, such as toilets attached to composting systems, to reduce the potable water demand.

Submission Requirements

- Report on the energy consumption in water transmission and the contribution from renewable energy

Credit 6.3: Water System Performance

Required

Intent

To improve the operational efficiency of the water management systems through use of smart technology.

Requirements

Undertake water audit at least once a year to meet all of the following requirements (1 point)

- Water use inventory (i.e. water use based on the end use or land use), smart metering and water efficiency.
- Measure the amount of municipal water available and total water utilized from both municipal water supply (e.g. water supplied by NWS&DB) and other sources.
- System efficiency and root-cause analysis for water losses through leaks and excessive abstraction losses such as infiltration.
- Identify strategies for improving system efficiency.
- Action plan to reduce water wastage

Evidence for at least 2% water reduction compared to the previous year (1 point)

Credit 6.4: Rainwater Harvesting

Required

Intent

Utilize rainwater to recharge/fill existing reservoirs and prioritize rainwater harvesting in a sustainable way to reduce municipal water demand, whilst ensuring ground water recharge.

Requirements

- Develop City Rain Water Harvesting Plan(s) based on the meteorological study of the city (1 Point)
- Encourage City population to use rainwater.
  Points are awarded as Table 11.

Table 11: Points allocated for using rainwater in the city

Percentage of population using rainwater in the city (with 2010 as base year)	Points
≥ 10%	1
≥ 20%	2

Submission Requirements

- Plan of rain water harvesting
- Rainwater harvesting calculations with water usage
- Evidence for groundwater recharge

Credit 6.5: Storm Water Management

Required

Intent

To reduce runoff volume, prevent erosion and flooding while facilitating groundwater recharge. Flooding needs to be taken as a situation where precipitation overwhelming the capacity of natural and/or man-made storm water drainage systems, therein fully or partially inundating and damaging environmentally and/or socio-economically important areas.

Requirements

Option 1 - Flooding Incidences (1 point)

Case 1 - No reported flooding incidences in

past five years Provide the following details:

- Design details of storm water infrastructure; must include at least the design storm (rainfall) (intensity and return period).
- Strategies adopted to manage storm water beyond its designed limits considering various factors of safety and/or climate variability
- Strategies adopted to inspect and ensure maintenance of storm water infrastructure.

Case 2 - Flooding incidences were reported in past five years, however comprehensive action is taken to completely mitigate floods within five years

Provide the following details:

- Details on floods (location, duration, water depth, impacts on the environment/socio-economic environment and so forth)
- Initiatives such a formulation of a storm water master plan by the local authority and/or any government agency with details on the role played by the local authority
- Community based initiatives to mitigate flooding such as community participated cleanup of storm water drainages

OR

Option 2 - Green Storm Water Infrastructure (1 point)

Provide details on strategies adopted to inspect and ensure maintenance of existing Green storm water management facilities and techniques to enhance abstraction losses such as

Infiltration, evapotranspiration, etc. To be qualified to get this credit evidence needs to be given on low non-renewable consumption of the storm water infrastructure.

For a coastal city, periodically carry out an assessment for the requirement of beach nourishment in order to prevent erosion and sedimentation control.
The use of soil bio engineering systems for erosion control
Monitor the safeguard of coral reefs along the coastline. – Dedicated local authority officer is suggested.

Potential Technologies and Strategies

Green infrastructure and low-impact development rainwater management strategies and techniques improve upon that conventional approach by mimicking an area's natural hydrology or the hydrological status quo. These techniques involve minimizing disturbed areas, preserving pre-development runoff conditions, limiting the amount of impervious cover, and infiltrating, storing, evaporating, or detaining rainwater runoff.

- Planting rain gardens with native or adapted plant material (e.g. tree shrubs)
- Green roofs, permeable pavements
- Installing permanent infiltration or collection features that can retain at least the 80th percentile of regional or local rainfall events.

