ASSESSMENT OF DISASTER-RESPONSIVE TRADITIONAL HOUSING IN COASTAL CITIES: A CASE STUDY OF GANJAM DISTRICT, ODISHA

Upasana Mohanty*[1] and Bhavna Shrivastava[2]

[1] *Student, Malaviya National Institute of Technology Jaipur, India /Department of Architecture and Planning, India, e-mail: 2022par5361@mnit.ac.in*

[2] *Assistant Professor, Malaviya National Institute of Technology Jaipur,India /Department of Architecture and Planning, India, e-mail: bhavna.arch@mnit.ac.in*

***Corresponding Author**

ABSTRACT

According to the World Risk Report 2022, developed by the Institute for Environment and Human Security (EHS), out of 193 countries with a risk of 42.31WRI (world risk index) India holds the 2nd position and Odisha is an eastern coastal state of India that has faced the maximum number of disasters since years. It shares a coastal length of 450Km with the Bay of Bengal and due to its geographical location and extreme weather conditions it suffers from a contrasting range of disasters from heat waves to cyclones & from droughts to floods. It has faced more than 100 cyclones since 1891 and hence is referred as the 'disaster capital' of India. (How Odisha's Model of Disaster Preparedness Came into Being, 2021).

Since the beginning of time, humans have relied on nature, e.g., trees, caves, etc., for shelter and protection from outer physical phenomena. Evolution in craftsmanship and technology resulted in housing evolution from caves to constructed houses, which shapes the image of a city through different architectural features; similarly, In cities, the network layouts (roads, water supply lines, electricity supply lines, drainage systems, etc.), environmental factors (air, water, and soil quality, natural vegetation or landforms), geographical factors (topography, climate, etc.), locally available materials, and craftsmanship define its "Vernacularity" which focuses on "Functionality" and disaster resilience plays a vital role in defining its vernacular characteristics which is evident in Ganjam district of Odisha, whose infrastructural planning is a resultant of its traditional housing pattern locally known as the "Rail dabba" housing concept which is resilient to local natural hazards like cyclones and floods. This concept protected the city from cyclones and floods to a large extend but with the increase in population, the pressure on infrastructural systems also increased, the district being constricted started facing a lot of urban issues. Hence, it is crucial to upgrade a city's "vernacular characters" over time in order to meet growing urban demands while continuing its original function.

This paper aims to analyze the impact of vernacular housing in spatial planning and investigate the planning-related challenges and solutions, taking a case study of Ganjam District, which is a cyclone-prone coastal district of Odisha. The ultimate goal of this paper is to contribute to disaster risk reduction by implementing the lessons learned in the spatial planning of future coastal cities.

Keywords: *Spatial Planning, cyclone prone areas, coastal resilience planning, Traditional Housing*

1. INTRODUCTION

A regions morphological characteristics and population distribution decides its vulnerability to different disasters and Odisha is an eastern Indian state (sharing its north-eastern boundary with West Bengal, northern boundary with Jharkhand, Western boundary with Chhattisgarh, Southern boundary with Andhra Pradesh and the rest of 480 Kms with the "Bay of Bengal") which consists of 5 major morphological regions based on its distinctive geographical features (Table 1) and half of the state's population resides along the coasts.

Out of a total area of approximately 1,55,000 square kilometres, Coastal Plain covers an area of approximately 25,000 square kilometres and runs parallel to the Bay of Bengal, Eastern Ghats covers an area of approximately 60,000 square kilometres, western rolling uplands 40,000 square kilometres and nearly 30,000 square kilometres are flood plains (*ODISHA STATE DISASTER MANAGEMENT AUTHORITY | State DM Plan, 2023*).This diversity is advantageous to the state in terms of agricultural production, availability natural resources, biodiversity and ecotourism but is also the major reasons behind it being one of the most disaster-vulnerable state. (ODISHA STATE DISASTER MANAGEMENT AUTHORITY | State DM Plan, 2023).

