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## Energy, Disaster, Climate Change: Sustainability and Just Transitions in Bangladesh

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### To Quote Bangabandhu Sheikh Mujibur Rahman:

*“My greatest strength is the love for my people, my greatest weakness is that I love them too much.”*  
 {from : <https://quotes.yourdictionary.com/author/sheikh-mujibur-rahman/>}

*“It is not possible to build golden Bengal without golden people”*  
 (The last public address at Suhrawardy Uddan, 26 March 1975)

*“I do not say anything to intellectuals. I respect them. I would only say this to them that, please use your intellects for the welfare of the people. I do not say anything more than this”.*  
 (The last public address at Suhrawardy Uddan, 26 March 1975)

*“As a man, what concerns mankind concerns me”.*  
 (Unfinished Memoirs, 3 May 1973)

*“We can suffer but we don't die. People's strength is the biggest force for the challenge of survival. Our aim is to achieve self-dependence”*  
 (Addressing the United Nations, 23 September 1974)

*“The world is divided into two halves, the oppressed and the oppressors. I am with the oppressed”.*  
 (At the conference of Non-Alliance Movement, Algiers, 6 September 1973)

(from: <https://www.7thmarch.com/quotations/>)

### 1. INTRODUCTION

Bangladesh, a country of 160 million people with declining population growth rate, to deliver human wellbeing equitably is justifiably poised for high economic growth rate. Framing 21st century economic growth agenda to achieve not only narrowly focused GDP (Gross Domestic Product) growth but focused towards human wellbeing is especially challenging for countries who are late comers in the economic development process compared to those who experienced fast growth phase during the past century. As of now, in the South Asian region, Bangladesh is the fastest growing economy. In 2015 the country leaving behind the status of a least developed country crossed the bar and entered into the Lower Middle-Income Country group as per World Bank's classification. The

country has declared the aspiration of reaching the developed country status by 2041. Bangladesh is passing through rapid transitions in multiple dimensions and sectors to attain transformative change within the next two decades. Going by the historical antecedents from around the Asian region, the timeframe to attain the aspiration level appears to be achievable technologically and economically. How social justice and fairness issues will get addressed within the country especially in a carbon constrained world is central to the scientific debate today globally as well as regionally and nationally.

How far Asian historical antecedents can guide future socio-economic-environmental growth pattern of Bangladesh is open for debate at this juncture of time. Challenges of 21st century fast growing economies are unique as global common goal of sustainable economic growth is an accepted frame for work to all the countries since the millennium summit of 2000. In this connection, committed expenditure on energy infrastructure and likely growth in investment centered around the energy sector is growing in multiple directions. Energy will continue to be of central importance over at least next three decades to push and thereafter stabilize the economy on a higher economic growth trajectory for coping with major equitable human wellbeing needs of 21st Century Bangladesh. Climate change concerns and also an additional need to become resilient to increasing threats of disasters with already

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~1° C temperature rise for countries with poverty and lower level of development are added constraints towards growth (Roy *et al.* 2018). Understanding the current status and critical analysis of opportunities are important to find solutions. Humanity progressed through learning by doing but visioning of possible pathway for development is a prerequisite (Roy *et al.*, 2019). However, it is undeniable that fundamental need is to make the energy sector sustainable, secure and disaster resilient as it holds the lifeline of economic and social growth within planetary boundaries. Recurrent and cascades of natural disasters and climate change induced challenges that threat Bangladesh make the developmental challenges complex.

## 2. SOME RELEVANT IMPORTANT CONCEPTS IN RECENT DEVELOPMENT DISCOURSE

**Human wellbeing** is the ultimate goal of humanity's progress towards well living (Hayward and Roy 2019). One intrinsic challenge of energy for development in the context of Bangladesh is how to meet the increasing demand for energy services and under what fuel mix. Procedural justice demands faster provision of modern energy sources to all. Question is how to meet this imperative without worsening climate system and enhancing disaster risks. As Bangladesh aims for catching up with developed country status by income growth indicator such as Gross Domestic Product (GDP) it can manage this transition path from middle income status of today to set an example where social inequity and environmental damages are kept to the minimum. No single indicator or action can measure multidimensional progress of a nation. This is now well established and acknowledged in the literature (Dasgupta *et al.*, 2015). Unless a broader human wellbeing perspective is taken as goal of the fast-growing economy multidimensional challenges cannot be addressed adequately and peacefully. Interestingly many industrialized countries are making it a political agenda to adopt human wellbeing rather than income growth as a national developmental goal (OECD 2019).

