

Desarrollo de la gobernanza urbana resiliente al cambio climático en Bangladesh . Evaluación de la vulnerabilidad del impacto del cambio climático en ciudades intermedias y comprensión de la gobernanza local

Developing climate change resilient urban governance in Bangladesh. Vulnerability Assesment of Climate Change Impact in Intermediate Cities and Understanding Local Governance

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ABSTRACT:

In this study five intermediate cities of Bangladesh as future populated urban centers have been investigated to formulate a comprehensive framework for climate resilient urban governance The conceptual framework adopted the modified structure of CRF model of S Tyler and M Moench (2012) incorporating Urban functional system, Local urban governance, and Climate resilience as major components. The cities have been conceptualized as a functional system to identify the climate change impact upon social, economic, environmental and political subsystems. The vulnerability assessment of climate change impact shows that the different level of risks caused by frequent climate hazards. The research initiates a resilience building process based on Mehta's good governance (1998) through a shared learning dialogue (SLD) among stakeholders.

1 INTRODUCCIÓN

According to Germanwatch's Global Climate Change Risk Index in 2020, Bangladesh ranked 7th most affected country by the frequent climate hazards (1999-2018) and is facing a huge challenge of 30 million people to be displaced in 2050. UN Habitat says the future of world lies within the development of Intermediate cities and 68% of world population will live in urban areas in 2050. Bangladesh has monocentric urban growth and poor urban governance causing unplanned urbanization in Bangladesh (Rahman HZ, 2014).

Governance for Urban Sustainability and Resilience is crucial for strategic decision making to respond Climate Change and the relevance of the Built Environment (Jeroen Van der Heijden 2014). An integrated urban development policy prioritizing the issue of sustainability and urban resilience must be formulated to mitigate the immediate challenges of global climate change for small and middle size cities in vulnerable developing countries. The line of proposed research will focus on urban governance as major strategic decision-making tool for strategic and spatial planning process for urban areas to be responsive and capable for future climate challenges.

2 OBJECTIVES

The objective of this research is to assess the climate change impact on the functional systems of intermediate cities and formulate a comprehensive framework for climate change resilient urban governance system. This study will examine the role of local governance regarding urban system, agents and institutions to enhance resilience building process.

3 METHODOLOGY

3.1 Understanding Functional system of intermediate cities in Bangladesh

To deal with the complexity, diversity and uncertainty of contemporary cities and to interpret the mounting challenges it is necessary to conceptualize the city as an evolving functional ecosystem (Fernandez-Guell, 2016). In the methodological framework each city of case studies will be conceptualized based on references, data and expert opinion collected from field works regarding four subsystems 1. Societal, 2. Economic 3. Environmental and 4. Political subsystem.

3.2 Climate change vulnerability assessment

Each city of case studies will be assessed for climate vulnerability to provide basis for understanding both direct and indirect impact of future climatic hazards on people, infrastructures, and urban system. The study will also examine the existing capacities to adapt and provide information to plan the city for a resilient future (Sarah Opitz-Stapleton, et al., 2009).

3.3 Formulation of Conceptual framework for building climate resilient urban governance

In this research the conceptual framework (Figure-01) adopted the structure of CRF model (Stephen Tyler and Marcus Moench, 2012) for building resilience in urban governance system. The operational framework of CRF model incorporated the general notion of urban climate resilience and identified three elements of urban resilience, a. Urban system which includes physical infrastructure and ecosystems providing key services, b. Agents which include individuals, households, private and public sector organizations, and c. Institutions linked to system access, decision making process, information flows and application of new knowledge, to their expositors to climate change vulnerability.

The proposed conceptual framework incorporates three major components 1. Urban functional system, 2. Local urban governance and 3. Climate resilience. The vulnerability assessment of climate change impact upon urban functional system will define the character and dynamics of local urban governance. This framework initiates a resilience building process for local urban governance based on the principles of good governance (Mehta, 1998) using scientific and local knowledge through a shared learning dialogue involving stakeholders.

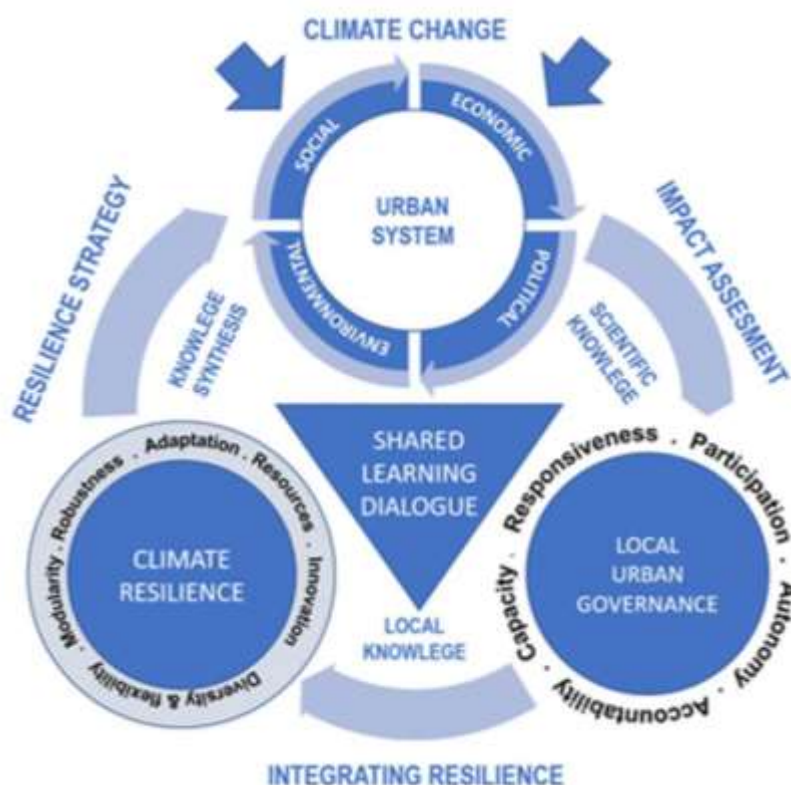


Figura 1. Conceptual framework for building resilient urban governance for intermediate cities in Bangladesh

Fuente: Own elaboration.

3.4 Shared Learning Dialogue (SLD)

Shared learning dialogue (SLD) is a mechanism to engage scientific experts, local government officials, research centers, civil society, private sectors and community representatives in local deliberations and knowledge sharing for identifying key priorities, needs and gaps in the cities. They facilitate open communication between various stakeholder groups and are designed to facilitate mutual learning and joint problem-solving within a project city to understand the linkages between urban growth and development and climate change and vulnerability of people and sectors; and to be able to identify actions to undertake urban climate change resilience (ACCCRN, 2013).

4 RESEARCH CONTEXT: BANGLADESH

Bangladesh is the 8th most populous country with a population more than 164 million in 2016, density of 1116 persons per Sq.Km. and growth rate 1.08% in 2018 (BBS, 2019). The total urban population is 64.8 million (2019) with 3.17% growth rate and it will reach to 56% by 2050. The country has more than 570 urban centers (Figure2a). The Capital city, Dhaka is a megacity with 27.76% of total urban population and the other 25 urban centers have more than 0.1 million people. Islam (2015) identified three factors for rapid urban growth which are (a) a persistently high natural increase of native urban population; (b) the territorial extension of existing urban areas to rural centers; and (c) rural to urban migration.

Bangladesh has 580 Km stretch of coastline on the Southern Bay of Bengal and fringed with largest mangrove forest it is one of the largest deltas in the world with dense network of tributaries of 405 rivers constituting 24,140 km waterway. Most of the country is less than 10m above sea level and 10% is less than 1m high (Figure2b).