Submission Requirements

- Evidence of Green infrastructure and their effectiveness
- Assessment report for beach nourishment requirement
- Assessment report by the local officer officer on periodic damage to coral reefs

Credit 6.6: Wastewater Management

Required

Intent

Wastewater auditing, and safe re-use of wastewater or treated wastewater for different end uses, therein by treating wastewater not as a waste but as a resource.

Notes:

- Non-potable applications include but not limited to flushing, irrigation, cooling tower make-up etc.
- If available should follow local and/or international standards and/or need to be certain the humans, flora and fauna are not faced a compromising situation.

Credit 6.6.1:

Wastewater Treatment

3 Points

Requirements

- Assessing amount of wastewater generated in the city with a clear separation of different types of wastewaters and the sources (1 point)
- Demonstrate increase in treatment of wastewater generated in the city, with 2015 as the base year. Further, ensure that the treated wastewater conforms to the effluent quality standards specified by CEA.

Table 12: Points allocated for treatment of wastewater generated in the city

Percentage increase in treatment of wastewater generated in the city	Points
≥ 25%	1
≥ 50%	2

Potential Technologies and Strategies

- Auditing methods, methods on selection of representative samples
- Reliability and sensitivity analysis

Submission Requirements

- Details of wastewater auditing with reliability analysis

Credit 6.6.2: Re-use of Treated Wastewater

3 Points

Requirements

Demonstrate increase in reuse of treated wastewater (effluent) generated in the city, with 2015 as base year. Points are awarded as Table 13;

Table 13: Points allocated for reuse of treated wastewater generated in the city

Percentage increase in reuse of treated wastewater generated in the city	Points
≥ 5%	1
≥ 10%	2
≥ 15%	3

Potential Technologies and Strategies

Provide wastewater treatment systems to treat 100% of the wastewater generated from residential or commercial uses that are without hazardous compounds. Also incorporate laws to mandate on site treatment plan to treat 100% of the wastewater contaminated with hazardous compounds therein to eliminate the risk of contamination of public or centralized sewerages. All treatment systems must demonstrate that the wastewater in raw or treated form is used for an end use that is beneficial to the humans and/or environment.

Submission Requirements

- Evidence that all wastewaters are treated
- Evidence on reuse of wastewater

Considered Sustainable Development Goals in the Water Management Criteria

Following Sustainable Development Goals have been taken into consideration under Transportation Facility Criteria.

- UN SDG 6 Clean Water & Sanitation
- UN SDG 9 Industry, Innovation & Infrastructure

Goal 6: Clean Water and Sanitation

Goal 9: Industry, Innovation, and Infrastructure

ENERGY AND ATMOSPHERE

7.0 ENERGY AND ATMOSPHERE

Prerequisite 1: Enhanced Electricity Accessibility and Monitoring Required

Intent

Intent is to provide safe, secured, reliable, and equitable access to electricity.

Requirements

Power system must meet the following requirements.

Cities with multiple utilities or service providers must aggregate the data from the respective utility to demonstrate compliance.

Case 1 - 100% coverage of households or population by electricity service

Case 2 - For cities which have not achieved 100% coverage of households or population by electricity supply, provide a roadmap for achieving the same within 5 years of certification.

Continuous monitoring and recording of interruptions for the complete distribution network at high, medium and low voltage levels.

Under special circumstances,

Identify city's critical loads or emergency facilities and essential services that require backup power during widespread outages or disasters. Determine minimum daily runtime requirements for all the emergency facilities and essential services. Demonstrate that the city, utility or service provider can supply power to all emergency facilities and essential services for at least duration greater than the minimum daily runtime for one week or longer.All buildings and infrastructure facilities (specially in hazard prone areas) should instal reliable backup & emergency power sources and communication systems including Backup Fire & Life Safety Communication systems.

Evacuation centers/ assembly areas should be powered with renewable energy sources
Battery back up/ self sustaining method
Smart grid and more generally ICT applications help to have real-time detailed information of when and how energy is consumed and on the renewable energy

produced. This helps identify areas of progress, giving control over energy consuming devices and helping to balance supply, demand and energy storage

Potential Technologies and Strategies

Assess current electricity plan of the city and if necessary, redesign it with highly complying of renewable energy to have an efficient access of electricity to all residents in the city. Hardening systems makes the major electrical equipment's less susceptible to damage by the severe weather events.