There is clear shift now from traditional development models to Sustainable Development models to work with for enhancing human wellbeing within planetary boundaries. Sustainable development defines those developmental efforts as sustainable which not only benefits the current generation but also ensures without undermining welfare of the future generation by at least maintaining and investing in the productive base of the economy. While Daly's operational principle (Hanley, N, J. Shogren and B. White 1999) talks about investing the income earned from exhaustible resources to develop service flow from renewable resources, reducing cumulative pollutants to zero, respect for natural growth and assimilative capacity of the environmental and natural resources are equally emphasized. Those who believe that technology does play a role in advancing human activities accept the substitution possibilities among various capital forms: natural, human and manmade. There can be debate

about the magnitude and extent of this substitution possibilities but the take home message from this discourse is every nation and all economic actors need to focus on managing the capital portfolio with at least three assets in it: physical man made, natural and human- through genuine investment (Roy 2013). So, developmental discourse is going beyond single dimensional indicator defined by income alone/ GDP as an indicator of development and getting into the realm of multiple indicators with links to natural capital and resource endowments and management of them. From this interlinkage (Figure 1), operational principles for sustainable development is becoming a global action agenda through political endorsement in international cooperation of the Millennium Summit, Millennium Development Goals (MDGs) and various 2015 cooperative agreements. Since 2015, the landmark UN agreements (*e.g.*, the Sendai Framework for Disaster Risk Reduction [SFDRR], Paris Agreement, and Sustainable Development Goals) have set the goals, targets, priorities for practical actions to reset and pre-set the developmental actions on Sustainable Development Path by 2030 (Pal 2020).

**Climate Change** is an unprecedented challenge to developmental process of this century (Roy 2009). Never before geographically fragmented world had to think of managing a global common asset like climate system. Fragmented goals, fragmented decisions were the development way. To avoid further worse impacts of climate change, it is important to keep global temperature rise well below 1.5°C and for that the global economy must achieve net-zero emissions by middle of this century (IPCC 2018) (Jackson *et al.* 2017). It is very clear that energy supply and demand sectors need to transform emissions from current fossil fuel use pattern to contribute the maximum to this mid-century net zero target. Land use and ocean sector also have very significant roles to play but energy sector is going to be the leader for transformation. This provides both challenges and opportunities for the energy sector for all countries. Crisis from climate induced changes will be larger, deeper and far reaching than that of the financial meltdown of 2008 and the global pandemic of 2020. With this comes unlimited opportunities to work on projects with long-lasting positive impacts. It needs to be in the mainstream discussion that Greenhouse Gas emission 'reduction' itself is an economic activity and an opportunity to find new investments, social practices and values and lifestyles (Roy and Pal 2009). New economic activities are going to be around investments on low carbon and no carbon activities. The prosperous economies are going to be those which recognize that the solution lies in additional investments on natural and environmental resource development. Sustainable development, environmental services are becoming key drivers of businesses. Late comers in development process have the advantage of becoming early movers in the new economy which adopts holistic approach toward human existence (Roy 2009).

