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EDITORIAL

SUB Journal of Sustainable Environment and Development

The *SUB Journal of Sustainable Environment and Development (SUBJSED)*, published annually, seeks to further research and debate on the nexus of environment and development issues at the local, national, regional, and international levels. It combines academic research with practical analysis of working policies. The broad scope and interdisciplinary nature of this publication are demonstrated by the wide variety of interests and disciplines of its readers and contributors. *SUBJSED* provides a forum that bridges the parallel debates among the stakeholders especially academics, researchers, practitioners and activists.

Research is a big challenge in general especially in a developing country due to paucity of funds and of course lack of vision. It is essential of getting involved in research for creation of knowledge. The need to carryout research appears to be fairly well recognized in academia. However, despite many challenges the higher education institutes (HEI) in Bangladesh especially the private universities are trying hard to carryout this task with many limitations. And dissemination of research findings through publication of journal is an usual practice. From that perspective the fourth issue of the SUBJSED is published with 9 papers.

Finally, the Journal relies heavily on the editorial staff and special thanks go to the reviewers and authors in time for the fourth edition.

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CLIMATE CHANGE AND VIOLENT CONFLICT: AN UNDERSTANDING AND ANALYSIS OF THEIR CAUSAL RELATIONS

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ABSTRACT

Climate change, which is a common concern to many has serious security implications in contemporary world. Many scholars have attempted to examine links between climate change and armed conflicts. Having this issue in consideration, this qualitative research paper aims to examine the extent to which climate change can contribute to violent conflicts. This paper has argued that climate change in its own does not lead to armed conflict, nor does its impacts do so. The effects of climate change, particularly climate change related environmental impacts and associated resource scarcity, and following migration of people once couple with other structural and socio-political factors can contribute to exacerbate existing conflicting relations between parties in destination area. For a fresh armed conflict, climate change may not a key factor, but could be a factor to create conditions for such a state. Considering these issues and factors, we can come to an inference that only climate change is not a direct factor, instead as a ‘threat multiplier’ to a great extent can contribute to intensify existing conflicting relations.

Keywords: Climate change, resource scarcity, insecurity, migration, violent conflict

Introduction

There is no discontent amongst scholars and policy-making elites about the fact that climate change is a reality, and it has greater impacts on society and human civilization in many respects.

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One of the key growing concerns related to climate change is that it could pose a profound challenge towards international community for its security implications (Salehyan, 2008; Ragnhild et al, 2007). There is a significant international scientific, political and developmental consensus that climate change could lead to enormous environmental degradation in many parts of the world, which also has potential for degrading peace and security (IPCC, 2007). The Third Assessment Report of IPCC sketched a few straight links between climate change and conflict such as climate-related migration could produce political instability and conflict, water resources may lead to international conflict and trans-boundary fishing resources may lead to inter-country conflict (IPCC, 2001). The UN Security Council’s first debate on the effects of climate change (UN, 2007) and UN Secretary-General Ban Ki-moon’s (2007) linking of the Darfur conflict with climate change gave more than enough heed on this debate.

Rapidly growing speculations of climate change and potential of violent conflicts, however, has been still a contested issue in academia for some time. The deterministic view of this concern is that the effects of climate change to human livelihood and its concomitant scarcities of resources as well as migration can undermine state capacity to manage tensions (Barnett et al. 2007), which can also “greatly increase risks of violent conflicts” (Raleigh et al. 2007). On the contrary of this prophecy, some academics have more skeptical views about the causal relations of climate change and conflict that can depend upon other more “complex and contingent” variables including structural, socio-economic and political factors (Salehyan, 2008:316). These causal links, moreover, often are more case specific rather than general substantive evidence (Nordas and Gleditsch, 2007).

Given this background, this paper answers a research question aiming to examine the extent to which climate change is contributing to violent conflicts and risks of violent conflicts. In answering this question, this secondary resource based qualitative paper takes a stand that environmental and socio-economic impacts of climate change, instead of its own, combining with other political
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and structural factors may lead to political violence in longer-term, if main issues of conflicts are not well addressed, or may exacerbate existing internal tensions rather than contributing to full scale interstate violent conflicts. As a part of this paper, we use Bangladesh as a case and its potential tensions with India to draw potential causal links between climate change-induced environmental degradation, migration and potential risks of conflict. Firstly, this essay briefly outlines climate change and its socio-economic impacts. Secondly, it looks through critical causal inter-relations of climate change and conflicts. Finally, considering the climate change vulnerabilities of Bangladesh and previous examples of tensions in other contexts, we focus to analyse the extent to which climate change can increase risks of violent conflicts, followed by a conclusion.

