

# City Resilience and Sustainable Infrastructure—An Introduction



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## 1 Introduction and Background

The cities are vulnerable to adverse effects of natural and manmade hazards and pose great challenges due to rapid urbanization and climate change. More than half of the population of the world lives in cities, and it is likely to increase in future. Cities also account for about 70% of global carbon emissions [43]. The urban sustainability focuses on managing resources in a way that ensures welfare and promotes equity for current and future generations [29]. Resilience is the capacity of a system to absorb disturbance, such as a natural hazard or disaster, essentially retaining the same function, structure, feedbacks and identity [29]. Sustainability should be the goal of society while resilience signifies a characteristic of the urban system. Both sustainability and resilience come together as a powerful tool in the context of urban development. OECD [29] defines resilient cities as “those which have the ability to absorb, recover and prepare for future shocks (environmental, economic, social and institutional). Resilient cities promote sustainable development, well-being and inclusive growth.”

The guiding principles are based on the predefined ten essentials helping the cities and local governments to share learning, access information, develop indicators, and performance measures and track progress. The Ten Essentials for Making Cities Resilient were proposed to hasten execution of the Sendai Framework for Disaster Risk Reduction (2015–2030) [31, 44].

Essential 1: Institutional and Administrative Framework.

Essential 2: Financing and Resources.

Essential 3: Multihazard Risk Assessment—Know Your Risk.

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- Essential 4: Infrastructure Protection, Upgrading, and Resilience.
- Essential 5: Protect Vital Facilities: Education and Health.
- Essential 6: Building Regulations and Land Use Planning.
- Essential 7: Training, Education and Public Awareness.
- Essential 8: Environmental Protection and Strengthening of Ecosystems.
- Essential 9: Effective Preparedness, Early Warning and Response.
- Essential 10: Recovery and Rebuilding Communities.

Sustainability and resilience need important attentions in planning, design, construction and operation of the cities' infrastructure. Thanvisitthpon et al. [42] describe flood risk management in urban areas relies on infrastructure development for flood prevention and management for resilience building and also through flood adaptive capacity of urban residents (i.e., non-structural strategy). Climate variability contributed to the unpredictability of precipitation in many parts of the world and significantly impacted the city development, livelihoods, the environment and the economy [41]. Similarly, seismic risk can be better addressed though the micro-zonation mapping to emphasis in any infrastructure development planning [37].

The chapters in this book volume present diverse insights on urban resilience and sustainable infrastructure. This article is an attempt to summarize the contents of the book volume on City Resilience and Sustainable Infrastructure. All the chapters in this volume are segregated in five clusters, e.g., resilient infrastructure in construction, innovative construction interventions, waste management and disaster risk reduction, urban development and sustainability and cross-cutting issues.

## 2 Resilient Infrastructure in Construction

Rungskunroch et al., in their exploratory study on *Risk and resilience of railway infrastructure: An assessment on uncertainties of rail accidents to improve risk and resilience through long-term data analysis*, aimed to analyze uncertainties of railway accidents and evaluating risk and resilience of rail's infrastructure after occurring an accident. The datasets are analyzed by using Bayes' and decision tree methods through Python programming. The model uses long-term data to measure the severity level of an accident by infrastructure failures. The result shows the severity level is scored at 18 of 32, which can be interpreted at 'high risk' [12]. Alok Rathore et al., Paper *Assessing Resilience of Transportation Networks under Multi-Hazards: A Review*, present a review of various methodologies for assessing and improving the resilience of the bridge network system against disasters. There are broadly two assessment approaches used by the authors in this paper, namely resilience aspect (quantitative) and resilience assessment (qualitative approaches). Resilience optimizes the maintenance method for faster recovery when the system's life cycle is considered. Therefore, a structural system's resilience is considered as a critical performance indicator for infrastructure [13]. S. Divya Sankar et al., in their *Risk*