**Natural hazards** can pose serious threat to a country's economy as well as people. Assessment and monitoring of any natural hazards like cyclone, flood,

earthquake, landslide, etc. in a region are of vital importance for the enterprises responsible for disaster risk reduction (DRR) and disaster risk management (DRM) (Sekac et al, 2016). With changing climate compounded risk due to interaction of multiple hazards or events that combine to produce extreme disasters are capable of generating widespread losses (IPCC, n d.) through cascading effects. The idea behind **cascading effects** is that primary event can trigger a chain of effects that can, in turn, cause secondary consequences amplifying the magnitude of primary event. As the matter of fact, cascading effects are non-linear, complex, and multidimensional and evolve constantly over time. In case of disasters, the impact of physical events or the development of a principal technological or human failure generate an escalation of secondary effects in other human or non-human systems that result in physical, social, or economic disruption. This escalation is more problematic than primary calamities because of their impacts on critical infrastructures, which represent vital elements to the preservation of social functions (Alexander 2013, Pescaroli, 2016). Resilience to energy infrastructures to achieve the priorities laid down in UN Sendai Framework for Disaster Risk Reduction 2015-2030 is paramount for the sustainable societies and achieving overall development agendas especially for Bangladesh, which is recently graduated from Least Developed country (LDC) to Low-Middle income country.

### ***Disaster and Bangladesh***

According to *Asia Pacific Disaster Report 2015 (UN-ESCAP)*, Bangladesh is one of the most vulnerable among 15 countries with high exposure (10<sup>th</sup> in exposure) and risk (5<sup>th</sup> in risk) respectively. Every year the country faces many natural disasters like floods, cyclone, tidal surges, tornado, thunderstorm, river and coastal erosion, landslides, salinity intrusion, hailstorm, extreme weather events etc. It is therefore likely that both acute hazards (such as flooding or cyclonic events) and chronic hazards (drought, sea level rise and saline intrusion, for example) will be more damaging to human lives and properties in the contexts of flourishing economic conditions where more investments will create more economic activities, e.g. infrastructure and human engagements in areas susceptible to different hazards.

Traditionally the country's disaster coping capacity evolved in reactive mode based on the lessons learned from success and failures of disaster management actions and processes. The Bengal Famine of 1943, severe consecutive floods in the years 1953, 1954, 1955, severe cyclone in 1970, famine in 1974 due to Brahmaputra flooding and crop failure, widespread and prolonged floods in 1987, 1988, cyclone strike in 1991, then cyclone Sidr in 2007 and Aila in 2009 are all big disaster events in Bangladesh in the past half century. The *floods* of 1988, 1998, and 2004 were catastrophic resulting in large scale destruction of physical assets and properties, loss of lives. A total of 129 cyclones of different categories hit Bangladesh coasts from 1978 to 2013 with annual mean occurrence of 3.6. It is important to note that cyclones appeared to be the deadly disasters

in Bangladesh. Cyclones caused about 90 percent (567587 numbers) of total deaths due to natural disaster during 1950 – 2016 (EM-DAT, 2016). *Earthquake* poses threat to the lives of people, damage of property and economy in Bangladesh because of its location in the tectonically active Himalayan orogenic belt. In recent memories, 1997, 1999 and 2003 earthquakes in greater Chittagong regions caused local level damages. Study suggests that around 250,000 buildings in the three major cities- Dhaka, Chittagong and Sylhet are extremely vulnerable to earthquakes (MoDMR 2015). Climate change is accelerating the intensity and frequency of disasters. Disasters have been the main contexts for centuries for Bangladesh communities within which they have been adapting to the challenges for everyday living and gradually strengthened capacities to thrive. Bangladesh could attain economic growth >6% through the last decade, boost budget revenue and strengthen financial discipline; poverty declined from 40% in 2005 to 24.7% in 2014) despite being exposed to natural hazards and unprecedented human migration in the region. It was estimated in the past that 14% of Bangladesh's GDP is exposed to disasters on an annual basis (Planning Commission, 2012). However, now with changing climate context disaster and sustainable development have become more complex as the speed of traditional adaptation is considered to be much slower than the speed of changes expected under changing climate. So special attention is needed in the intersection of energy, climate change and disasters with human wellbeing at the centre and sustainable development as the model of growth (Figure 1).