Climate Change and its multiple Socio-Economic Impacts
Climate change is a continuous process of changing global weather pattern. It indicates “any change in climate over time as a result of both natural vulnerability and human activity” (BIISS and Saferworld, 2009: 1). The main responsible causes of climate change are of global warming, caused by greenhouse gas emissions, habitat change by tropical deforestation and increased atmospheric concentrations of aerosols (Lee, 2009). The primary impacts of climate change are exposed through sea-level rise, increasing natural disasters, deforestation, desertification and scarcity of fresh water that can impair basic human livelihoods and can generate newer vulnerabilities.

These changing events of climate have profound impacts on agricultural activities, food productions, human health system, diseases and economic activities (Salehyan, 2008). Moreover, the socio-economic impacts like loss of infrastructure, scarcity of essential resources such as food, water and energy, and population displacement and settlement patterns are more issues for wider peace and security dynamics in contemporary world (Abbott, 2008). These vulnerabilities of people, however, to climate change depend on “the extent to which they are dependent on natural resources and ecosystem services . . . and their capacity to adapt to changes in
these resources and services” (Barnett and Adger, 2007). This means that when people rely more on climate sensitive natural capitals than economic and social capitals, the risk will be more from climate change on that society. The developing countries, which are more dependent on agrarian economy with low economic growth, are perhaps more vulnerable than developed world to climate change impacts. Nordas and Gleditsch’s (2007: 634) in this regard stated that “effect would vary considerably both geographically and by sector”. Homer-Dixon (1994: 6) argued, “poor societies will be particularly affected since they are less able to buffer themselves from environmental scarcities and the social crises they cause”. Many countries of global south are, in fact, already in poverty, shortage of water, fertile land and forests coupling with high population growth etc. that to a considerable extent can undermine socio-political situation when climate change impacts firmly are rooting in such societies. The following section pays attention to examine causal relations of climate change and armed conflicts.

Climate Change and Conflict: An Understanding of their Causal Relations

Although climate change and potential for violent conflict is a much talked issue in the 21st century security arrangements, the causal links between climate change and violent conflict are still debated in academic research. The United Nations Security Council (30 January 2018) President in a statement referring to West Africa and Sahel region recognized climate change and its impacts including drought, desertification, land degradation and food insecurity, and ecological changes along with other factors can contribute to tension and risks. However, most of the analyses have a close proximity of Homar-Dixon’s (1994) primary model of causal links between environmental scarcity and violence. In this model, environmental scarcity is comprising of three set of scarcities, namely of supply-induced scarcity, demand-induced scarcity and structural scarcity (ibid). Therefore, such kind of impacts in society can lead to both “rural and urban violence” (ibid: 133-168). However, three basic hypotheses of this chain highlight that decline
of facilities of physically controllable environmental resources like water, agricultural land could lead inter-state resources-wars, environmental degradation generated migration could lead to group-identity conflict, and economic deprivation and disruption of social institutions caused by environmental scarcity have the chance of increasing deprivation conflict such as “civil strife and insurgency” (ibid: 6).

Another group of scholars and researchers, however, are skeptical about these causal relationships, which exclude different pattern of existing or latent political disputes and important socio-economic and political contextual factors, which can contribute to risks and tensions (Dalby, 2002; Gleditsch, 1998). However, pressure which climate change can put upon natural resources can undermine capacity of a state to govern in such complex fragile situation where other political, economic and demographic factors can contribute to fragility. Yet, institutional mechanisms to mitigate environmental conflicts are overlooked, rather only considered the capacity of promoting compromise for effective handling of international disputes over water (Yoffe and Giordano, 2003). Therefore, a simplistic argument of climate change can lead to conflict should not be accepted without concrete and solid examples, which are absent in the present context. The over simplified and generalized starting-point for climate change and violent conflicts link is that climate change will exacerbate resource scarcity, produce population migration, both internally and externally, and as a consequence violent conflict will take place in societies and countries. Weak and fragile countries, where agricultural economies are sensitive to environmental degradation, are more vulnerable to such kinds of risks of conflict and violence. Therefore, climate change, resource scarcity and potential for conflicts depend on an interrelated issues and processes. Nordas and Gleditsch (2007:631) have depicted this simplistic causal pathways as:

Climate change results in a reduction of essential resources for livelihood, such as food or water, which can have one of two consequences: those affected by the increasing scarcity may start fighting over the remaining resources. Alternatively,
people may be forced to leave the area, adding to the number of international refugees or internally displaced persons. Fleeing environmental destruction is at the outset a less violent response to adverse conditions than armed conflict or genocide. But when the migrants encroach on the territory of other people who may also be resource constrained, the potential for violence rises.