*Management In Construction Industry*, present how the people in construction organizations need to manage the risks and need to know how to manage the risks by using different techniques of construction management. The analysis of risk and also techniques of management are applied rarely by the Visakhapatnam construction organizations because of the absence of knowledge and also expertise. Therefore, the construction industry is not confident relating to the techniques used and also its applicability in the construction projects [2]. Poornima Ramesh and Bharani Alagirisamy in their paper *Achieving Sustainability Goals through infrastructure modifications: Lessons learnt from COVID-19 pandemic* present how the world produced by antivirus looks on the basis of the lessons learned and the value of a stable and safe environment. This paper looks at the future COVID-19 steps to gradual and systemic improvements in varying time frames and sizes, which enhance air quality and less energy use, or the use of materials that eventually fulfill the sustainability objectives. The pandemic caused decision makers, designers and architects to reflect more, attempt to mold our physical areas and reset the current built environment, or to create more ideas to confront potential attacks on the virus [4]. Katopodis et al., in their exploratory study, explains the vulnerability and impact assessment of extreme climate events in the Greek oil industry by identifying the vulnerability status of employees, processes and structures through a three-level analysis. The proposed approach is built on the use of the high resolution WRF regional climate model to determine the climate hazards with the most severe impacts to oil infrastructure, the most exposed structures and processes, and the changes of the trends in extreme events, under the future analysis. The study highlighted the need for the re-design or improvement of the defenses of the oil infrastructure, taking into consideration the prospect of climate change, to withstand extreme hazards and loads expected in 50 years ahead [14]. Elena Dolgoplova in the paper *Catastrophic events at the river basins due to permafrost thawing: review and examples* discussed about how thawing of permafrost results in intensive erosion of river banks, breaking of constructions and pipes, thermokarst subsidence of landscape, etc. Most of the river discharges under consideration show increased trends, the rate of increase of water discharge decreases with a rise of air temperature. At the same time, correlation between the rate of river discharge increase and growth of ground temperature is found to be positive. It is found that a river bend is a potential source of hazard connected with the cemetery erosion. Growth of water discharges increases water levels which result in intensification of river bank erosion and may be a source of catastrophic pollution of water due to wash out of burial wastes [10]. Smaranika Panda in the paper *Effect of Land Uses on Personal Exposure of Street Vendors at a Metropolitan City* presents the impact of contrasting land uses on personal exposure of street vendors in one of the metropolitan cities of India (Bengaluru). Study results indicated heavy particulate exposure at both the locations. The PM<sub>5</sub> personal exposure was observed to be exceeding the PM<sub>10</sub> and PM<sub>2.5</sub> standards by several folds at both the land uses. However, at the traffic intersection the exposure concentration of PM<sub>5</sub> was observed three times higher than the residential area [32]. Sumeet Moktan et al., in their paper *Social Vulnerability Assessment to Natural Hazards in Western Nepal*, explained about the social vulnerability to natural hazards in western Nepal and have aimed

to assess social vulnerability in 40 districts of the Western regions of Nepal. The overall vulnerability map was prepared using the indicator-specific outputs obtained in this research. The indicators considered in this study were population, gender, age, education, health, poverty, ethnicity, economic and housing unit. The results of this study have the potential in contributing to policy making and preparedness, emergency planning, public awareness and altogether in creating a more successful and focused crisis response program [7]. The paper Sustainable Urban Drainage System to avoid flooding of rain origin and improving green areas, Lima, Peru by López Amaro et al. aims to provide an engineering solution to the problem with a sustainable urban drainage system (SUDS). It consists of a set of elements of the drainage network that will allow the collection, transport, decontamination, retention, infiltration and rainwater evacuation sustainably. It is recommended to implement SUDS alternatives to reduce the risk of floods due to the urbanization process and improvement of green areas and to avoid their occurrence in the urban development process in this and other areas of the city [39].

### 3 Innovative Construction Interventions

The explorative study on *Replacement of river sand with coal bottom ash as fine aggregate in cement mortar* by Wasnik et al. explained about utilization of coal bottom ash as fine aggregate in cement mortars. Compression tests are conducted on cement-mortar cubes (with different proportions of coal bottom ash) to determine compressive strength. Further, a compression test is conducted on cement-mortar cylinders in a displacement controlled Universal Testing Machine (UTM) to obtain the stress–strain curve and modulus of elasticity. The study found that river sand replaced with up to 50% coal bottom ash exhibited satisfactory performance as fine aggregate in cement mortar [45]. Vasavi G S et al., in their paper *Strength and Durability properties of Alkali activated Flyash Earth bricks*, discussed the strength and durability characteristics of alkali activated Flyash Earth bricks. Two kinds of bricks were produced, one set of bricks with the use of manufactured sand or M-sand and another set without M-sand. Soil Fly Ash alkali activated bricks can be used as an alternative to traditional burnt clay bricks as the strength parameters of these bricks are in the same range or even slightly higher than that of burnt clay bricks. It was found that the dry compressive strength of the bricks is in the range of 8 to 10 MPa, and wet compressive strength is around 70% of dry compressive strength [26]. Roy et al., in their paper *Experimental optimization of GGBS Fly ash-based geopolymer concrete paver blocks*, discussed about an extensive experimental investigation is carried out using various mix proportions of Geopolymer concrete (GPC), to identify the design mix considering the compression testing results and other key parameters of GPC with low-cost technology. From the compression testing results, GPC can be considered as the right material for construction from both strength and deformation considerations. Apart from its high strength, this material requires low production cost at high durability. Practical implementation of GPC technology in