Submission Requirements

- Declaration from municipal official with authority for public works and/or energy infrastructure confirming 100% coverage of buildings with power supply. (Case 1)
- Commitment and narrative of roadmap for achieving 100% coverage within 5 years of certification or at the time of recertification. (Case 2)
- Reliability performance monitoring: Three months of recorded interruption information.
- Power surety and resiliency: List the cities' or communities' critical loads or emergency facilities and essential services, with their minimum daily runtimes, and the alternative power supply for each, including type, location, capacity, and minimum daily runtime.
- Reliability, resiliency and power surety: Narrative describing the design considerations and strategies undertaken to protect the power system from common external threats. For critical loads and emergency facilities, explain the energy storage or backup generators duty cycle, with their energy storage capacity (including fuel) and typical energy consumption.
- Arranagement for Back up power and communication, at evacuation centers (evidence of usage of renewable sources)

Credit 7.1: Energy Audit

3 Points

Intent

Assessing existing energy base environment and enhance energy efficiency while reducing energy loss.

Requirements

Conduct an energy audit

Required Documentation

- A report on energy audit of high energy users within the city with classification of different energy consumption sources (1 point)
- Strategies taken to reduce consumption of conventional energy use by high energy users (2 points). Points are awarded as Table 14;

Table 14: Points allocated for energy reduction

Percentage of energy reduction comparing to previous year by highe energy users	Points
≥10%	2

Credit 7.2: Encourage to Use of Renewable Energy

2 Points

Intent

Encourage the use of renewable energy for built environment.

Requirement

Demonstrate that the city has plans to source at least 5% renewable energy to the total energy requirement of the city. Points are awarded as Table 7.2.

Table 15: Percentage of renewable energy

Percentage of Renewable Energy to Total energy requirement of the City	Points
5%	1
Above 5%	2

Potential technologies and strategies

- Assess the city for potential renewable energies including solar, wind, geothermal, biomass, hydro, and bio-gas strategies. When applying these strategies, take advantage of the net metering with local utility.

Submission Requirements

- Submit a plan identifying sources of renewable energy.
- Schematic plan highlighting location of on-site RE applications at city level.

Goal 7: Affordable and Clean Energy

Credit 7.3: Greenhouse Gas Emissions Management

4 Points

Intent

Intent is to support energy management and move towards a zero energy and emissions city.

Requirements

- Measure the annual Greenhouse Gas (GHG) emissions for the city (2 point).
- Polices adapted to reduce greenhouse gas emission in the city (1 point)
- Strategies successfully adapted to reduce greenhouse gas emission (1 point).

Submission Requirements

- Evidence to prove that there is a reduction in greenhouse gas emission.
- Submit the GHG emission calculation and the method of calculation.
- Evidence of executing strategies to reduce GHG emission.
- Submit a document with the polices that have adapted to reduce GHG emission.
- Supporting documentation for GHG emissions such as GHG inventory.

Considered Sustainable Development Goals in Energy and Atmosphere Criteria

Following Sustainable Development Goals have been taken into consideration under Transportation Facility Criteria.

- UN SDG 7 – Affordable and Clean Energy

SOCIAL, CULTURAL AND ECONOMIC ACHIEVEMETS

8.0 SOCIAL, CULTURAL AND ECONOMIC ACHIEVEMENTS

Prerequisite 1: Demographic Assessment

Required

Intent

Making housing and other infrastructure development to suite the demographic profile (all age categories, gender, disability persons, different ethnic groups, etc.)