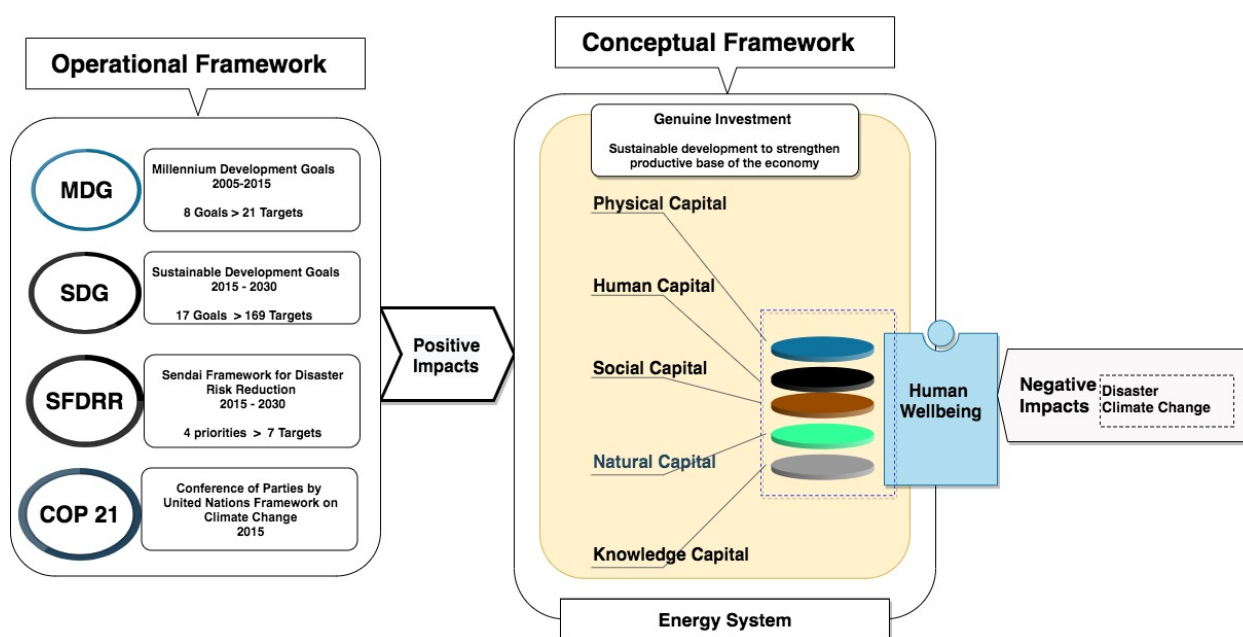
National reports on climate change in Bangladesh (e.g. National Communication Reports to UNFCCC 2002 and 2012, BCCSAP 2009, INDC 2015) give accounts on climate change trends and describe impact. The reports mention that the contributions of Bangladesh to global greenhouse gas (GHG) is less than 0.35% but the country is likely to experience the highest level of impacts. It is also suggested in the national documents that no action or limited actions would cause the country to lose 2% of the GDP by 2030 and 9.4% by 2050 (INDC 2015) and these will lead to more poverty ridden conditions, impact human wellbeing dimensions, result in displacement of millions of people. The most important issue to mention here is that local understanding on climate change is still poor. The local understanding based on critical assessment of climate variabilities (e.g. temperature, rainfall, humidity, wind direction, sunshine hour, wind pressure etc.) are inadequate. Less efforts in commissioning scientific research projects which is cardinal to data driven rational policy/decision making is one of the primary reasons why tackling climate change problems still remain in difficulty in Bangladesh (Islam and Neelim 2010), Brammer (2014), Shamsuddin *et al.* (2015), Alam (2011). The government of Bangladesh carried out research investigations such as CPEIR (Climate Public Expenditure and Institutional Review 2012), CFF (Climate Fiscal Framework 2014, 2018) aiming towards mainstreaming and align necessary instruments

(Development Project Proposal, DPP by Ministry of Planning; and national account tracking system through Budget and Accounting Classification System, BACS by Ministry of Finance etc.). In this contexts, science driven policy recommendations are of primary importance which can shape an action agenda for sustainable development path for Bangladesh in coming 8<sup>th</sup> Five Year Plan.