Table 1: Percentage of total area coverage by each morphological region in Odisha

Morphological Region	Area Coverage	Percentage
Coastal Plains	25,000 sq.km	16 %
Flood Plains	30,000 sq.km	20 %
Western Rolling Uplands	40,000 sq.km	26 %
Eastern Ghats	60,000 sq.km	38 %
Total Area : 1,50,000 sq.km		

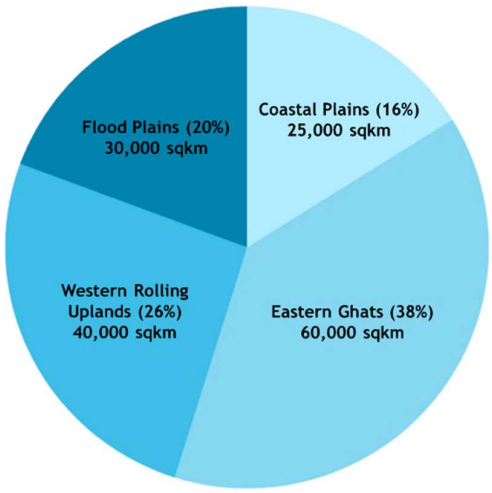

Figure 1: Percentage of total area coverage by each morphological region in Odisha

According to 2011 Census of India, the population of Odisha was approximately 41 million people, and a significant population of around 14 million are settled in the coastal districts out of which Ganjam district has a highest population of 35 lakhs (3.5 millions) (Odisha Population Census 2011, Odisha Religion, Literacy, Sex Ratio - Census India).

The people settled in the coastal areas and low-lying areas are considered as the "vulnerable population" as they are exposed to the severe effects of cyclones, including the powerful winds, storm surges, and heavy rains, which can harm human lives and infrastructure, houses, and livelihoods.

Vernacular architecture embodies the rich tapestry of local knowledge and practices woven into built spaces (Oliver, 2013) and is rooted to specific environments and cultural contexts, these dwellings tell stories of adaptation, resilience, and a deep understanding of sustainability (Brawne, 2014).The traditional housing styles of Ganjam district (one of the coastal districts of Odisha) craft harmonious relationships between people and place with their "vernacular architecture," locally termed the "Rail-

dabba" concept, which has clearly safeguarded cities for ages but faced strain as it was unable to meet the demands of modern cities, leading to urban issues as it grapples with the dual challenges of population growth and increasing urbanization.

This paper aims to understand the traditional housing of Ganjam district and unravel the challenges and propose viable solutions, contributing valuable insights to the broader field of Disaster Risk Reduction. Building upon the existing literature on disaster management and spatial planning, this research addresses the dearth of comprehensive studies tailored to the specific needs of cyclone-prone regions. By delving into the vernacular characteristics of Ganjam District, we aim to shed light on the intricate relationship between infrastructural planning, disaster vulnerability, and resilience. This paper not only presents a case study but also outlines a broader framework that can inform spatial planning strategies for future coastal cities.

2. METHODOLOGY

This research paper uses a mixed qualitative-method approach to collect and analyse data. This is based on the authors' own observations and past experiences (self-reflection method), which include the traditional housing style of Ganjam district (Coastal district of Odisha) and its response to local disasters and risks. Thematic analysis approach is used for data analysis. Observational facts and interviews with local inhabitants helped to develop a deeper understanding of traditional housing and increasing coastal city problems and to find their respective and potential solutions, findings from various research papers and documents were used which include strategies for better resilience and to meet the needs of modern coastal cities. Its qualitative nature restricts this study's generalisation to a wider population.