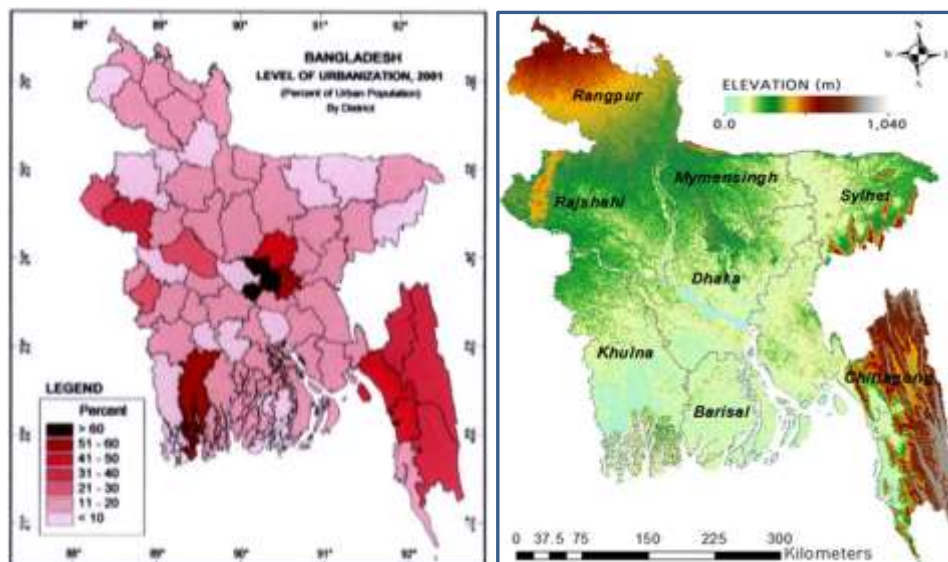


Figura 2. 2a. Urbanization map (www.theigc.org); 2b. Elevation map of Bangladesh

Fuente: <https://SRTM.csi.cgiar.org>

4.1 Intermediate cities of Bangladesh as case study areas

55% of the global urban population living in small and intermediate cities in 2015 will be increased to 60% in 2025. Intermediate cities create important bridges between rural and urban areas, offering rural population an opportunity to access basic facilities and services. The Global report of UN Habitat 2006 asserts that attaining Millennium Development Goals (MDG) largely depends on strengthening local economic development and improvement of living and working conditions in small towns.

Bangladesh has monocentric urban growth with 27.7% urban population in Dhaka (Tabel-1. Figure 3). People from rural areas are being migrated to urban areas because of being affected by natural disasters and to avail employment opportunities, education and health services, other amenities.

District	Rank	Population in 2020 (Millions)	Urban population percentage (%)	Area (Sq. Km)	Elevation (Meter)	Climate change risks
Dhaka	1	21	27.76%	306	4	Flash Flood
Chittagong	2	5	9.39%	155	29	Cyclone
Khulna	3	0.95	2.32%	50.61	9	Cyclone, Salinity
Sylhet	4	0.9	2.25%	97.18	21	Flash flood
Rajshahi	5	0.85	2.55%	41.85	35	Drought
Bogra	6	0.77	2.0%	69.19	20	
Comilla	7	0.59	2.5%	23.44	72	
Barishal	8	0.48		69.19	1.22	Cyclone, Salinity

Figura 3. Cities Ranking in terms of population in Bangladesh

Fuente: Un World population prospectus 2019

For our research purpose 05 (five) cities of Bangladesh have been selected as the intermediate cities based on their location, demography and geographical vulnerability to climate change. Khulna and Barisal are located in coastal zone with elevation of 9m and 1.2 m respectively. Both cities are highly vulnerable to natural disasters like cyclones and flood. Rajshahi and Rangpur are districts subject to drought because of climate change. Sylhet is in the region highly vulnerable to heavy rainfall and flash floods.

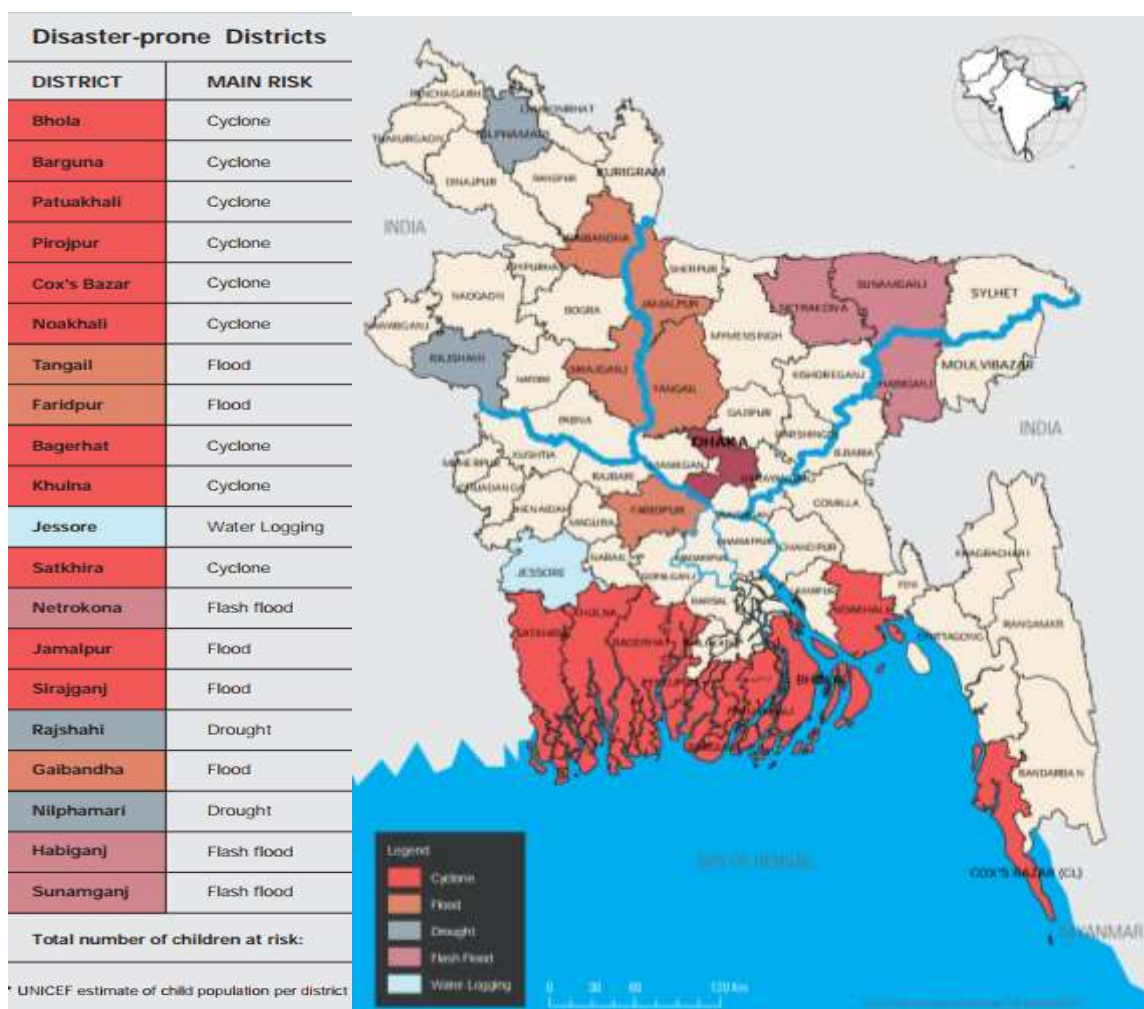


Figura 4. Disaster-prone districts in Bangladesh.

Fuente: Disaster Management Information Cell, Bangladesh 2012

5 METHODOLOGICAL FRAMEWORK APPLIED TO INTERMEDIATE CITIES OF BANGLADESH

5.1 Climate change impact upon functional subsystems of intermediate cities in Bangladesh

Each city of case studies has been assessed for climate vulnerability to provide basis for understanding both direct and indirect impact of future climatic hazards on people, infrastructures, and urban system specific to their city. The assessment will include the city's exposure of climate risks in terms of its impact on people and city's functional systems. The study will also examine the existing capacities to adapt and provide information to plan the city for a resilient future (Sarah Opitz-Stapleton, et al., 2009).