In addition to BCCSAP and CFF, Climate change challenges are given priorities in the 7<sup>th</sup> Five Year Plan (2016-2021) including the Perspective Plan of Bangladesh. It is important to note that the government of Bangladesh plans to undertake 15 research projects as outlined in BESF (Bangladesh Environmental Statistics Framework 2016-2030 through Bangladesh Bureau of

Statistics; proposed cost is about 0.5 billion USD) which are strongly aligned with UNFDES, DRSF (Disaster Related Statistics Framework), PEI (Poverty Environment Initiative - integration between poverty and environment).

This is the **first volume of the Bangabandhu Chair Special issue of *International Journal of Energy***. In this special volume our aim is to present how the intellectuals and experts from within the country, region and from outside the region situate sustainable energy transition of Bangladesh in the context of national economic growth aspiration, responses to climate risk, disaster risk and dynamics of regional cooperation and global common good goal.



**Fig. 1. Interlinkage among Human wellbeing, Disaster, Climate Change for Sustainable Development in the context of Bangladesh.**

### 3. OUTLINE OF THE SPECIAL ISSUE

This volume examines the hypothesis that current complex developmental challenge faced by fast growing developing countries like Bangladesh provide opportunity for these countries to break away from historical single dimensional economic growth reflected through GDP centric path which created a path dependency towards increasing inequity and injustice in resource sharing and environmentally unsustainable world (Roy and Pal 2009). Countries like Bangladesh can leapfrog and adopt the new innovation paths to their own contexts for creating new path dependency towards fairness and justice by creating multidimensional sustainable development pathway (Roy et. al. 2018). So, our framework in which core is sustainable development for human wellbeing with justice allows us to take a deeper look at the (1) existing energy systems both from

supply side and demand side to understand the embedded structure and scope of incremental as well as transformative change (2) find ways to minimize destructions and damages to short duration natural disasters (3) manage transition without compromising justice through proactive preparedness for reducing impacts of slow onset long term and cumulative highly likely events like climate change. The articles compiled in this journal volume through double blind peer review process address following broad research questions:

- How can Bangladesh economy grow at more than 7% through next three decades and make attempts towards setting new normal for energy supply sector moving beyond fossil fuel dependence at the same time creating decent jobs?
- What is the scope of new major innovations that can be embedded in energy demand sectors

like buildings, transport etc. through domestic and international collaboration?

- For a natural disaster exposed nation like Bangladesh how people, community and institutions interact to build resilience organically and which needs to be strengthened by scientific approaches?
- How is the nation reacting and influencing the climate change debate globally with national preparedness?

As the original inspiration for this volume comes from the thematic area “Energy Sector Development in Bangladesh” of Bangabandhu Chair endowment at AIT, Thailand by the Government of Bangladesh, Ministry of Foreign Affairs and also given the Journal’s core focus on Energy, all article have focus on Bangladesh and majority of the articles focus on energy. It is complemented by articles on climate change and disasters as they pose a valid threat to sustainable energy sector development directly or indirectly. Content diversity has been managed in such a way that policy makers in Bangladesh can get useful tools and information to decide on a course of action with sustainability goal. Researchers on Bangladesh economy can get a status review of a branch of knowledge and identify the research gaps that can add value through future knowledge gap filling studies.

Fossil fuel sector which is providing energy supply of Bangladesh today cannot be continued for long time both due to resource depletion and secondly due to rising demand. The first nine articles focus on the energy supply side innovations which are technically, economically, environmentally feasible and acceptable from social justice point of view.

*H. Mahmud and J. Roy* set the scene by presenting the challenges for fast growing economy like Bangladesh by comparing the current challenges *vis-à-vis* Asian countries who were growing fast in the second half of the past century. The shift in global perspective of development towards sustainable development makes it an imperative for energy sector to become sustainable. This means a new innovation path and new exploration of alternative solutions for demand and supply of energy even for a country like Bangladesh.