precast concrete products such as paver block has been developed in Indian scenarios under ambient curing [11]. The explorative study on An Experimental Study of Creep Behavior for Disturbance of Unsaturated Expansive Clay Soil by Balaganesh P et al. explained about how the recent trends in technological innovations involved in the design and implementation of a smart composter enabled with IoT. The control and accuracy of results mainly depend on the selection of the major processing units having suitable output-related hardware such as Arduino UNO, Node MCU, Raspberry Pi model 3, track recorder, Siretta antenna and wireless communication module. It is also observed that selection of proper internet gateway is essential to address the challenges in data transmission, data safety and power consumption as in the case of a community-based cluster of smart composters. The study makes design-oriented prospects toward development of a smart-rapid composter involving provisions for advanced process control and quality checking (Expansive Soils). Kok Shien Ng and Yee Ming Chew in their paper *Practical Design of Stone Column in Predicting Settlement Performance* present a simple yet practical design method for both the end bearing and floating stone columns for large and small column groups. Hence, the methods introduced here focus mainly on the estimation of the settlements of stone columns and improved ground. They were developed based on a series of numerical studies using 2D and 3D finite element analyses. Three methods have been introduced for large stone columns groups and two methods for small stone columns groups. The methods are derived from numerical analyses where the effect of influencing factors on the settlement performance is taken into accounts [28]. Thanh Quang Khai LAM et al., in their paper Using prestressed reinforced concrete piles as basement walls for high-rise buildings discussed the latest construction techniques. There are currently some construction methods for building houses with basements, such as: pile construction method is done, then dig the soil to the bottom of the foundation and then build the house from the bottom up, or build according to the soil wall method (Barret wall), or the top down method, semi top down methods, etc. The authors present in this paper: "Using pre-stressed reinforced concrete piles for high-rise buildings as a basement wall." The use of pre-stressed reinforced concrete piles saves and lowers the project's cost, bringing the construction to high quality [20]. Prakash et al., in their paper *Analytical Study on Single Span Reinforced Concrete Beam with Continuous Spiral Reinforcement Under Pure Torsion* discussed the construction methods. In this paper, four inclination angles of stirrups and traditional stirrups are adopted. The torsion behavior in beams is studied by monitoring the load deflection curves, ultimate load values, vertical deflections measurements and crack propagation during static tests. Test results indicate that using rectangular spiral shear reinforcement improved the torsion capacity of beams compared with traditional individual closed stirrup beams. Using rectangular spiral shear reinforcement is recommended because it enhances the stiffness in beams [33]. Vigneshwaran R and Prabavathy S in their paper *Investigation of wind loads on setback building using Computational Fluid Dynamics* explained about the actual wind loads acting on the setback tall building. The simulation is carried using computational fluid dynamics (CFD) with the help of turbulence model realizable  $k-\epsilon$ . The analysis is carried for a particular wind angle  $0^\circ$  at a scaled wind velocity of 10 m/s.

From the results, the mean pressure coefficient ( $C_p$ ) is obtained for each face of the setback building and further pictorial representation the pressure contour on each face of the building is presented. Additionally, the physics of the wind flow behavior around the setback is studied [34]. Mahesh Mungulea and Kannan K. R Iyer in their paper *A Review on Role of Pavement Materials on Urban Heat Island Effects* have done the comparison of thermal performance of pavement materials, namely asphalt and concrete. Despite the obvious advantage with concrete, little attention has been paid to improve albedo values of concrete. Limited experimental investigations on modified concrete pavement highlight the potential gain that can be achieved. The utilization of admixtures for enhancing the albedo value of concrete pavement can be seen as an effective way to reduce the UHI effects, especially in urban areas [21]. Anjali A et al., in their paper *Studies on Strip footings resting on lateritic slopes*, had investigated the settlement behavior of strip footings resting at various levels on lateritic slopes, by carrying out a series of laboratory scale load tests on model footings resting along the slope surface. The parameters varied are distance of footing from edge of slope and slope angles. Finite element analyses are carried out with the FE software PLAXIS 2D, and the results are compared with those obtained from laboratory scale load tests for validation. Eccentricity and slope angle are major factors which affect the load settlement behavior of footing resting on slopes [1].