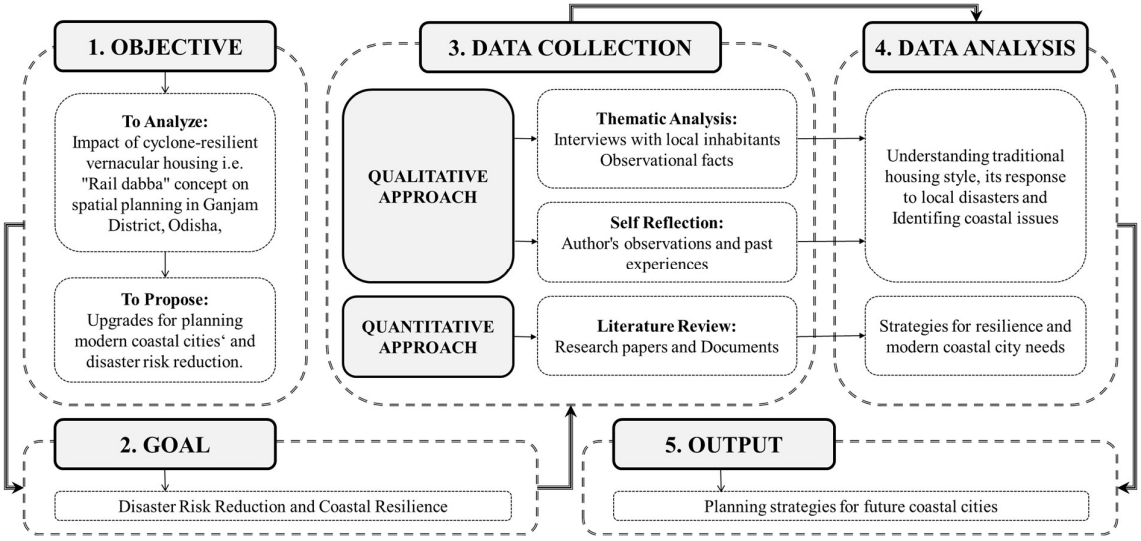

Figure 2: Research Methodology

3. TRADITIONAL HOUSING IN COASTAL AREAS: A CASE OF GANJAM DISTRICT

A region's vernacular architecture is directly influenced by a variety of factors, including the climate, the environment, social and cultural contexts, locally available building materials, traditional construction techniques, adaptability, flexibility, and creativity (House, Form and Culture, 2023), For example, Ganjam, a coastal district of Odisha, continues an ancient tradition of building structures that are safe, secure, and suitable for the local climate.

The houses have a linear layout, with rooms arranged one after another along a central corridor. They use small courtyards for ventilation, which allow the prevailing winds and restrict cyclonic winds from entering the courtyards. Only the front and back facades of the houses, which are the walls with the smallest widths, have the door and window openings that face the cyclonic winds, and by securing them,

the whole house gets shielded from the disastrous winds. The housing features with descriptions and their functions are discussed in Table 2.