Requirement

Provide a comprehensive demographic narrative that includes the following population and housing characteristics:

- Brief history of development, noting critical points of change for the overall area or specific neighborhoods.
- Age cohorts, including the following categories: Under 18 years, 18 years and over and 65 years and over.
- Racial/ethnic composition.
- Other prominent sociocultural groups present, such as migrants, religious groups, and linguistically isolated.
- A housing needs assessment addressing housing supply affordability, diversity of housing stock by unit and ownership type, and community demographics.
- Ensure social mixity in new developments and on urban regeneration sites

A human rights-based approach is adopted, promoting and protecting all human rights, including ensuring equality (when each person is seen as equal in the eyes of the law with no discrimination based on their gender, race, religion, or sexuality, and social justice) to all citizens. Each person can exercise their rights within the society with the promotion of social justice, which ensures that everyone has physical security, education, healthcare, and employment.
Subject Coastal cities to a Recovery Potentiality analysis (Socio-economic and Infrastructural)

Submission Requirements

- Comprehensive demographic narrative describing all of the population and housing characteristics listed in the requirements.
- Overlay maps or interactive layers highlighting all of the demographic indicators listed in the requirement, residential densities within the city or community, highlighting the public accommodations and services.

Credit 8.1: Social Housing Initiatives & Social Initiatives

Required

Intent

To encourage city efforts to create new housing stocks or develop existing housing units to up lift the living standards of low-income families/citizens.

Credit 8.1.1: Social Housing Initiatives

Required

Intent

Demonstrate City's efforts to uplift the living conditions (access to basic services, access to basic health care and education) of housing such as;

- Development of Low-income areas
- Affordable housing
- Low income (Economically Weaker Section) housing Projects

Requirements

Demonstrate City's Slum Redevelopment and Affordable Housing projects with provision of appropriate infrastructure with respect to a base line year. Points are awarded as Table 16;

Table 16: affordable housing schemes development or redevelopment housing schemes

Increment of Affordable Housing Schemes development or redevelopment housing schemes percentage with compared to *<a baseline year>*	Points Allocated
≥ 10 %	1
≥20%	2

Submission Requirements

- Submit calculation of the slum redevelopment dwellings in the city as in year base or Calculate the total number of affordable housing / EWS housing dwellings in the city as in base year.
- Map indicating slump / low income dwellings of city as base year.
- Submit proof on successful redevelopment/relocation projects

Credit 8.1.2: Social Initiatives

Required

Intent

Demonstrate City's undertakings/efforts to improve the community e ngagement, interactions and recreational activities

Requirements

Improvements on community engagement, interactions, and recreational projects by conducting a qualitative social survey.

Socio Economic development programs organized by the local authority discussing following aspects

- Entrepreneurship opportunities within the locality and beyond
- Disaster risk reduction strategies and creation of forums working groups to undertake programs to enhance the resilience from coastal hazards

Submission Requirements

- Submit extractions of policies, regulations and plans indicating the basic utilities provided for the relocated/redeveloped projects
- Map indicating recreational activity places such as open-air theaters, gymnasiums, amusement parks, film halls, parks etc.
- Submit Calculation on city expenditure/resource allocation on community engagement/interaction /recreational projects compared to *<base year> 3 consecutive years*
- Submit extractions on City's budget indicating provisions for community uplifting /engaging enhancement projects for current year
- List of cities owned/maintained or completed community engagement/interaction enhancing projects
- Demonstrate a year-on-year increment of such projects

Credit 8.2: Quality of Life Performance

6 Points

Intent

Living conditions and quality of life to encourage the improvement of the wellbeing and living standard of the city and its people.

Requirements

Measure all of the Quality-of-Life parameters below for a minimum period of the most recent calendar year or fiscal year. For all the following parameters the base year will be the previous year of the comparison year

I. Access to Education (1 point)

- Nursery, Primary Secondary and Vocational training opportunities in the city area
- Improvement of general literacy through basic and additional educational platforms
- Libraries
- ICT Centers
- Compulsory courses for children
- Vocational Training Centers

II. Economic Empowerment (1 point)

- Access to funds provided by local banks
- Self-empowerment projects
- Per capita income and gini factor of the city

III. Social Empowerment (1 point)

- Percentage of people receiving on government welfare

IV. Employment opportunity (1 point)

- Unemployment rate of the city –10%

below the district average level
(consider age between 18 to 55 years)