#### 4 Waste Management and Disaster Risk Reduction

Rohan Deshmukh et al., in their paper *Effective Utilization of Waste Plastic Bottle as Geocell in Road Pavement: A Numerical Study*, describe about an approach to use cellular reinforcement made up from Waste Plastic Bottle Geocell (WPBG) for the improvement of pavement. In this study, unreinforced and cellular reinforced pavement was analyzed by numerical modeling in PLAXIS 2D and 3D. This study gives an effective result and proves to be a boon for road construction as it improves the subgrade and also for environmental conservation as it provides effective utilization of waste plastic bottles in the form of geocell [40]. The explorative study on *Impacts of Temple waste on the environment and its mitigation* by Jahagirdar S. et al. reviewed about the temple waste management. India is land consisting of millions of temples which in turn generate thousands of tons of waste every year. This study and analysis indicated that proper management of temple waste has emerging benefits like excellent quality manure and reusability of water, making the temples more sustainable and smarter, rather than disposing of the temple waste with domestic waste [22]. Dani Irwan et al., in their paper *Age and Household Solid Waste Arising in Suburban Malaysia: A Statistical Approach*, aim to examine the relationship between age and the rate of household solid waste (HSW) generation per capita from households in selected residential areas of the suburban Malaysian townships of Bandar Baru Bangi, Putrajaya and Kajang. Subsequent data refinement resulted in a final sample of 219 households consisting of 4623 discrete measurements being used for statistical analysis in the IBM SPSS software package. Results of statistical analyses

show that weighted average age has a small and positive but statistically insignificant correlation to average daily per capita HSW arising. However, evidence from this study shows that the relationship between the two is insignificant from a statistical perspective [19]. The paper Feasibility study on Municipal Solid Waste (MSW) as sustainable engineering material using suction characteristics by M. V. Shah and A. J. discussed about the study which attempts to observe the suction characteristics of the waste for different moisture content and to establish the relation between suction parameters and strength of the waste. To check its suitability as the alternate material for construction purpose, the same study is carried out on silty sand so that the influence of the volatile matters present in the MSW on suction can be observed. The average pore size of the compressed mass is carried out using the relation of matric suction to pore size and the void formation is observed in a high magnification microscope to visually check and correlate the variation in pore size. The suction has an unavoidable impact on strength, compressibility and pore size of the compressed mass. The compaction on the dry side of optimum is preferable for achieving higher strength and more continuous structure of compressed solid waste [24].

## 5 Urban Development and Sustainability

Bharani Alagirisamy and Poornima Ramesh in their paper *Smart Sustainable cities: Principles and Future Trends* discussed new sustainable development concepts and intelligent city approaches with respect to the planning policy. This further addresses the successes and shortcomings with special focus on the degree to which it is related to in incorporating the principles of sustainable growth. As the examined papers revealed, many elements are needed to create sustainable cities, but the main emphasis is on the threefold approach to sustainability (i.e., environment, economics and equity). Each aspect is linked with these principles of sustainability either directly or indirectly. In the end, the potential of our future cities to imitate the carbon and water cycles of nature is critical for regeneration and reuse, rather than the present mitigation conditions that prioritize recycling [8]. Saif Al Zabeeb in the paper *Tire derived aggregate as a sustainable technique to mitigate transient seismic effect on buried concrete pipes* explains how the tire derived aggregate (TDA) is used as sustainable lightweight fill during the last few years. This research has been conducted to investigate the static and seismic performance of buried concrete pipe that is supported using TDA. The finite element method has been utilized in the analyses using earthquake records that cover a predominant frequency range and a peak ground acceleration (PGA) range. The results showed that the TDA reduces the maximum bending moments induced in the pipe wall by 27% for static condition and by 22 to 39% for seismic conditions. Based on the obtained results, the TDA can be considered as one of the feasible options to be used as material supporting buried concrete pipes subjected to transient seismic shake [3]. Ebne Alam et al., in their paper *Temporal Variation of Land Surface Temperature in Response to Changes in Vegetation Index of Bhawal National Park, Bangladesh*, discussed about the generality of