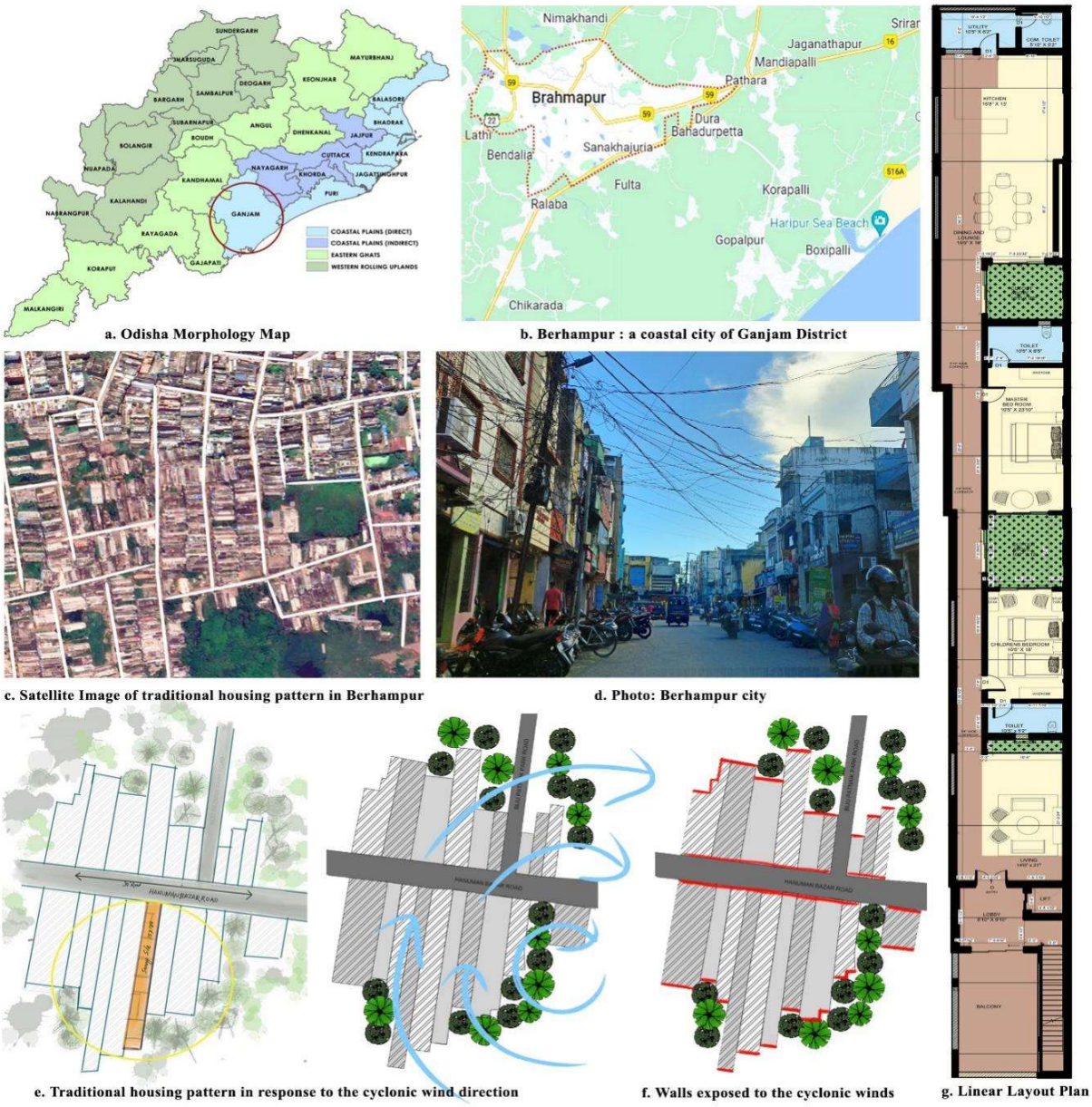

Figure 3: Concept of Traditional Housing in coastal cities of Odisha – Case of Ganjam District

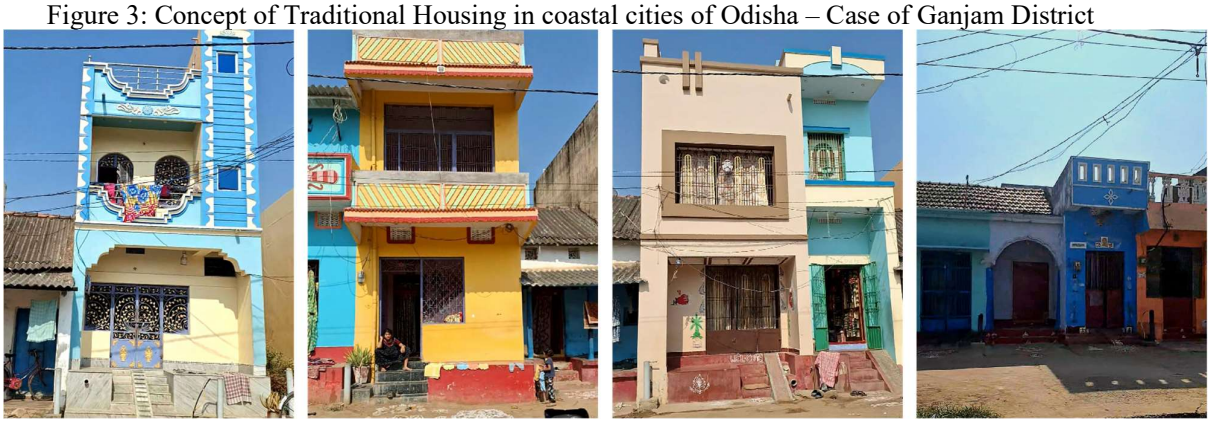

Figure 4: Front facades of houses constructed according to the vernacular architecture of Ganjam

Table 2: Features and functions that reflects the vernacular architecture of Ganjam district