The article by *Roy et al.*, discusses one likely energy transition roadmap for Bangladesh beyond the natural gas-based energy solution. The study proposes the new use options for the existing gas infrastructures to plan in energy system around geothermal sources. The country needs to preplan leapfrog to sustainable energy solution now. This represents the scope of energy transitions considering the current and future challenges and opportunities based on available infrastructures, human capacities and institutions.

Article by *Samanta et al.*, discusses how design optimization in Biodiesel production from palm oil can provide a sustainable alternative fuel solution for Bangladesh. The authors performed a laboratory investigation about how palm oil can effectively be converted into diesel and be used in a range of sectors where diesel is commonly used.

Article by *Katekar et al.*, makes an assessment and Way Forward for Bangladesh on SDG-7: Affordable and Clean Energy. The authors provided a comprehensive assessment of energy sector of Bangladesh by focusing on (i) decision making landscape of the sector, (ii) energy demand, production and consumption aspects, (iii) current energy-mix and heavy dependence on non-renewable gas reserve which is forecasted to be extinguished by the year 2026. The paper also made a comparative assessment of energy sectors of the South Asian countries. The authors commended the progress made by Bangladesh since independence in 1971, quoting the impressive growth rate in GDP, per capita income and at the same time called for necessary actions towards attaining SDG targets.

Article by *Manimekalai et al.*, elaborated a comprehensive guideline on what is the current status of energy storage technologies/devices and what is the current status within Bangladesh and what are the alternatives one can explore going forward. One gets an idea that globally it is the Pumped hydro storage technology which dominates the storage practices in power sector. While battery storage and the variety of options exist with chemical, thermal processes as well. The top currently winning storage device in use within Bangladesh is not the state of the art so which provides scope of new technology choice, development of enough technical and human capacity, supply chain, policy incentive, market competition for going forward.

Article by *Islam and Singh* is a futuristic case study for Bangladesh with a high growth rate of Plug-in Electric Vehicles (PEVs) (20-25%) and rooftop solar PV (8%) for decarbonization. How such changes can be handled by utilities need attention from now. The installations of solar photovoltaics (PVs) in the distribution system including rooftop photovoltaic (PVR) change the shape of the daily demand profile in a way that makes the load curve to look like a duck due to high penetration of solar energy for a specific period of daytime. So, this study provides a detailed analysis which can provide guidance for new technology and policy planning.

*Arefin et al.*, highlight the current state of research taking place in Bangladesh regarding the development of photovoltaic solar cells and the potential for thin-film solar cells to effectively harness solar energy. The use of different kinds of plasmonic metal nanoparticles (NPs) such as core-shell NPs, NP dimers made of metallic alloys and hybrid bow-tie shaped NPs with thin-film solar cells are discussed. These nanoparticles are found to significantly improve the efficiency of thin-film solar cells. It is expected that fabrication of such plasmonic solar cells will not pose a major technological challenge due to the advanced stage of fabrication technology of Si due to its widespread use in the electronics industry. Hence, Bangladesh can also have bright prospects to be a part of a multi-billion-dollar solar cell industry and become a market leader like it is in the ready-made garments (RMG) industry. Thus such “plasmonic solar cells” with a higher current conversion efficiency can lead to fewer solar cells needed to produce a specified amount of electricity, and thus potentially significantly

reducing the price and increasing the accessibility of the “green energy” in developing nations like Bangladesh.

*Gorantla et al.*, shows in a rapidly urbanizing country energy saving is one of the opportunities which needs to be used for reducing burden on supply side. How proper selection of window glasses reduces the energy consumption in the built environment is explained. The objective of this work is to ascertain the best glazing and its orientation to save the high air-conditioning costs in buildings of the Dhaka in Bangladesh. This article presents the experimental results of solar optical characteristics of four different glasses such as clear, tinted bronze, tinted green, and bronze reflective glasses. Burnt brick buildings were modeled with four different glasses and analyzed for air-conditioning cost-saving prospects.

Article by *Ruba Al-Foraih et al.*, emphasize the importance of developing the transportation infrastructure to reduce dependence on private vehicles and to encourage the use of public transportation facilities. The method paper evaluates the economic impact of implementing energy efficiency strategies in the transportation sector using a system dynamic model and associated scenario analysis that can be applied to Bangladesh.