V. Health- 1 point
- Infant mortality- Should be equal or better than Sri Lankan rate
- Life expectancy- Should be equal or better than Sri Lankan rate
- Access to primary health care – all areas of the city should have all the primary healthcare facilities and a hospital within 5 km25 km, respectively.
- Community training and awareness on emergency health care

VI. Safety and crime prevention- 1 point
- Crime reduction
  Number of crimes should be less than the national average
- Fatal Accident reduction
  Number of accidents should be less than the national average
- Counseling facilities in the city
- Enforcement on occupational health and safety of the employees in the city

Submission Requirements

- Data for each of the metric in the prerequisite
- Supporting documentation clearly highlighting the data points in the respective documents
- Supporting documents for respects to each data responding items
- Evidence/Schedules of additional educational programs/ new developments conducted/to be conducted

Credit 8.3: Affordable Housing

Required

Intent

To provide an adequate and diverse supply of location-efficient and affordable housing options for all.

Requirements

Responding a comprehensive housing policy that addresses the following elements

- Neighborhood or housing enclaves within 800 meters of walking distance to public transport facilities
- Programs or code enforcement ensuring healthy housing standards for both rental and owner-occupied units

Promotion of affordable rental housing to encourage social mobility – at least 5% from the total housing stock

Emergency facilities for a disaster situation in coordination with governmental and/or non- governmental service providers.

Credit 8.4: Accessibility of Elderly and Persons with Disability

1 Point

Intent

To promote social inclusion and ensure the safety and accessibility of elderly and differently abled people.

Requirements

Provide barrier free accessibility for elderly and differently abled persons at least for three of the following public areas.

- Pedestrian Pathways
- Road Crossings
- Public spaces
- Public Toilets
- Parks and Recreational areas

Provide evacuation arrangements for persons with special needs

- Blindness/ Deafness
- Cognitive diseases
- Pregnancy

Potential Technologies and Strategies

Any public building, public place or places where public come to seek good or services shall be designed in accordance with the design requirements specified in Disabled Persons (Accessibility) Regulations, no 01 of 2006 published in the Government Gazette.

Submission Requirements

- Submit a document highlighting strategy for provision of Barrier-free accessibility in selected public spaces as mentioned under requirement section.
- Submit a perception survey data

Credit 8.5: Implementing Circular Economic Practices

1Point

Intent

To promote business models with circular processes respecting and optimizing the local raw materials and local skills as much as possible.

Requirements

- Recognize circular processes where efforts are made to design out waste and pollution, keep products and materials continually in use and regenerate natural systems are adopted
- Introduce new approaches and research to invent systems that are circular in nature and promote and facilitate such business processes in the city area.
- Designing out waste and pollution ensuring cleaner production processes and continual use and regeneration of materials for the production.
- Recognizes business models promoting cycles rather than linear processes.

Submission Requirements

Submit evidences that the initiative was made consciously and the resultant economic benefits have been established.

Credit 8.6: Recognize Cooperate Social Responsibility (CSR) with sustainability focus

1 Point

Intent

To cultivate corporate investment strategies to recognize local resources and facilitate skills
training and product development based on the availability of local resource base, considering such inputs as part of corporate social responsibility.

Requirements

- Social responsibility action undertaken as a moral obligation and built into the system will be considered. This will mean that any CSR activity promoted for marketing or building self-reputation will not be considered.
- Recognizes consequence of CSR activities on environmental sustainability any intervention contributing to improving environmental quality through emission control cultivating environmentally friendly customs and traditions and protecting natural habitat.

Credit 8.7: Promotion of Sustainable Local Products & Services and Sustainable Consumption Habits

1 Point

Intent

To promote local product and services and enhance the required skills through training and education and increasing awareness of the community to appreciate the value of using local products and services to sustain the local economy.