Features	Description	Function
Orientation Buildings oriented parallel to the wind direction	The main entrance, known as the "mukhya dwara," and the back door to the backyard known as "bari" are opposite to each other and the windows, "jharaka," should face the direction that receives the most sunlight and prevailing breezes.	This ensures sufficient natural light and air circulation throughout the home from 2 ends.
Layout plan Linear building layout plan	The houses are characterised by their long, narrow, and linear layout, with a row of rooms arranged alongside a central corridor that stretches straight from the frontyard to the back yard, known as the "danda" and "bari," respectively.	This design facilitates easy mobility within the house and effective utilisation of available space. During cyclones, it becomes easier to protect the house by securing the openings at the front and back, which restrict the entry of cyclonic winds inside the house.
Room arrangement	The houses have a linear arrangement of rooms along the corridor, strategically based on their purpose and privacy requirements. Commonly, the bedrooms are placed towards the rear for privacy, while the living room, dining area, and kitchen are positioned towards the front or centre of the house for easy access.	This makes the rooms less exposed to the outside environment.
Plinths	Plinths are the elevated platforms. The houses are constructed above a plinth height of 3-5feet.	The plinth spreads the weight outward, distributing it more equally throughout the ground, and it also prevents flooding of water into the interiors during heavy rain or cyclones and minimizes damage to the house.
Windows & ventilation	Incorporate sufficient windows and ventilation openings along the corridor and rooms to ensure proper airflow and ventilation.	Windows along the corridors are less vulnerable to cyclonic winds as compared to the windows perpendicular to the corridors.
Outdoor spaces	Linear plan houses often have limited width; hence, spaces like a courtyard or a small garden at the front, known as "danda," or rear of the house, known as "barri," are created.	To have an indirect connection with the outside environment.
Structural consideration/ Robust construction	The house is constructed with durable materials such as reinforced concrete and a cyclone-resistant structural design, i.e., the walls and roofs are designed to withstand high wind speeds and impacts from debris during cyclones.	For protection against natural calamities and unfavourable weather, such as severe monsoon rains and occasional cyclones.
Expandability	Linear plan houses can be easily expanded by extending the corridor and adding rooms as needed.	

4. TRADITIONAL HOUSING IN COASTAL AREAS IN RESPONSE TO DISASTERS

The traditional housing style of Ganjam district is mainly characterized by the sharing walls, or the common walls, between two different houses.

The common walls restrict the cyclonic wind from flowing through the settlements, which reduces their exposure, and the plinth restricts the flooding of water inside the houses. Other features of the houses and their roles during a disaster are depicted in Table 2 and Figure 5, respectively.

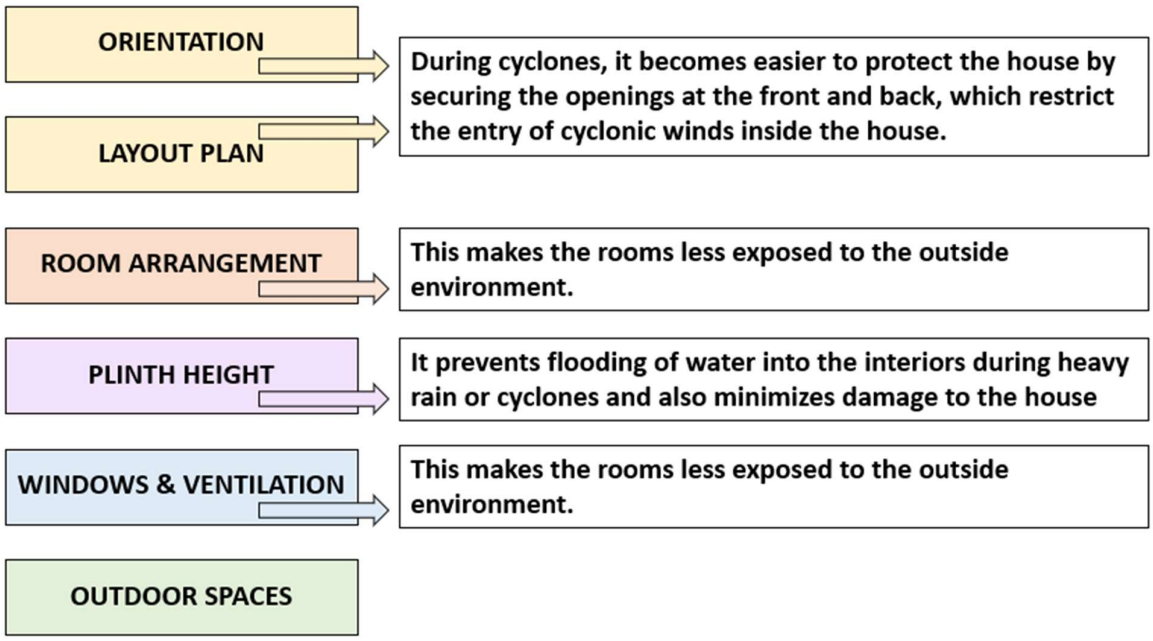

Figure 5: Features of Ganjam's Traditional Housing style and their response to disasters.