Intermediate City in Bangladesh	Social subsystem	Environmental subsystem	Economic subsystem	Political subsystem
Khulna Karim, R., et al., 2013 Shamsuddoha, M. & Karim, R., 2007	1.Forced Migration 2.Increase of homeless people	1.Salinity increases due to sea level rise. 2.Cyclone causes huge damage on Sundarbans, largest Mangrove forest in the world.	1.Loss of agricultural production 2.Loss of livelihood	1.Illegal settlements in Khulna city 2.Lack of services 3. Deterioration of law and order
Sylhet Akhter, S., et al., 2019 Shahid, S., et al., 2015	1. Loss of livelihood affects living standard	1. Reduced rainfall affects the discharge of Surma river. 2. increased temperature reduced cold waves	1. Negative agricultural production and unstable livelihood	1. Migration to Assam in India creates religious ethnic tensions
Rajshahi Kamaker, S., et al., 2018	1. Increase of social problems 2.Child and women health became vulnerable	1. Use of ground water increases 2. Use of chemical fertilizers increases	1. Decrease of agricultural production 2. Increase of health cost	1. Political pressure increases to revise water treaty with India
Rangpur Chakraborti, BK et al., 2018 Zinnatul-Bassar, ATM., Habib, M. A., 2017	1. Less access to work 2.Migration to urban area	1.Increase of lightning and thunderstorm causes huge dry air in summer season. 2.Riverbank erosion due to flood	1.Property damage and loss of life 2.Food insecurity, 'Monga' due to drought	1. Poverty causes rise of radicalism
Barishal Akter, T., et al., 2015 Hasan, M. M., et al., 2018	1. increases rate of migration due to loss of livelihood 2. increases social conflict and poverty	1.Water logging blocks drainage of storm water. 2.Cyclone and thunderstorm destroys plants. 3.Sealevel rise causes reduced upstream flow and causes salinity intrusion in surface and ground water. 4. Excessive siltation and accretion of land causes loss of navigability. 5. Declining aquatic resources	1.Erratic and irregular rainfall causes loss in crop production 2.Livestock production is affected 3. Irrigation cost rises during drought and Commodity price rises 4.increase occupational changes, reduce employment and income, loss of valuable wealth, increases health problem,	1. Increases political tension

Figura 5. Climate change impact on functional system of intermediate cities in Bangladesh based on secondary data from journal papers.

Fuente: Own elaboration

5.2 Mapping Climate Hazards in Case study cities

The secondary data collected from Meteorological department of Bangladesh, CEGIS and SPARRSO. Four major climate hazards such as Salinity, River flood, Flash flood, River erosion, Drought have been plotted with ARCGIS in case study areas to identify the affected areas due to the climate change impact.