Credit 8.7.1: Promote supply chain with sustainable local products & services and promote sustainable consumption

1 Point

Intent

- Facilitate manufacturing of products and services using local raw materials and local skills.
- Conduct programs to promote local products and services and efforts to increase awareness of the benefits of using sustainable products and services.
- Promote sustainable consumption habits while ensuring food security within city area

Credit 8.7.2: Undertaking training /education & research on sustainable product & services

1 Point

Requirements

- Provide training/ education and promoting research on developing sustainable products and services
- Promote mechanisms to recognize green product and services with established standards and practices (E.g. Green labeling)

Considered Sustainable Development Goals in Economic, Social and Cultural Achievements Criteria

Following Sustainable Development Goals should be taken into consideration under Economic, Social and Cultural Achievements Criteria.

- UN SDG 1 – No Poverty
- UN SDG 2 - Zero hunger
- UN SDG 3 - Good Health & Well-Being
- UN SDG 4 - Quality Education
- UN SDG 5 - Gender Equality
- UN SDG 8 - Decent Work and Economic Growth
- UN SDG 12 - Responsible Consumption and Production

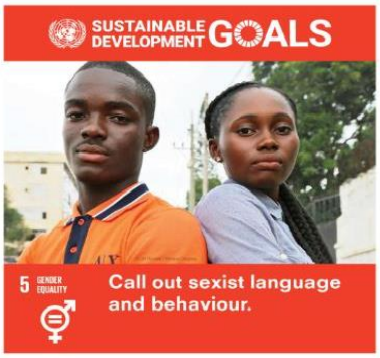
- UN SDG 16 - Peace, Justice and Strong Institutions

Goal 1: No Poverty

Goal 2: Zero Hunger

Goal 3: Good Health and Well-Being

Goal 4: Quality Education



Goal 5: Gender Equality

Goal 8: Decent Work and Economic Growth

Goal 12: Responsible Consumption and Production

Goal 16: Peace, Justice and Strong Institutions

Credit 8.8 Community Engagement in Disaster risk reduction activities and planning process

Requirements:
Disaster risk reduction strategies and creation of forums working groups to undertake programs to enhance the resilience from coastal hazards

Submittals:
Proof for establishing working groups or forums and their activities listed

INNOVATION

9.0 INNOVATION

Intent

Intent is to encourage Cities to achieve exceptional or innovative performances.

Credit 9.1: Exemplary Performance

Requirements

One point is awarded for each Innovation credit achieved, up to a maximum of two. A City or community may use any combination of the options below.

Option 1 - Achieve significant, measurable environmental performance using a strategy not addressed in the GREEN^{SL} rating system.

Identify all of the following:

- Intent of the proposed innovation credit
- Proposed requirements for compliance
- Proposed submittals to demonstrate compliance
- Design approach or strategies used to meet the requirements. AND / OR

Option 2 - Achieve exemplary performance in any of the GREEN^{SL} Sustainable Cities prerequisite or credit. An exemplary performance point is typically earned for achieving double the credit requirements or the next incremental percentage threshold.

Potential Technologies and Strategies

Potential technologies benchmarking with existing innovative technologies and practices for achieving sustainability.

Submission Requirements

- Documentation to support the design approach or strategies used to achieve innovation.
- Identify the GREEN^{SL} for Sustainable Cities prerequisite or credit for exemplary performance

Considered Sustainable Development Goals in Innovation Performance Criteria

Following Sustainable Development Goals have been taken into consideration under Social and Cultural Consciousness Criteria.

- UN SDG 9 –Industry, Innovation & Infrastructure
- UN SDG 11 –Sustainable Cities and Communities

Goal 9: Industry, Innovation, and Infrastructure

Goal 11: Sustainable Cities and Communities

Credit 9.2: Innovation in Resilience

Credit 9.2.1 Innovation to address climate change and hazard risk

Requirements

Introduce flood, earthquake and landslide warning systems and sensors in all major infrastructure facilities and services (multi stories residential and comercial buildings, ctitical infrastructures such as hospitals and schools) to detect the respective hazards and disseminate early warning alerts.