The vernacularism or traditional housing style of Ganjam District protected its vulnerable coastal population from various natural disasters like cyclones and floods to a large extent, but the increase in coastal population within a restricted and confined coastal area is accompanied by an increase in its dependency on the existing infrastructural facilities and networks.

5. NEGETIVE IMPACT OF TRADITIONAL HOUSING IN SPATIAL PLANNING AND SERVICE MANAGEMENT IN GANJAM

The way houses are arranged and developed directly impacts the structure of a city.In Ganjam, the linear housing with sharing walls limits the cities growth and clashess with the challenges like population growth and increasing urbanization.

The houses were originally intended to be 20 to 24 feet high (maximum 2 stories), but due to population growth, housing shortage and lack of available space for house extensions, vertical expansion occurred instead of horizontal expansion (Asian Development Bank, 2018), which rendered the houses' primary purpose of resisting cyclonic winds ineffective. Some of the other impacts are listed as follows:

Housing density: The linearly planned traditional houses are built on the linearly plotted divisions, and due to the sharing walls between two different houses, it leads to an increase in the housing density of a coastal city. (World Bank, 2018).

Strain in Infrastructure and services: An increase in housing density also increases the strain on infrastructure, and as a result, service costs rise and it fails to provide basic services like water supply, electricity, etc. to the city as it is difficult to maneuver machinery and equipment for its expansion, maintenance and repair operations (World Health Organization, 2018)

Transportation and road related issues: The close proximity between structures can cause severe traffic-related issues like traffic congestion and parking problems. (World Resources Institute, 2018) and in coastal cities this can degrades the tourism quality. Electric poles placed too close and on-street parking tappers the lanes, creating bottlenecks and reducing traffic capacity.

Vulnerability to other disasters: As the houses are interconnected, they become vulnerable to fire, structural damage (IPCC, 2021) and crumbling of multiple attached houses.

Environmental Impact: Densely packed houses limit green spaces, hindering biodiversity and causing heat island effect causing a negative impacts on the natural environment. The strain on resources like water and energy can further exacerbate these issues. (WRI, 2018).

Figure 6: Photos from the narrow streets of Ganjam district

6. MITIGATION MEASURES AGAINST THE URBAN COASTAL PROBLEMS

To cope with these rising coastal city problems, certain mitigation measures need to be adapted by the coastal inhabitants and the planning regulations. New York City, Rotterdam and Tokyo are some of the coastal cities that have implemented city-level mitigation measures against coastal problems (*How to Adapt Your City to Sea Level Rise and Coastal Flooding*, 2023) which includes the following:

Land-use regulations: Promote mixed-use zoning of residential, commercial, and light industrial uses (Florida Department of Community Affairs, 2020) which may be associated with zoning conflicts related to balancing development, density, and character while navigating concerns about gentrification.

Building regulation: Manage building heights (increasing elevation of buildings by increasing the plinth height or by constructing buildings above stilts) to maintain the scale and character of row houses and ensuring adequate sunlight and airflow (City of Vancouver, 2023) and provide roadside setback for easy maneuver machinery and equipment for its expansion, maintenance and repair operations. These measures can be prohibitively expensive but will be significant for coastal resilience.

Flood-Proofing infrastructural measures: This includes variety of engineering and design features that can be implemented to reduce the risk of disruption caused by flooding. Example; Building levees and seawalls to create barriers between floodwaters and vulnerable areas, Raising the elevation of roads and bridges to keep them above the flood level, installing floodgates and tide gates to control the flow of water in and out of flood-prone areas, improving drainage systems to remove floodwaters etc (*FEMA.Gov*, 2012) which are associated with dilemmas of high costs weigh against potential benefits.