the Normalized Difference of Vegetation Index (NDVI) and Land Surface Temperature (LST) correlations encountered over a wide range of vegetation coverage areas of the Bhawal National Park during the winter season. Information on LST and NDVI was obtained from long-term (30 years) datasets acquired from Landsat 5 TM and Landsat 8 OLI after atmospheric correction. Regression analysis is used to find the correlation between LST and NDVI. The rise in temperature in the recent year and the correlation coefficient found in this study support the progressive declination of vegetation coverage in the Bhawal National Park of Bangladesh. The findings also indicate the negative effects of deforestation and the importance of the forest areas in the city areas which are altered by the rapid human settlement, urbanization day by day [46]. Daniel Rios in the paper *Use of stream power as a tool for the detection of critical reaches in channeled streams* has explained how we can use stream power for detection of critical reach in channeled streams. The need of a tool for prioritizing intervention reach in the Aburrá River arises because there is a canalized reach of approximately 24 km along the valley, and additionally, there is a metro line and main roads parallel to the canal to great extent of its length. Finally, the classification obtained with the criterion of the Task Force Stream Power was compared against a personal photographic record that the author built over four years in the different analysis sites. Finding that the active process in the six sites corresponds to predicted with the criterion of unit stream power, therefore, the use of stream power as a tool for the detection of critical reaches and schedule your preventive maintenance in channeled streams is recommended [6]. Dasandara et al., in their paper *Urban Facilities Management: A Way of Attaining Sustainable Cities in Sri Lanka Dynamics*, intended to analyze the drivers and barriers to the successful adaptation of UFM into Sri Lankan context. A qualitative research approach with qualitative interview survey strategy was followed to accomplish the aim of this study. The empirical findings revealed that UFM adaptation into Sri Lankan context is still at its nascent stage in Sri Lanka. The findings would therefore enable relevant stakeholders, who engaged in management and development of cities, to make informed decisions and thereby promote modern, innovative and sustainable ways for ensuring the well-being of the whole society [35]. Shubham Pandey et al., in their paper *Fuzzy-AHP Based Design and Performance Indexing Model for Tall Buildings*, aim an effort to encompass all such parameters into a simple, easy to understand hierarchical unit, which is very simple and can highlight the crucial parameters and make it possible to assess the comparative need and requirement of one factor and criterion over the other. In the end, the prevailing design practices and norms are reviewed, and some suggestions have been summarized considerations of which can further enhance and improve the likely performance of the tall buildings [36]. The paper *Carbon Neutral Communities: Model for Integrating Climate Action into Development Planning* by Sajjan et al., explains that Climate change is one of the major discussions pertaining to economic development across the globe. The concept of ‘carbon neutrality’ puts forth the notions of zero carbon development, food and energy self-sufficiency at local government level and falls in line with the sustainable development goals put forward by the United Nations. This pilot project paves way for low carbon development in Kerala and serves as a model for the rest of the country to follow. Achieving carbon



neutral status is an arduous but worthy task as the resulting sustainable economy will benefit all. By adopting policies and schemes and setting short-term and long-term projects, a community can easily become carbon neutral with the support of all actors in the community [27].

## 6 Cross-Cutting Issues

Akheel K. et al., in their paper *Review of Free Vibration Response of Spar Supported Wind Turbine with Tuned Mass Damper*, have reviewed the necessity and advantages of offshore floating-type wind turbines compared to the onshore wind turbines are carried out. Successively a floating-type spar-supported OC3-Hywind wind turbine is selected for the investigation. The structural modeling details are studied, and OpenFAST software framework is used for the analysis. The corresponding changes in the considered structural degrees of freedom vibrations are evaluated. Corresponding to this instant, the fore-aft, surge and pitch responses had reductions of 80%, 53% and 99%, respectively. It is found that the response control improves (further) positively with the increase of Tuned Mass Damper mass ratio [25]. Abitha Babu and Sitaram Nayak in their paper *A Review on Methods for Analysis of Laterally Loaded Piles* have reviewed different methods for the analysis of laterally loaded piles. The applicability, advantages, limitations and comparison of various methods are also included in the study. With the increased computational power of the computers and the availability of appropriate software, numerical simulation and analysis of the problem has become the most cost effective and accurate method [23]. Sumathi A and Saravana Raja Mohan K in their paper *Effect of Silica fume and Steel fiber on Mechanical Characteristics of High Strength Concrete reviewed* about characteristics of high strength concrete. In the present work, the effect of silica fume (SF) as a partial substitute to cement on mechanical properties of steel fiber reinforced concrete with a characteristic compressive strength of 60 MPa was considered. ANOVA statistical method was used to evaluate the substantial effect of SF and fiber in concrete strength. The additions of steel fibers to HSC containing silica fume change the complete basic trend of stress–strain response. The descending branch slope enhances based on the increase of fiber in volume fractions. The strength model was developed using experimental findings on the basis of regression analysis. In estimating the different intensity at 28, 90 and 180 days on the basis of estimation more or less similar with measurements, the proposed regression linear model was found to be accurate [38]. Nurhanani A et al., in their paper *Particle Deposition Analysis using DPM-DEM*, have explained about coastal erosion. The effect of regular strengths, such as wind and waves, can alter the shoreline structure and rapid coastal erosion. The numerical study showed that the number of particles changes as time increases due to the generation of waves. The findings have been validated with the smooth-particle hydrodynamics method to investigate the effectiveness and accuracy of the numerical analysis of DPM-DEM. It is also proved that the length of time would generally increase the number of particles erosion and change the formation of sand that would lead to erosion [5]. Balaganesh