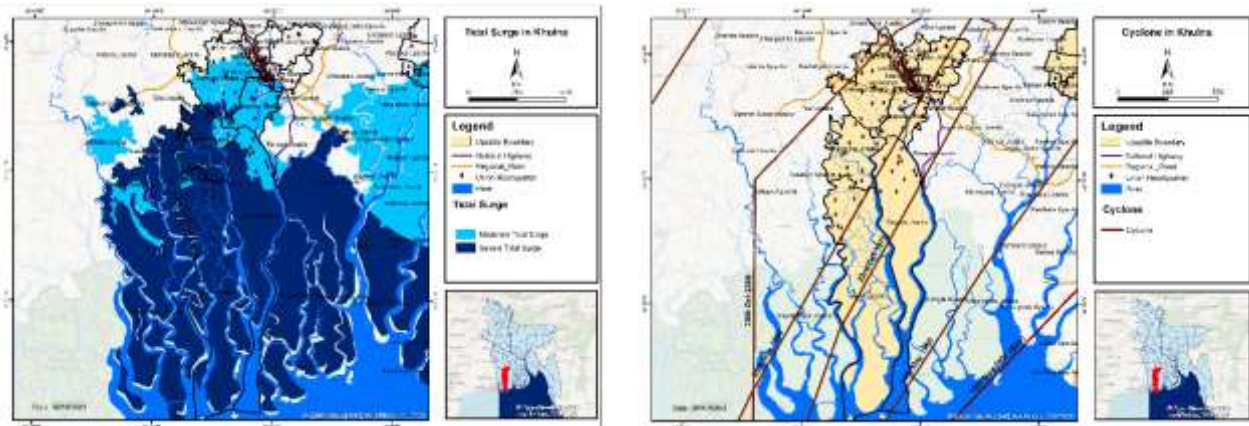


Figura 6. a) Tidal surge y b) Cyclone
Fuente: Own elaboration

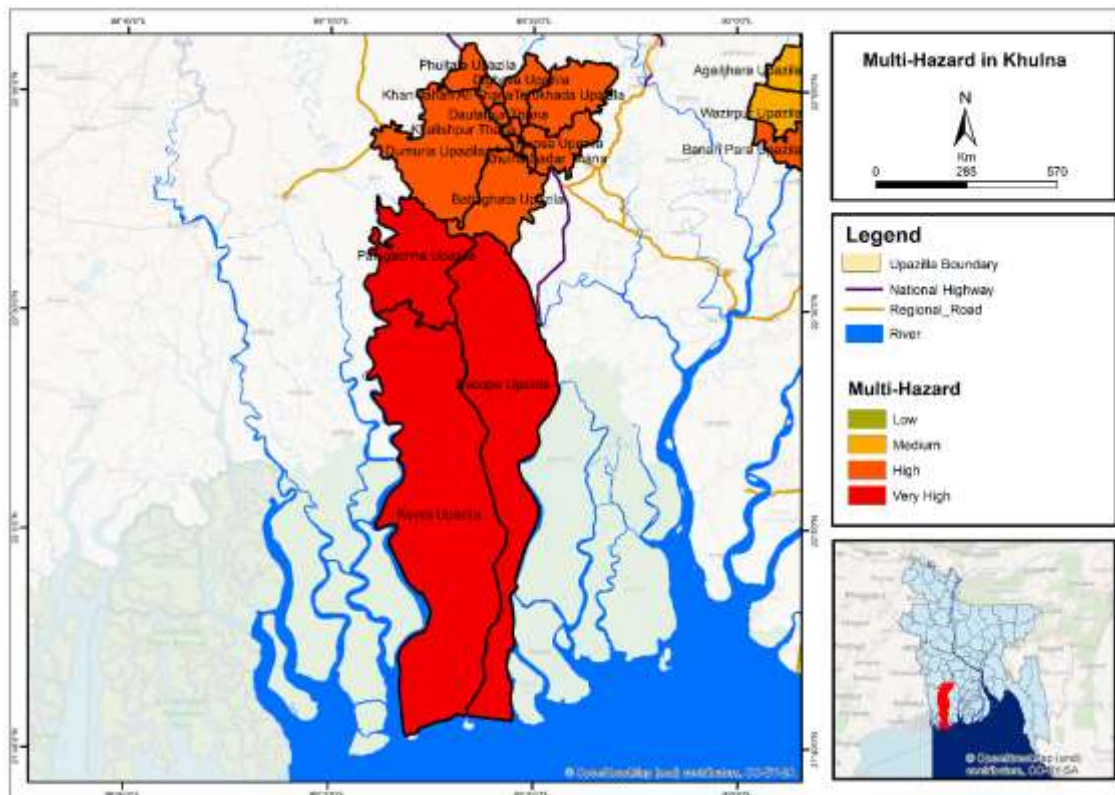


Figura 7. Multi-hazard map of Khulna.
Fuente: Own elaboration

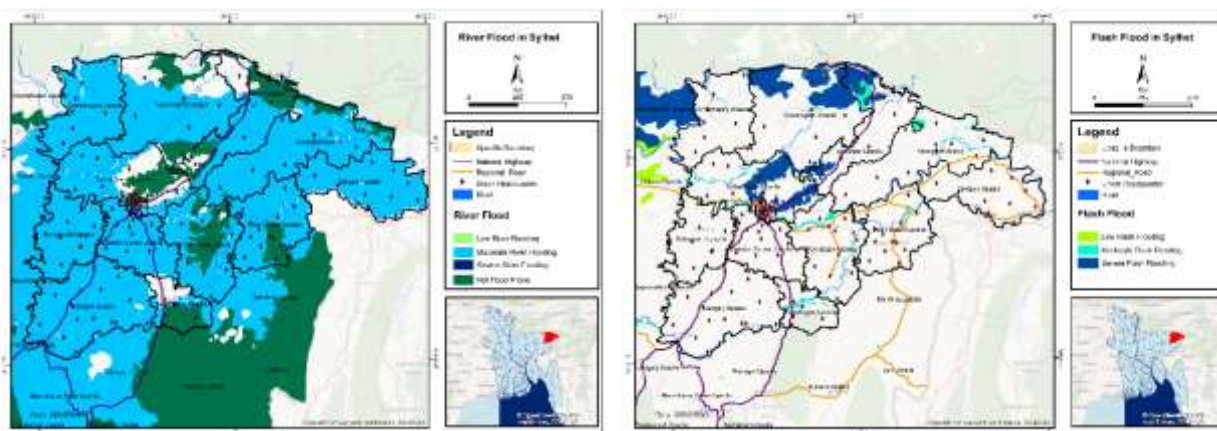


Figura 8. a) River floor y b) Flash flood
Fuente: Own elaboration

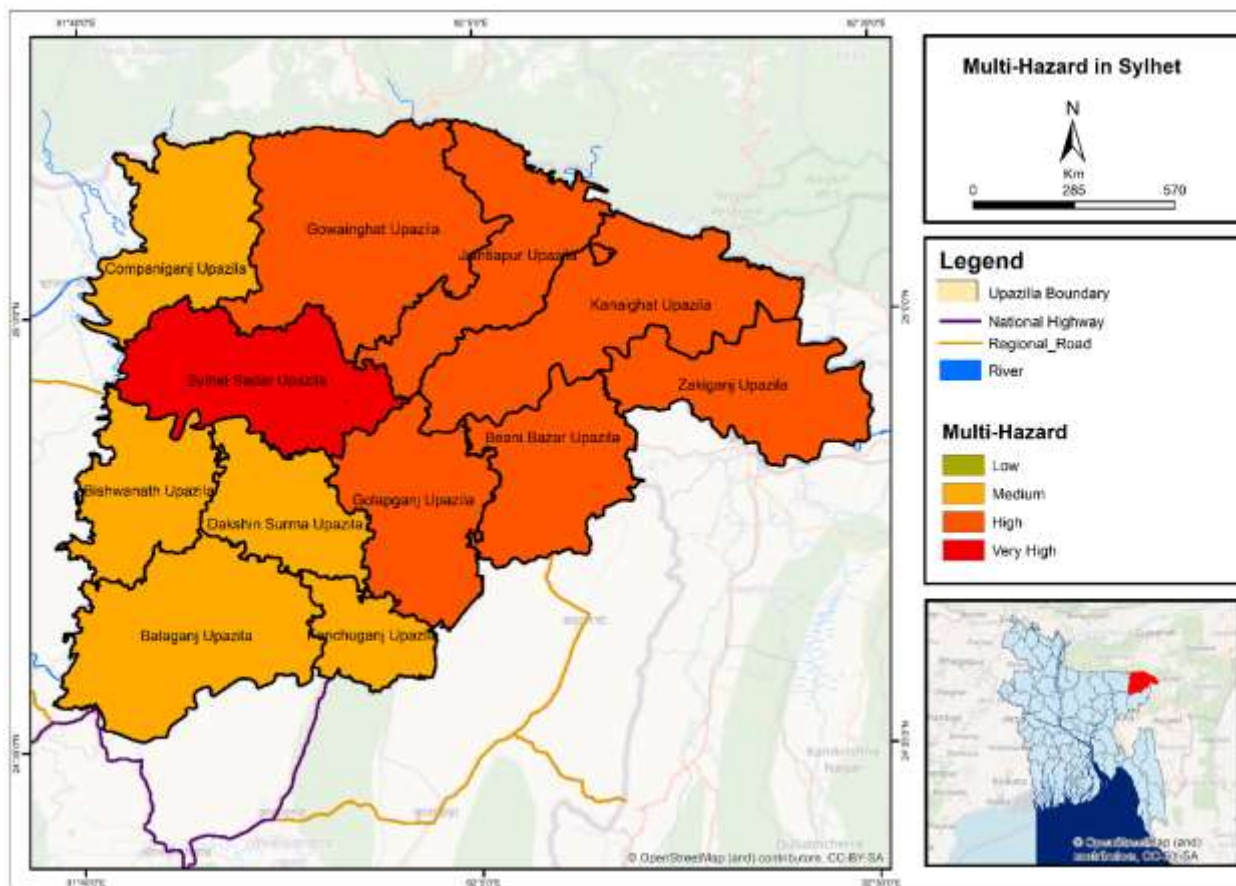


Figura 9. Multi-Hazard Map of Sylhet
Fuente: Own elaboration

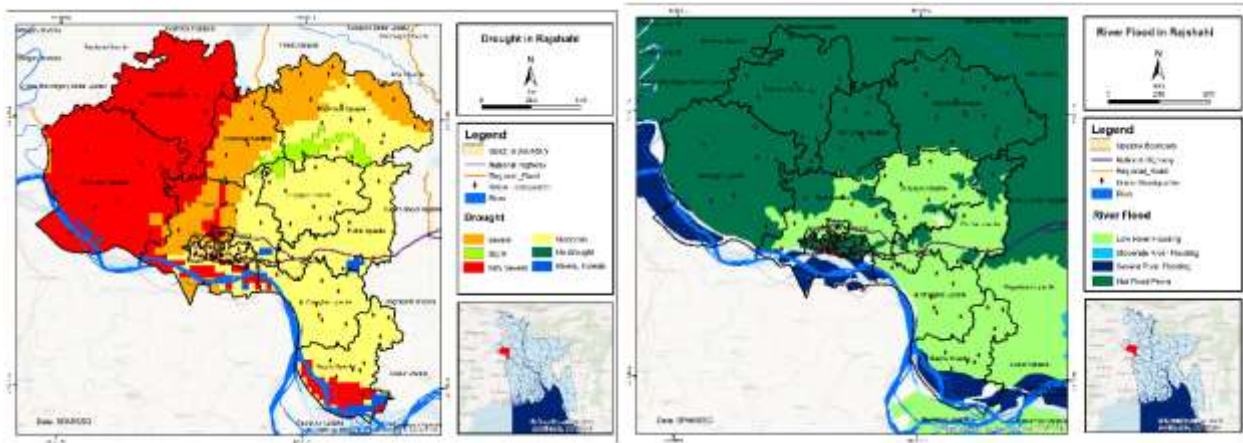


Figura 10. a) Drought y b) River floor
Fuente: Own elaboration

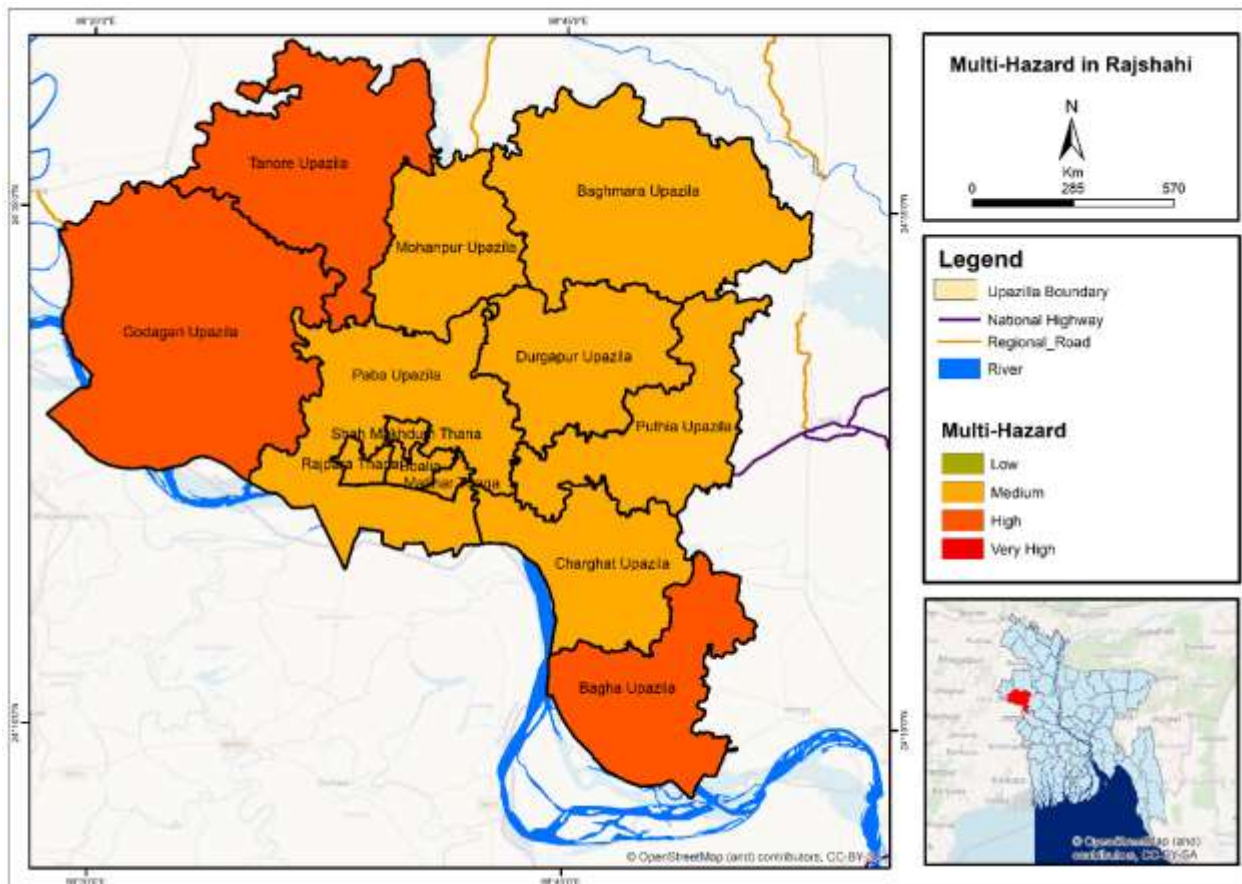


Figura 11. Multi-Hazard Map of Rajshahi
Fuente: Own Elaboration.