Promoting green: Encourage green infrastructure elements like rain gardens, bioswales, and permeable pavements to manage storm water runoff and prevent flooding (EPA, 2023). Space constraints, maintenance requirements, and public acceptance can hinder wider adoption.

Increasing community awareness and preparedness: This includes educating coastal population about the risks of coastal disasters and preparation of emergency evacuation plans (*How to Adapt Your City to Sea Level Rise and Coastal Flooding*, 2023) which is a long-term commitment to overcome apathy, reach out to diverse populations, sustain engagement beyond crises etc.

7. CONCLUSIONS

Vernacularism, traditional housing styles, and city structures are some of the features that are set by a city with respect to its climatic conditions, locally available materials, risks to disasters, cultures, socio-demographic configurations, etc that sets it apart from other cities. This study found that the concept of building structures with linear layout plan with common walls and orienting them parallel to the wind directions protects the city from disasters like cyclones and floods to a large extend but it also restricts the city's development which as a result degrades the city's quality. As a solution it is needed to upgrade the land-use and building regulations of the coastal cities in accordance to its vernacularism of housing, spatial planning and booming city demands, so that we can implement the potential mitigation measures and solutions in designing future coastal cities.This finding has important implications in order to increasing the coastal resilience by developing and planning coastal cities. Overall, this paper contributes into the field of disaster management and coastal resilience.

ACKNOWLEDGEMENTS

Dr. Bhavna Shrivastava, for their guidance and support throughout the project.

REFERENCES

Bündnis Entwicklung Hilft & Ruhr-Universität Bochum - Institute für Völkerrecht und Friedenssicherung. (2022). World risk report 2022. https://www.weltrisikobericht.de

ODISHA STATE DISASTER MANAGEMENT AUTHORITY | State DM Plan 2023.Retrieved November 12, 2023, from https://www.osdma.org/state-dm-plan/

Odisha Population Census 2011, Odisha Religion, Literacy, Sex Ratio—Census India. Www.Censusindia.Co.In. Retrieved November 12, 2023, https://www.censusindia.co.in/states/odisha

(PDF) House, Form and Culture. Dokumen.Tips. Retrieved November 12, 2023, from https://dokumen.tips/documents/house-form-and-culture-55e7f8784da1f.html

World Development Report 2018: Learning to Realize Education's Promise. World Bank. Retrieved November 13, 2023, from https://www.worldbank.org/en/publication/wdr2018

World Health Organization (WHO). (2019). WHO results report, programme budget 2018–2019. World Health Organization, from https://www.who.int/docs/default-source/globalreportspdffiles/who-results-report-1819-clean.pdf

World Resources Institute. (2018). World Resources Report 2018: Turning the Tide on Coastal Flooding and Land Loss. https://www.jpl.nasa.gov/news/study-projects-a-surge-in-coastal-flooding-starting-in-2030s

Asian Development Bank (ADB). (2018). Urban development in Asia: A review of trends and issues. https://www.adb.org/publications/series/asian-development-review

Intergovernmental Panel on Climate Change (IPCC). (2021). Sixth Assessment Report. https://www.ipcc.ch/assessment-report/ar6/

How to adapt your city to sea level rise and coastal flooding.Retrieved November 13, 2023, from https://www.c40knowledgehub.org/s/article/How-to-adapt-your-city-to-sea-level-rise-and-coastal-flooding?language=en_US

City-level mitigation measures against urban coastal problems: https://www.c40knowledgehub.org/s/article/How-to-adapt-your-city-to-sea-level-rise-and-coastal-flooding FEMA.gov.Retrieved November 13, 2023, from https://www.fema.gov/

Federal Emergency Management Agency (FEMA). (2012). FEMA. https://www.fema.gov/

City of Vancouver. (2023). Zoning and development regulations. https://vancouver.ca/home-property-development/zoning-and-development-bylaw.aspx

U. S. Environmental Protection Agency. (2023). Green infrastructure. https://www.epa.gov/green-infrastructure

Oliver, P. (2013). Built to last: A guide to vernacular architecture. Reaktion Books https://doi.org/10.4324/9780080476308