Climate change can increase human insecurity in densely populated countries by reducing access to, and quality of, natural resources which are fundamental for supporting livelihood of people living in such societies (Barnett and Adger, 2007). Water, is a key source of agriculture, industry and livelihood in every society, can be considered to be a key source of contention for many regions as a consequence of climate change (Mazo, 2009). There is a widely known argument that reducing freshwater availability has a positive effect on the likelihood of conflicts (Raleigh and Urdal, 2007). Shortage of rainfall and constrained flow of river water, furthermore, can increase desertification in many countries including in African continent that have the chance to exacerbate existing political relationships between states, and possibility of armed conflicts could increase. What is more is that shared river basins may turn to inter-state conflicts between the upstream and downstream neighboring countries (Gleditsch et al. 2006), if such issues are poorly managed, and inadequate attentions are paid to ensure access to water to inhabitants of such countries.

Declining access to livelihood sustaining resource can aggravate relative poverty and increase frustration and grievance amongst many people including young generation (Barnett and Adger, 2007). Frustrated young people, who have expectations for a better life, in such circumstances can be recruited by rebel groups for their purposes, which can increase potential of violence (Ohlsson, 2000). Fearon and Laitin (2003) says that weak states are more prone to civil war due to different structural and inequality factors. Kahl (2006) argued that environmental stresses and demographic variables are more likely to lead internal violence than international conflict, while Raleigh and Urdal (2007) have given more stress on
the scarcity of water resources for increasing risk of conflict in low-income countries having high population growth. Hauge and Ellingsen (1998), on the contrary, summarized that political and economic factors are strongest contributors of environmental conflict rather than demographic pressure and environmental factors.

Nevertheless, climate change can contribute to reduce the capacity of states, through its impact on income, legitimacy, and social cohesion, to manage environmental problems effectively in fragile and transitional countries, where political elites try to exploit environmental and social issues to capitalize personal gains (Kahl, 2006) is linked with Pervis and Busby (2004: 68) logic of “depletion and altered distribution of natural resources” and possible risk of violent conflicts. Smith and Vivekananda (2009) have argued that bad governance and weak institutions lead to failure of climate change adaptation, where poor and marginalized remain more vulnerable. Weak institutional capacity of states can be considered as a major factor of insecurity, instability and armed conflict in such states.

Civil strife and deprivation conflicts, therefore, have chances to become violent in weak states, which sometimes are unable to contain outbreaks of armed violence (Salehyan, 2008). The cause is not as simplistic as that poor people desperately take arms against the state or privileged groups. Marginalization of the poor, lack of adequate participation in decision-making process and “lack of an accessible institutional framework for handling and settling conflicts and disputes” are main reasons for spreading outbreak of violence (Smith and Vivekananda, 2009: 10). A vicious cycle amongst these variables continues including other variables, such as poverty, state fragility and a propensity to violent conflicts (ibid). International community is therefore more concerned about these fragile and failed states as Lee (2009) have argued that “failed states tend to multiply and create other failed states that challenge the stability of the international system”.

Developed countries, therefore, are often more concerned about climate change and its effects, and prioritized their strategies
considering the plight of such vulnerable countries of global south and possible population displacements. Schwartz and Randall (2003: 2) stated:

Nations with the resources to do so may build virtual fortresses around their countries, preserving resources for themselves. Less fortunate nations … may initiate struggles for access to food, clean water or energy … defense priorities shift and the goal is resources for survival rather than religion, ideology, or national honor.

Climate change induced migration is considered as a great concern for possible violent conflict in destination country. The basic assumption of this thesis is that population displacement, as a secondary impact of climate change, and large cross-border migration may produce violent conflict in the migration hosting communities (Mazo, 2009; Reuveny, 2005). Reuveny (ibid: 4) argued:

Climate change may intensify migration, particularly in LDCs, and the migration may lead to conflict. These conflicts, in turn, may reduce global political stability . . . However, the interconnections between environmental degradation, migration and conflict in the future do not have to be linear or static.