The article by *Hossain et al.*, provide an insight on high seismic risk on energy infrastructures in Bangladesh due to the seismogenic gaps in the active faults. Author mapped the exposure and seismic vulnerability of energy infrastructures in Bangladesh and, e.g., gas fields, gas production facilities, processing plants, gas transmission network, oil refinery, power grid. The study also suggests, guidelines based on a comprehensive seismic zonation map and site-specific probabilistic seismic hazard map for all major engineering constructions, specifically large-scale energy infrastructures.

The discussion by *Khan et al.*, introduces new form of discussions for possible integration of the issues like energy security, disaster risk management and climate change. The authors show the importance of energy in disaster management vis-à-vis emergency response and recovery processes. In doing that synergies among the sectors and related challenges are identified and a number of suggestions towards integration are provided.

*Sanyal et al.* conducts a comparative assessment of coastal hazards and their resultant impacts on communities and physical systems/resources in the countries located in the Asian coastal regions and maritime areas. The authors also discuss the types of natural hazards in Asian coastal countries and categories based on exposures to hazards. The paper primarily focused on climate induced hazards and vulnerability that are narrated in the National Communication Reports (NCR) submitted to UNFCCC by 22 coastal countries of Asia. The paper explains that complex and interconnected human-nature interface in the coastal areas evolved based on the long-term knowledge, understanding, and familiarity of the coastal communities with the systems and resources they are settled in.

The authors *Esrar-Ul-Zannat et al.* assess the impacts of climate change induced disasters in southwestern coastal city Khulna, Bangladesh. The city faces a number of hydro-meteorological hazards such as urban flooding, waterlogging which creates different kinds of secondary forms of impacts like waterlogging, overflow of sewers, scarcity of safe water in the city. The authors indicated that the locational attributes of the city such as flat and low-lying topography and its proximity to the Bay of Bengal made this coastal city susceptible to hazards which will be exacerbated under the influence of climate change, especially sea level rise and extreme weather conditions. The authors examine the likely impacts of sea level rise by performing different kinds of city-scale spatial analysis.

The article by *Islam et al.*, reviewed the chronological progression on climate change knowledge and actions in Bangladesh to understand the climate resilient development. The study also indicates decisions, actions, and interventions in regard to climate change turbulence in the conceptualization of the crisis, impact reduction project formulation, finance management, and implementation processes. The study characterizes the climate-resilient development through mainstreaming climate change investments / expenditures of the government of Bangladesh. The chronology of significant works on climate change in Bangladesh undertaken by different agencies since 1989 is useful documentation.

Finally, an interesting aspect of this volume, from a sustainable development perspective, is that all of its lead authors, as well as a large majority of its other contributing authors, are from the region and from the country. While this author mix outcome has been mostly incidental, as it is outcome of an open call for papers widely circulated, it does demonstrate that there is a pool of highly qualified researchers and thinkers all around the world ready to commit time and effort to influence academic and policy discourses at the highest levels in the field of sustainable energy transformations, climate change and disaster risks in the context of Bangladesh. Unfortunately, despite the efforts of the editors it was not possible to keep all the submissions as 30% had to be rejected after double blind peer review process either due to divergence of the objectives from the thematic goal of this special issue or because they did not satisfy the scientific rigour and standard of the Journal.

Guest Editors synthesizes the recommendations that emerge from the research studies and presents at the end in the form of a white paper which will be useful for decision makers in Bangladesh. Guest editors acknowledge with thanks cooperation from a large number of experts from various continents and institutions for their full cooperation, sometimes very tight timeline for review, taking the burden of reviewing more than one article, and sometime to review twice/thrice after resubmission in response to review comments. We acknowledge with thanks the voluntary time commitment of reviewers. Our sincere thanks to all the experts Professors/Dr/Ms/Mr. Abdul Salam, Amir Safari, Alak Pal, Anamika Barua, Anjal Prakash, Anupa

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