P et al., in their paper *Recent Trends in IOT enabled composter for Organic Wastes*, reviewed the recent trends in technological innovations involved in the design and implementation of a smart composter enabled with IoT. The control and accuracy of results mainly depend on the selection of the major processing units having suitable output-related hardware such as Arduino UNO, Node MCU, Raspberry Pi model 3, track recorder, Siretta antenna and wireless communication module. It is also observed that selection of proper internet gateway is essential to address the challenges in data transmission, data safety and power consumption as in the case of a community-based cluster of smart composters. The study makes design-oriented prospects toward development of a smart-rapid composter involving provisions for advanced process control and quality checking [9]. The paper *Study on the Effects of CNT and Nano Graphene in Clayey Soil of Aligarh City of Northern India* by Jibran Qadri et al. explains and analyzes the possible advantages of nanotechnology for revolutionary applications in the soil enhancement area. The aim of the study is to investigate the effect of the addition of different nano-CNT and nano-Graphene on the geotechnical properties of clayey soil samples from Aligarh city in university campus. When the nanoparticles apply the liquid limit, the plastic limit and the plasticity index decreases. With the inclusion of nanoparticles exceeding the optimal quantity, the state of a mass cluster is associated, thereby influencing the mechanical features of soils. Thus, even in very tiny quantities, the inclusion of nanoparticles will exquisitely increase strength and strengthen properties. The overall cohesion and the angle of friction have increased, which suggest an increase in shear strength [16]. Site Onyejekwe et al., in the paper *Highway Development-Related Gully Erosion: The Case of the Okigwe-Isuikwuato Highway, Southeastern Nigeria*, discussed about the anthropogenic, hydraulic and hydrological factors that led to the development of these gullies. It also proffered suggestions for the mitigation of the effect of these gullies. This paper reviewed the causes of these gullies and found that there was interplay of a number of factors at work in this respect on the inception and progression of gully development and erosion generally was demonstrated. Considering the scale of the problem, it is clearly evident that strategies for the control and remediation of erosion ravaged areas should involve a serious reforestation program and all other strategies that reduce the rate of flow of surface runoff [17]. Site Onyejekwe et al., in their paper *Assessment of the Causes of Erosion and Gullying Along the Leru—Nkwoagu, Amuda (Isuochi)—Mbala (Isuochi) Highway, Southeastern Nigeria: A Case Study*, reviewed the causes of erosion and gullying on the Leru–Nkwoagu–Mbala highway, a highway in the semi-tropical environment of Southeastern Nigeria. The failure to implement safeguards, poor design considerations, particularly in relation to the aspects of design relating to hydraulics, hydrology and geotechnics, and the general lack of enforcement of environmental regulations on this highway have been found not to be an outlier. Hence, a river basin-wide, intergovernmental, multisectoral, multidisciplinary, and all-stakeholder approach to the solution of highway-related soil erosion is strongly recommended for adoption [18].

## 7 Summary

UN Sustainable Development Goal 11: “Make cities inclusive, safe, resilient and sustainable,” target 11 focuses on resilience and sustainability in urban development and human settlement. It suggests to substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans toward inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels, and to support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials. System approach for flood vulnerability and community resilience assessment at the local level is one of the major components for resilience building [30].

This chapter summarized the contents of the book volume on City Resilience and Sustainable Infrastructure. All the chapters in this volume are segregated in five sections such as resilient infrastructure in construction, innovative construction interventions, waste management and disaster risk reduction, urban development and sustainability and cross-cutting issues.

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