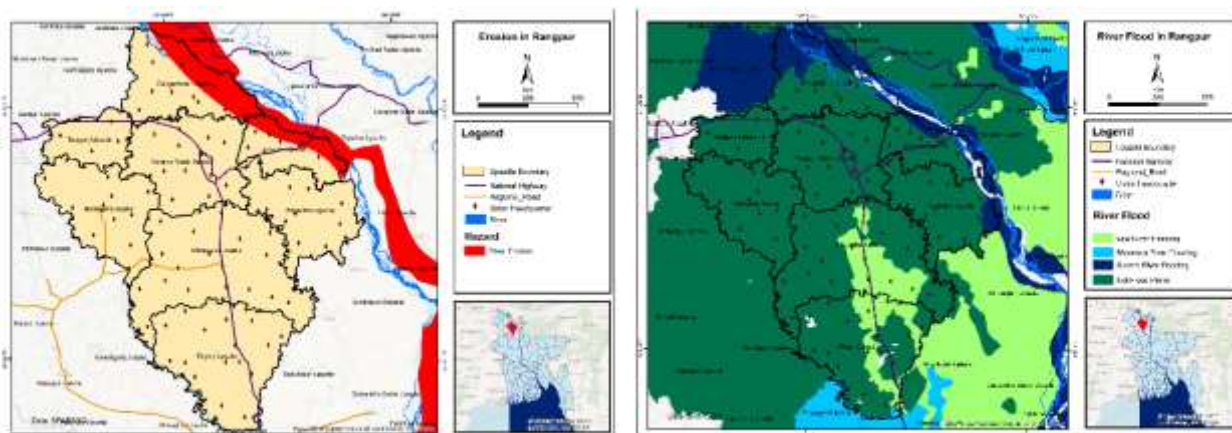


Figura 22. a) River erosion y b) River floor
Fuente: Own Elaboration.

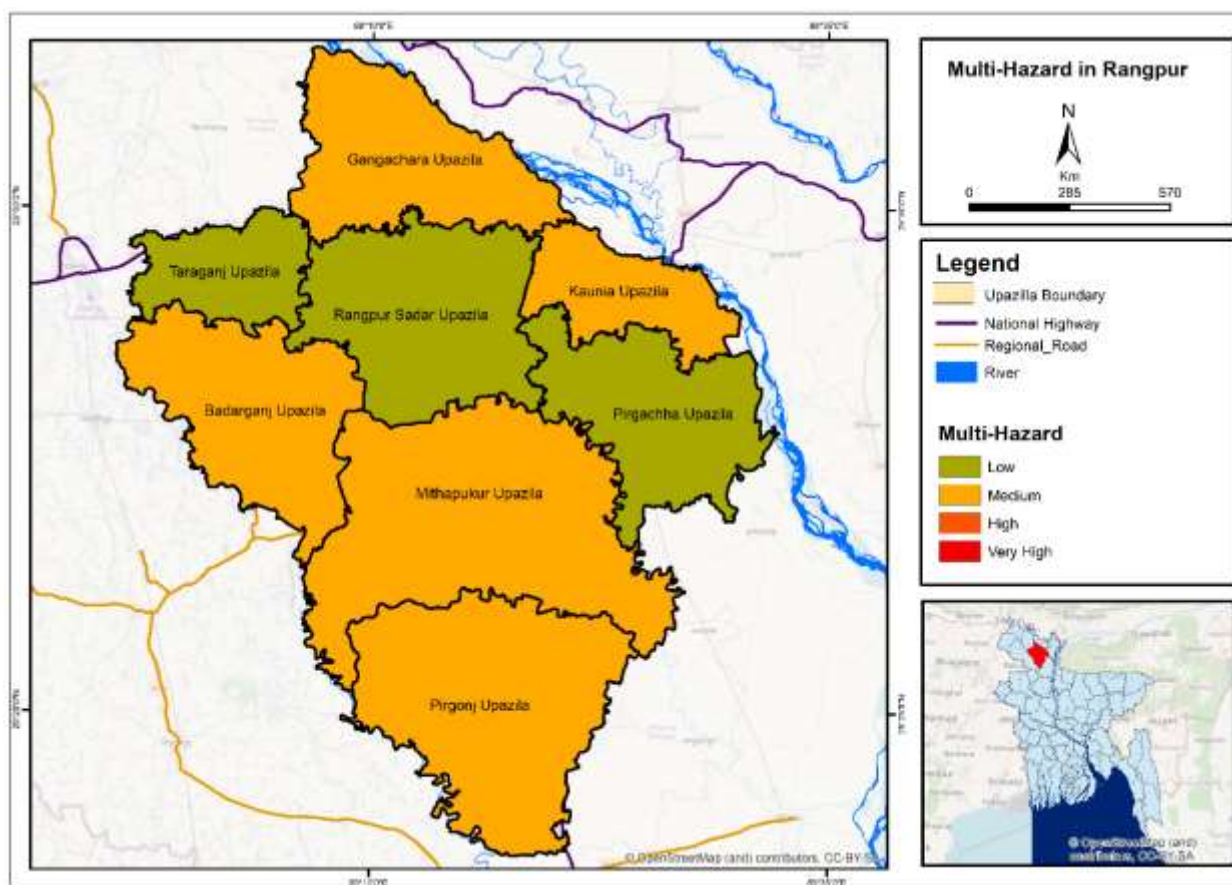


Figura 33. Multi-Hazard Map of Rangpur
Fuente: Own Elaboration.

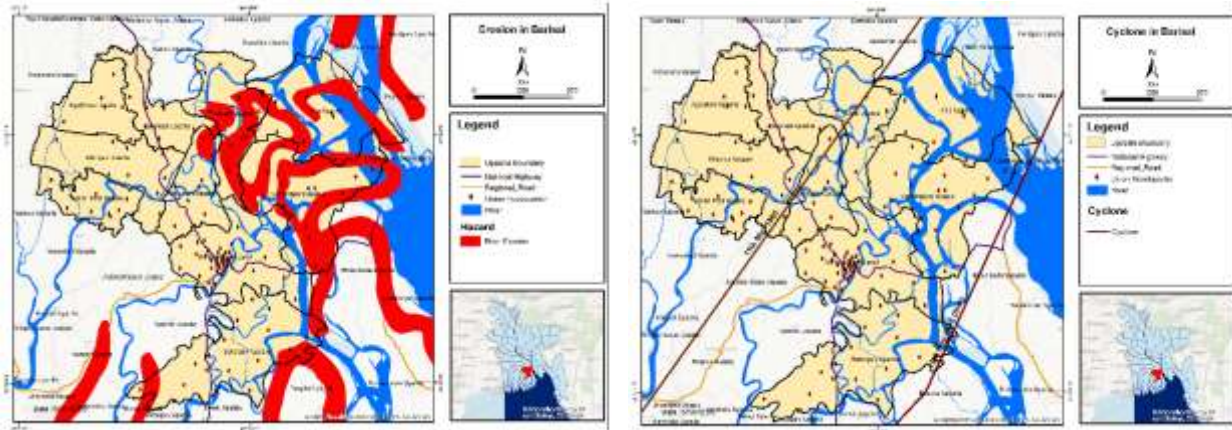


Figura 44. a) River erosion y b) Cyclone
Fuente: Own Elaboration.