Submittals

Information on improvements in eary warning systems

Credit 9.2.2 Innovative interventions for attitude change towards resilience

Requirements

Coherent approaches are in place to integrate disaster resilience for sustainable development. For example, there are novel platforms using the modern technology for built environment professionals and general public in the city to get educated and ensure the resilience in every aspect when decision and policy making in their capacity

Submittals

Information on novel strategies proposed and the implementation guide for each

Credit 9.2.3

Global Warming

Requirements

Integrate Global warming Impact to all estimates

Submittals

Revised calculations and designs for major criteria

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Annexure 3

Implementation of Sustainable and Resilient Measures in the Panadura City

1. Management

1. Are there green building practitioners involved in any planning-related team of the city?

2. Are there disaster management specialists involved in any planning-related team of the city?

3. Is there a public/community consultation mechanism to ensure public/community participation in the planning process?

4. Are previous hazard information available to the public?

5. Are the risk management strategies are incorporated into public awareness programs?

6. Is an emergency preparedness information and instructions manual available for the city?

7. Has the city developed an eco-vision- Have the city's significantly problematic areas in terms of poor performance in environment, social and economic domains been identified?

8. Are technological applications appropriate to the city plan in use to ensure a better performance?

9. Are the city development proposals showing evidence of integration of different aspects and key stakeholders?

10. Are there existing buildings or new construction in the city rated or registered for GreenSL Building certification?

2. Ecology and Preservation

1. Has the city's existing ecosystem been assessed ?

2. Has the urban green space been calculated? If yes what is the urban green space per capita?

3. Has the public open space area been calculated? What percentage of city's developed area is located within 400 m of total public green space/open spaces?

4. Is the city plan in accordance with the UDA General Regulation part1 and Town and Country Planning ordinance?

5. Are there strategies taken so far by the city council to restore/rehabilitate and conserve existing natural resources?

6. Has the city council Identified responsible maintenance agencies and their methodology of maintenance for roads?

7. Is there a policy to incentivize buildings that use high reflective roofing material (or) vegetation (or) combination, to cover the exposed roof areas.

8. Are vulnerability and capacity assessments for climate change risks, natural

hazards and extreme events ; Tsunamis and heavy winds undertaken?

9. Is there a resilience plan for the city which includes climate adapation strategies emergency response and evacuation practices?

10. Has the environmentally degraded areas been identified an is there a policy to allocate future developments in environmentally degraded areas?

3. Infrastructure Management

1. Are there proper maintenance carried out for public street light system?

2. Are there LED lamps in use for public space light systems which proper maintains under any authority (or solar or any other renewable lighting source)?

3. Are the noise levels should comply with the National Environmental (Noise Control) Regulations No. 1 of 1996.

4. Is there an implementation plan to mitigate vision pollution. (Control of advertisements etc)?

5. Is there a Monitoring system for air pollution controls for factories and industrial activities?

6. Are there Collection centers provided within the boundary and equipped with facilities to collect and store the waste products/ Is there waste stream audits conducted?

7. Is any approval taken in the form of a certificate of appropriateness for alteration from the Department of Archeology in case of buildings subject to national review?

8. Are there any areas restricts permitted land use/density in hazardous areas; (special hazard zones or sensitive open space protection zones)

9.Is the development plan for the city complying to UDA and H&T ordinance Arrangement of public open spaces?

10. When planning for new developments in the city, Is the local authority consulting and check the compliance of guidelines recommended for respective potential hazards (landslides, Floods, Cyclones and Tsunamis)

11. Are there structural barriers / coastal protection/defense structures available in the city?

12. Are their any structural health monitoring requirements for buildings

4. Waste Management

1. Is there a solid waste management plan for the city complying to the National waste management Policy?

2. Is there assessments carried out to assess the volumes and nature of solid wastes?

3.Are Waste audits carried out?

4. Is there any special waste (of hospitals/industries/manufacturers) management techniques for the city?

5. Is there any smart waste management systems for the city?

5. Transport Facilities

1. Is there a Public transport network plan of the city with the evidence of involvement in public transport facility upgrading, interaction with transport authorities?