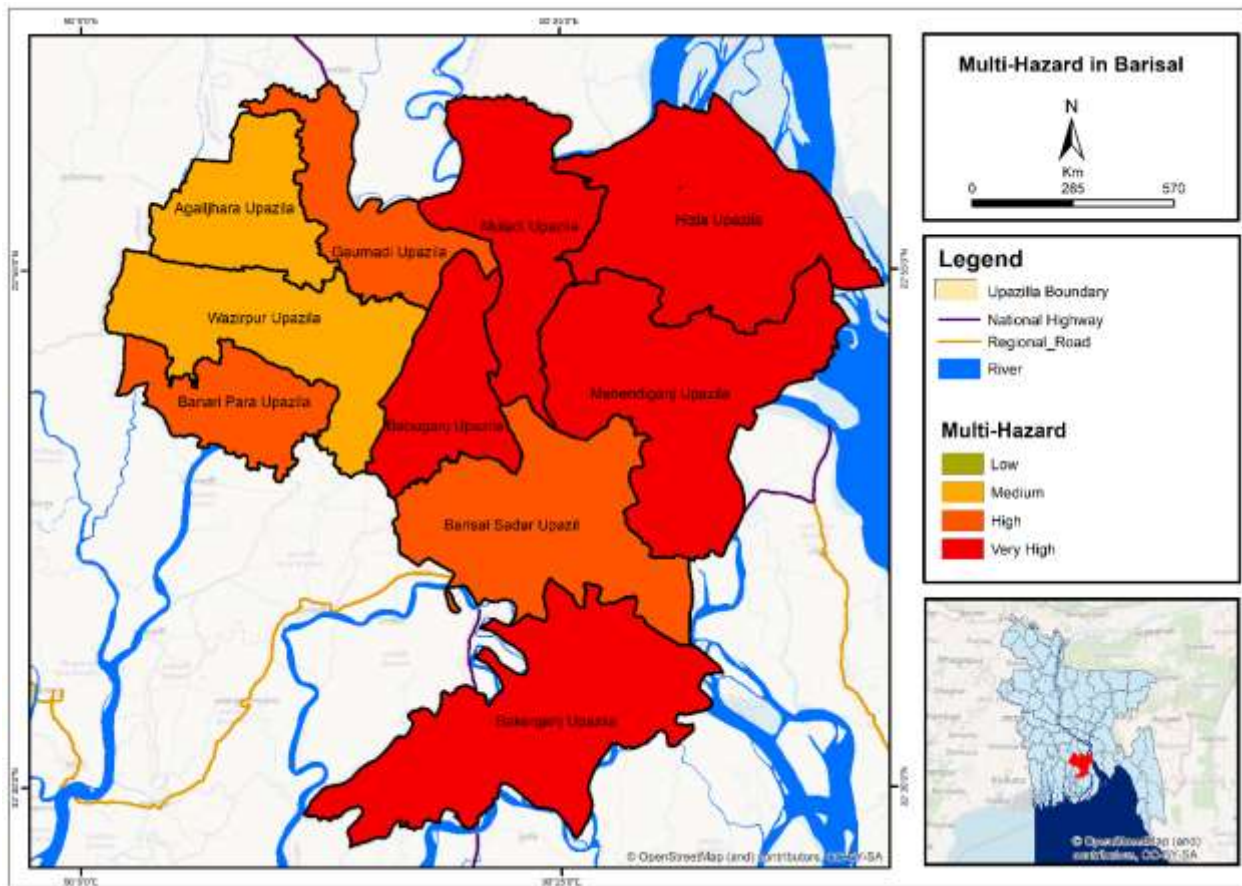


Figura 55. Multi-Hazard Map of Barishal.
Fuente: Own Elaboration.

5.3 Climate vulnerability assessment of intermediate cities of Bangladesh

The framework for urban climate risk assessment has been adapted from Mehrotra (2009) and Rosenzweig and Hillel (2008). The specific objectives of this framework are Characterizing the hazards associated with climate change at city level, Identifying the most vulnerable segments of the city and Assessing the city's ability to adapt to anticipated changes in climate.

HAZARDS		Reference	KHULNA	BARISHAL	RAJSHAHI	SYLHET	RANGPUR
Temperature observed trend		MG Ferdous, MA Baten 2011	Increasing trend (1961-2010) by 0.016°C/yr		Decreasing trend (1961-2010) by 0.0134°C/yr	Increasing trend (1961-2010) by 0.016°C/yr	Decreasing trend (1961-2010) by 0.0262°C/yr
Precipitation		MG Ferdous, MA Baten 2011	Decreasing trend by 0.742 mm/year	Decreasing trends by 0.131 mm/year	Decreasing trend by 3.0698 mm/year	Decreasing trends by 0.463 mm/year	Increasing trend by 3.0698 mm/year
Sea level rise		G M Sarwar 2007, World bank 2000	Bangladesh has 710 km coastline gently sloped to South. 35.1 million population live in the coastal zone. It is predicted that 25 cm in 2050 and 1m sea level rise in 2100. This rise would inundate 4% and 17.5% of the country.				
Extreme events	Cyclones	N.J. Erickson 1997	Barishal cyclone, May 11, 1965. Total death 16456, 160km wind speed and 3.7 – 7.6 m storm surge, Bhola cyclone, 11 Nov, 1970, death 0.3 million, Cyclone in 1991, total death 1,38,868. 19.27% of total land mostly coastal areas were affected. Cyclone Sidre, Nov 15, 2007, 223 km wind speed claimed 3363 lives. Cyclone Aila, 2005,				
	Flooding	Babul Hossain et al, 2020	As a result of climate change, Bangladesh faces further recurrent extreme flood events every year. For example, in the 1988 and 1998 respectively, floods wreaked havoc and submerged 61 districts totaling approximately 68% of the area				

	Salinity intrusion	G M Sarwar 2007	A comparative study of the Soil Salinity map of SRDI (1998b, 1998c) for the period 1973- 97 shows that south-western part of the country had become salinized in course of last 24 years.				
	Drought	N.J. Ericksen 1997					Severe drought of 1978/79 to 1979/80 directly affected about 42 per cent of the cultivated land and some 44 per cent of the population
VULNERIBILITY							
Population		Bangladesh Census 2011	1,046,341	339,308	763,952	526,412	328,777
Density			3,913/km ²	10,524/km ²	2,026/km ²	9,123/km ²	4,846/km ²
Percent poor or slum dwellers		Bangladesh Slum Census 2014	3.47	1.61	1.72	2.01	1.06
Urban area susceptible to flooding		In 1988, 61% of Bangladesh was inundated with 2000~ 6500 deaths. Almost every year at least 10% of the country is flooded.					
City % of national GDP		Bangladesh Economic census 2013	12.8	4.8	15.1	4.5	13.5
ADAPTIVE CAPACITY							
Institutions and governance measures affecting climate change actions		Bangladesh Climate change strategy and Action plan (BCCSAP), 2009	CPI Country Ranking 146, Score 26 in 2020. Centralized decision making, Local needs are neglected.				
Willingness of city leadership to address climate change			All city corporations/municipalities are responsible for Climate change mitigation and low carbon development under energy and water efficiency in built environment according to T5P9 of National Climate change strategy and Action plan 2009. Local government institutions partnering with NGOs and donors are to implement climate change initiatives.				
Information and resources comprehensive analysis of climate risk for the city			Government supports range of research program under climate change Action plan 2009. Mostly universities, research centers, NGOs are disseminating research-based knowledge for climate change initiatives.				
Administrative unit assigned to address climate change			Ministry of Environment and Forests to address climate change issues at all levels. No city specific local authority to address climate change problems.				

Balance between adaptation and mitigation		Mitigation >> Adaptation Climate change initiatives prioritize adaptation and disaster risk reduction through building capacity and resilience				
RISK		VERY HIGH	HIGH	MEDIUM	LOW	MEDIUM
		Climate hazards: Sea level rise, coastal flooding, storm surge, salinity intrusion and heat waves. Vulnerability: The industrial production, large slum population are subject to frequent cyclones and coastal surge,	Climate hazards: Sea level rise, storm surge and salinity intrusion coastal flooding. Vulnerability: Lived in coastal areas and agricultural sector are vulnerable to natural hazards and possibility to turn as climate refugees.	Climate hazards, Inland flooding, and drought. Vulnerability: Agriculture sector is highly vulnerable to drought, Slum people has lack of access to housing.	Climate hazards: Heavy rainfall with flash floods Vulnerability: Currently large population are vulnerable to flash floods and heatwaves. Agriculture sector is vulnerable to future drought.	Climate hazards: Heavy rainfall with flash floods. Vulnerability: Large poor population. Vulnerability: Large population is exposed to inland flooding, river erosion.
		Adaptive capacity: Since all policies are decided by central government, there is no local initiative for building capacity. Local authorities are only responsible to implement national action plan in coordination with NGOs.				
RESPONSE		Poor governance, Policy from Central government, Lack of public participations and awareness, No funding for local initiatives.				

Figura 16. Climate change vulnerability assessment of intermediate cities of Bangladesh.

Fuente: Own Elaboration.

6 URBAN GOVERNANCE IN BANGLADESH

6.1 History of Urban Governance System (UGS) in Bangladesh

Urban governance system has been initiated by the Mughal rulers (16th Century) and a lot of changes came through the British rule (18th and 19th century) to form the

current democratic system. By the Municipal Administration Act 1793, the British structured the urban governance considering cities as centers of trade, commerce and industry. Dhaka was the first municipality in Bangladesh under Bengal Municipal Act, 1864. Article 59 and 60 of the Bangladesh Constitution, 1972 clearly specifies the legal basis and responsibilities of the local government in every administrative unit (P Panday, 2007). After 1991 the parliamentary democracy was restored, and the urban local government got into the process of democratization (Local Govt. Act 1994).

6.2 Structure of Local Urban Governance System

The article 59 and 60 of the national constitution ensures to have elected bodies at all levels of administrative units with specific functions and responsibilities. There are two tier urban local government system in urban areas – City Corporation (CC) in big cities and Pouroshova for urban centers. The administrative body of a CC consists of the Mayor and Councilors. As per Local government (City corporation) Act 2009, Mayor is the head of CC as well as the approval authority for administrative, financial, policy and decision-making matters and chair of the councilors meeting elected for 05 years (Pandey 2006). Like Mayor, councilors are also elected by the respective citizens of wards. Councilors are the key persons who play the effective roles for their wards. The development plan formulated by the councilors for the wards are included in the CC's development program.

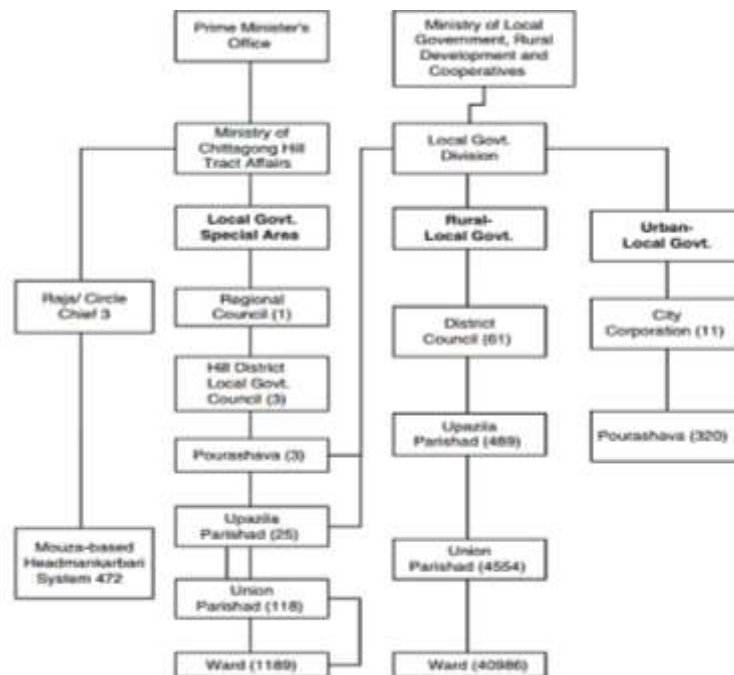


Figura 67. Existing structure of urban-local government in Bangladesh

Fuente: Ahmed 1998 & Panday, 2011.

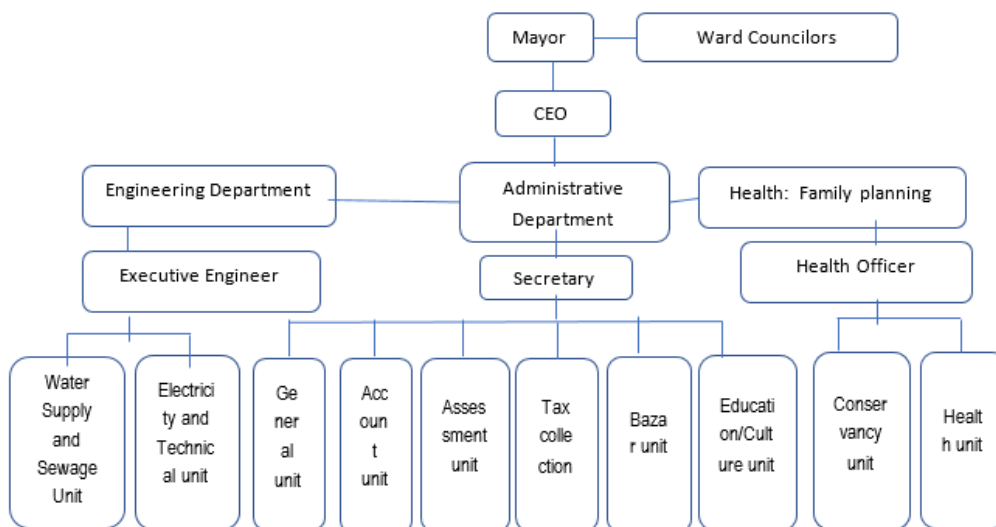


Figura 18. General organogram of a Pouroshova, the smallest urban governance unit
Fuente: Own Elaboration.

6.3 Scope of services provided by the local urban government

The city corporations are delegated with a long list of functions (Figure-19) by the central government. Though the city corporation act 2009 allows CC to take any development initiative and its implementation, but the local government division leaves limited scope for CC to work and make impact independently. Mostly the Government agencies are responsible for providing urban services which overlaps with the jurisdiction of CC and having no coordination among them. Though advocating for strong local urban governance, the central government is retaining the control over CC regarding financing, initiating and executing development works.



Figura 79. Broad functional jurisdiction of city corporation.
Fuente: Pandey, 2017.

Four types of organizations providing services regarding urban governance are i) a municipal government which includes CC and Pouroshova, ii) special development agencies, iii) special purpose authority and iv) special government bodies (Panday 2006). Besides CC four development authorities for development works of old CCs and these authorities are directed by the chairman and board members appointed by the central government lacking accountability, credibility, and public support. (Panday 2006). Due to poor management, lack of interorganizational coordination and insufficient human resources they have very limited success in development projects. The government has also established four other organizations as Water and Sewerage Authority to provide water supply and sanitary drainage system. Some special authorities have also been working beside CC responsible for other urban services.



Figura 20. Organizational constraints for urban governance in Bangladesh
Fuente: Own elaboration.

6.4 Understanding the Local Governance of Intermediate cities based on good governance (Mehta, 1998)

As part of the proposed conceptual framework, the urban governance system in has been analyzed based on the five principles of good governance (Mehta, 1998) that considers attributes of good governance in Asia.

- a) Decentralization and Autonomy. Current urban governments in intermediate cities of Bangladesh are evidently under heavy control of central government like enactment of legislation of CC, determining the areas of CCs jurisdiction,

control human resources, even Central Government has power to dissolve CC. Though the CCs are given certain degree of fiscal autonomy to generate funds through tax collection, grants, loans, etc, but lacking the financial autonomy, because the major part of development budget provided by Central Government. A consensus developed regarding strengthening of Local Government as the main agencies for inclusive development.

- b) Transparency and Accountability . Accountability of the government employees to the elect representative and accountability of elected personals to public are both important in urban governance system. Dominated by the central administers, Citizen charter' is the place where CC should mention how the services are delivered. But in Bangladesh no City Corporation is doing these standard practices. Since urban institutions are heavily controlled by the concerned ministry, they are not structured to adapt the lessons of accountability and are not accountable to the urban populations particularly poor.
- c) Responsiveness and flexibility. Responsiveness to the disasters and flexibility to adapt with new scenarios are the key to be resilient. Emergency response to the crisis is dependent upon the good coordination between different urban agencies. The organizations providing urban services near coastal areas (Khulna and Barishal) have developed some capacity to respond immediately to the natural disasters like cyclones, surges but the other cities have not enough capacities to deal with disasters.
- d) Participation and Inclusion. People's participation has been legally ensured by the ACT 2009 through electoral participation and the participation in decision making and implementation of CCs different policies. Scope of participation has been restricted within the elite people of the society, poor has no scope to participate in decision making and implementation. Central government appoints administrator in all CC which restricts the opportunity for elected persons and thus against the constitution.
- e) Experience and Support. Good coordination between national government and local agencies builds experience and support to work for disaster management and adaptation. In this case participation and inclusion of citizens, NGOs, professionals can have significant contribution in capacity building process.