2. Are there any disaster response mechanisms (evacuation routes etc.) integrated in the transportation plan and are Emergency preparedness procedure and post disaster instructions and the evacuation plans displayed in roads?

3. Are sufficient pedestrian sidewalks and other pedestrian facilities facilitated? (hard surfaced sidewalks of minimum 1.5m width on either side of the road?

4. Are Bicycle lanes and other cycling facilities provided with adequate safety?

5. Is there any record keeping of the city traffic management systems /Implementation of advanced traffic management systems / Parking Inventory of the city and frequent upgrading , safety procedures for parking

6. Is the local authority involved in TDM implementation during the past 5 years?

7. Are there at least two interventions by the local authority implemented already and evidence of continued involvement for Transit oriented Development?

8. Is there continuous empowerment and an inventory of facilities in the city for vehicles powered by alternative energy?

6. Water Efficiency

1. Is 100% coverage of all buildings provided by water supply schemes and sewerages either by centralized or decentralized systems.?

2. Is the Number of Toilets at Public Places and Institutions comply with UDA and H&T ordinance regulations?

3. Are there 25% extra sanitary facilities with adequate water supply to evacuation centers/assembly areas used in a disaster response scenario4. Is the compliance with NWS&DB Drinking Water Standards for maintained?

5. Are the effluents of centralized or decentralized sewerages complying with CEA standards,and in case of septic tanks, the SLS standards?

6. Is the quality of storm water discharged from all types of land uses monitored and quality ensured?

7. Is the Treated wastewater quality measured?

8. Are any sustainable water management system in place to reduce water use and demand as a means to conserve water in the city?

9. Are there any systems supply water through innovative treatment and transmission using renewable energy?

10. Are water audits undertaken at least once a year?

11. Is rainwater harvesting taking place to recharge/fill existing reservoirs and prioritize rainwater harvesting in a sustainable way to reduce municipal water demand?

12. Are there measures to reduce runoff volume, prevent erosion and flooding?

13. Is the amount of wastewater generated in the city assessed with a clear separation of different types of wastewaters and the sources?

14. Is the treated water re-used?

7. Energy and Atmosphere

1. is there 100% coverage of households or population by electricity service?

2. Have all buildings and infrastructure facilities (specially in hazard prone areas) installed reliable backup & emergency power sources and communication systems?

3. Are energy audites undertaken?

4. Are there renewable energy sources, and communication atleast for evacuation centers?

5. Is the annual Greenhouse Gas (GHG) emissions for the city measured?

8. Social, Cultural and Economic Achievements

1. Are the demographic assessments undertaken for the city, and the data available?

2. Are there efforts to create new housing stocks or develop existing housing units to up lift the living standards of low-income families/citizens.

3.Are there Socio Economic development programs organized by the local authority discussing following aspects and Entrepreneurship opportunities within the locality?

4. Are there Disaster risk reduction strategies and creation of forums working groups to undertake programs to enhance the resilience from coastal hazards?

5. are there additional educational programs/ new developments conducted/to be conducted to increase the quity of life? Safety/ health, employment, education?

6. Is Promotion of affordable rental housing to encourage social mobility taking place?

7. Are there Emergency facilities for a disaster situation in coordination with governmental and/or non- governmental service providers?

8. Is barrier free accessibility providec for elderly and differently abled persons at least for three of the following public areas?

9. Are new approaches and research introduced to invent systems that are circular in nature and promote and facilitate such business processes in the city area.

10. Are there CSR activities on environmental sustainability any intervention contributing to improving environmental quality?

11.Is manufacturing of products and services using local raw materials and local skills promoted?

12. Is training/ education and promoting research on developing sustainable products and services taking place?

9. Innovation

1. Is the city achieving significant, measurable environmental performance using a strategy not addressed in the GREEN^{SL} rating system.

2. Are there any innovations to address climate change and hazard risk?

3. Are Coherent approaches are in place to integrate disaster resilience for sustainable development. For example, there are novel platforms using the modern technology for built environment professionals and general public in the city to get educated?

4. Is the city Integrating Global warming Impact to all estimates?