7 RESULTS AND DISCUSSION

The location, geography and climatic pattern of each intermediate city are the reasons of facing different climatic hazards and consequences.

Table 2 (Fig-5) shows Khulna is mostly affected by the sea level rise facing cyclones, storm surge, salinity intrusion and flooding. Barishal is subject to same hazards since it is located in the low-lying coastal zone. Rajshahi and Rangpur have the similar trend of severe drought because of decreasing rainfall. While Sylhet

experiences regular flash flood due to heavy rainfall and incoming water flow from rivers originated in Himalaya.

The salinity intrusion and cyclones are altering the social subsystem of Khulna by the displacing people from coastal areas. The ecological system is also at the risk of loss by climate hazards (Fig-7). The loss of agricultural production changed the economic system causing lack of services and political tensions. In Sylhet the climatic events (Fig-9) have damaging influence on food production and livelihood forcing people migrating to neighboring state of India and thus creating ethnic tensions. The reduced rainfall, increased use of ground water and withdrawal of water from Padma-river by India are resulting extreme weather condition with frequent drought in Rajshahi (Fig-11). The loss of agricultural production is creating social tensions and affecting people's health and livelihood. Rangpur has been experiencing extreme poverty due to lack of employment. The riverbank erosion by river flood (Fig-13) cause losses of livelihood and forcing people to migrate or involve in radicalism. The increased rate of migration is resulting social conflict in Barishal. The aquatic environment is severely damaged by the erratic climate change events (Fig-15) and creating tensions in political arena.

Table-3 (Fig-16) shows that the corruption in public institutions, the powerful central government and weak local governance are responsible for not building institutional capacity for mitigating climate change impact. The lack of stakeholder's participation in decision making and top-down policy compels local government for implementation of national climate change strategy. Though government supports of research and developing resources for climate change but not enough yet for intermediate cities to produce enough information and data. The ministry of environment is responsible for climate change but there is no specific body in local government to deal with local climate challenges.

The vulnerability assessment shows that Khulna became very high-risk zone due to frequent climatic hazards which has been dangerously affecting population living in informal settlements losing employment and livelihood. Population in Barishal city has the same high risk of being migrated due to loss of agricultural production. Rajshahi and Rangpur cities is vulnerable due to lack of employment opportunities, access to housing and loss of food production due to annual drought. Sylhet is less vulnerable having a vibrant economy created by large share of remittance from expats living in UK and Europe, but the population is in risk of suffering from flash floods, river erosion.

The "Top-down" bureaucratic and centralized governance system are the main reason of local governance inefficiency to provide urban services (Fig-20). The fiscal autonomy, accountability to public, transparency in their performance, immediate responsiveness to crisis, participation in decision making and experience-based capacity building are the main challenges for the local governance.

8 CONCLUSION

The climate vulnerability assessment shows that though all cities are affected, but coastal cities are more vulnerable to climate induced disasters associated with weak infrastructural support and services, lack of institutional capacity, dependency of local government for financial resources and lack of public participation in decision making process. The vulnerable urban functional systems of intermediate cities are linked with poor local governance as well as inadequate public policy for mitigating climate change impact. The climate change policy mainly focuses on adaptation and reduction of risk and vulnerability through building capacity and resilience. The understanding of climate change implications upon functional systems of small and medium size cities as well as the risks and responses would help to build institutional capacity and strengthen local governance to develop a comprehensive framework for climate resilient urban governance.

More investigation and analysis are required to establish the extent of good and efficient governance to deliver climate adaptation through achieving risk reduction, to be able to address infrastructure, support and services for marginalized and vulnerable population.

9 BIBLIOGRAPHY

Akter, T. et al. (2015). *Climate Change impact on Agriculture and Food security of Barishal District. International conference on Climate Change in relation to Water and Environment (I3CWE-2015)*. Department of Civil Engineering. DUET - Gazipur, Bangladesh

Asian Cities Climate Change Resilience Network (ACCCRN): Responding to the Urban Climate Challenge. Eds. ISET, Boulder, Colorado, USA, 60 pp. ISBN: 978-0-9843616-0-1

Chakraborti, BK. (2018). Thunderstorm and Lightning: The Temperature Effect on Climate Change of Rangpur Region in Bangladesh. *Science Journal of Energy Engineering* DOI: 10.11648/j.sjee.20180602.11

Ericksen, N.J., Ahmad, Q.K. and Chowdhury, A.R., 1993. Socio-Economic Implications of Climate Change for Bangladesh. Briefing Document No. 4. ISBN 984-8126-03-1, Bangladesh Unnayan Parishad (BUP), Dhanmondi, Dhaka-1205, Bangladesh. DOI: 10.1007/978-94-009-0241-1_5

Ferdous, M. G. and Baten M. A. 2011, Climatic Variables of 50 Years and their Trends over Rajshahi and Rangpur Division, *Journal of Environmental Science & Natural Resources*, 4(2), pp. 147-150. DOI:10.3329/jesnr.v4i2.10165

Fernandez-Guell J.M. et. al. (2016): Incorporating a Systemic and Foresight Approach into Smart City Initiatives: The Case of Spanish Cities. *Journal of Urban Technology*. DOI:10.1080/10630732.2016.116444.

Geag. (2009). *Vulnerability Analysis – Gorakhpur City*. GEAG, Gorakhpur.

Hasan, M. M. et. al. (2018). Environmental Change and Its Impacts on Lives and Livelihoods of South-Central Coastal Districts of Bangladesh. *American Journal of Biological and Environmental Statistics*. 4(2). 42-48. doi: 10.11648/j.ajbes.20180402.11

Islam, N. (2015). *Urbanization and Urban Poverty in Bangladesh: Issues in Disparities, Deprivations and Rights*. Barrister Syed Ishtiaq Ahmed Memorial Lecture 2015. Dhaka: Asiatic Society of Bangladesh. ISBN-13 : 978-9843475381

Karim, R. et. al. (2013). Impacts of Climate Change on Socio-Economic Sector and Health profile in the interior Coast, Bangladesh: the Case Study of Dumuria Upazilla, Khulna, Bangladesh. *IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)*. 5(1). 38-46. e-ISSN: 2319-2402,p- ISSN: 2319-2399. <https://www.iosrjournals.org/>

Mehta, D. (1998) *Urban Governance: Lessons from Best Practice in Asia*, UMPAsia Occasional Paper 40, Pathumthani, Thailand: UN-HABITAT Urban Management Programme. OCLC Number / Unique Identifier:434321303, <https://www.worldcat.org/>

Mehrotra, S., Natenzon, C. E., Omojola, A., Folorunsho, R., Gilbride, J., & Rosenzweig, C. (2009, June). Framework for city climate risk assessment. In *Fifth Urban Research Symposium, Marseille, France* (pp. 28-30). Retrived from https://www.academia.edu/68165903/Framework_for_City_Climate_Risk_Assessment

Opitz-Stapleton, S. et. al. (2009). *ACCCRN: Responding to the urban climate challenge*. ISBN: 978-0-9843616-0-1.

Panday, P. K. (2006). *Problems of urban governance in Bangladesh*. New Delhi: Serials Publication. ISBN:9788183872164

Panday, P.K. (2007). Policy Implementation in Urban Bangladesh: Role of Intra-organizational Coordination. *Public Organization Review*. 7. 237-259. DOI: 10.1007/s11115-007-0034-3

Rosenzweig, C., & Hillel, D. (2008). *Climate Variability and the Global Harvest: Impact of El Niño and Other Oscillations on Agro-Ecosystems*. New York: Oxford University Press. <https://doi.org/10.2135/cropsci2008.05.0004br>

Sarwar GM, Khan MH (2007) Sea level rise: a threat to the coast of Bangladesh. *Int Forum Int Q Asian Stud* 38(3/4):375–397. DOI: <https://doi.org/10.11588/iaf.2007.38.329>

Shamsuddoha, M. and Chowdhury, R. K. (2007). *Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh, COAST Trust and Equity and Justice Working Group (EJWG)*, Retrieved from <https://www.preventionweb.net/publications/view/4032>.

Tyler, S. and Moench, M. (2012). A framework for urban climate resilience, *Climate and Development* 4(4). 311-326, DOI: 10.1080/17565529.2012.745389.

Van Der Heijden J. (2014). Governance for Urban Sustainability and Resilience: Responding to Climate Change and the Relevance of the Built Environment, *Science and Public Policy* 42(6).scv040. DOI:[10.1093/scipol/scv040](https://doi.org/10.1093/scipol/scv040)