Migration is considered as the last resort of survival of impoverished people, who are unable to adapt in their own community due to climatic vulnerability to their livelihood. Most climatic migration as Mazo (2009: 102) argued will be “from rural to urban areas, and within the worst-affected nations and countries rather than from such regions to developed nations”. Environmental displacement can increase the likelihood of conflict in all destination areas as Abbott (2008: 7) speculated that “major problems can be expected where there are large, poor populations adjacent to small, rich populations” specially in Mexico and USA, North America and Southern Europe, and South East Asia and Australia. Nevertheless, relative resource abundance has a possibility to increase risks of conflict. Lee (2009: 6) argued by saying that “competition over newly available resources may lead to
conflict, especially when these resources turn up in places where boundaries are not clearly set.” Resource abundance is often considered as a pull factor for migration, which in turn may lead to violent conflicts (ibid).

However, a systematic general link between migration and violent conflict has often remained missing (Suhrke, 1997). Migrants, especially young displaced people, could be easy target for rebellions and armed conflicts but purely environmental displaced mass “do not have the same political agenda and grievances, nor do they have the same experience in organizing armed insurgency” (Nordas and Gleditsch, 2007). Small scale squabbles and individual murder to rioting can take place in the refugee receiving communities due to scarcity of resources and competition of jobs. Moreover, some other driving and triggering factors like easy availability of weapons, violent history of the area, political regime and ethnic heterogeneity, high proportion of young in total working population, resource dependence and existing tensions over resources etc. are equally important for measuring the extent of risks of violent conflicts (Boutwell and Klare, 1999; Collier, 2000; Hegre et al. 2001; Cincotta, 2004; de Soysa, 2000).

Full-scale ethnic conflict is not a product of environmental refugees rather diverse political, economic, social, religious and structural factors contribute more to such situations in refugee hosting areas. Political and institutional responses are important to consider in these conflicts. Goldstone (2001) stressed that “it is the political and institutional responses to new migrants – rather than the existence of migrants per se that seems to be most important in cases where migration is a factor in violent conflict”. This implies that not only climate change but also structure of the society, institutional decisions towards migrants and refugees, and state capacity of resilience are important factors need to be calculated for measuring the extent to whether climate change can play a crucial role to contribute violent conflicts or increase risks for violence. It is, hence, evident that climate change and its effects have some potential to influence other dependent social, political and cultural variables, both directly and indirectly. Climate change induced
resource scarcity and concomitant migration may contribute to increase native and migrants fighting for jobs and resources from ethnic lines, but only climate change cannot lead to war unless there is high political issue attached to this process.

However, it is important to take into account, when measuring and analyzing the links between climate change and risk of violent conflict, that the issues of “human agency, ingenuity, the potential for technological innovation, and the vital role of political institutions in managing conflict (of failing to do so)” cannot be ignored (Salehyan, 2008: 317). Ignoring the role of governing authorities in vulnerable countries and societies may give an incorrect analysis and understanding of degree of conflict and may encourage policymakers to bypass claim of civil wars and human rights violation in many respects in such situation.

**Bangladesh: Climate Vulnerabilities and Risk of Tensions**

Bangladesh, a flat and low-lying topography, densely populated and agriculture-dependent country of South Asia, has always been in international discussions for climate change and its impacts to people as well as related concerns of potential migration induced conflicts. According to the *Global Climate Risk Index 2009*, Bangladesh is the riskiest country to climate change. As Bangladesh has been in global discussion in this regard, this country over the period has went through a number of natural disasters related to climate change. These include 1991 April Cyclone, 1997 November Cyclone, 2007 Cyclone Sidr, 2009 Cyclone Bijli and Cyclone Aila etc. which had made sever impacts in localized areas (Chowdhury, 2009).

However, assuming a causal links between climate change and conflict are not straightforward for Bangladesh. There are other economic, structural, strategic, institutional and political factors, both inside the country and from its neighbor, India, are important to consider for measuring and understanding potential risks of climate change related tensions. A growing speculation of security vulnerability like interstate conflict between Bangladesh and India getting much heed in this century. A *New York Times* report stressed
by saying that (Broder, 2008):

The potential impact of a destructive flood in Bangladesh that send hundreds of thousands of refugees streaming into neighboring India, touching off religious conflict, the spread of contagious diseases and vast damage to infrastructure. It gets real complicated real quickly.

Given this speculative context, it is therefore important to conduct a collective analysis of three basic components of causal chains like environmental scarcity, population displacement, and institutional responses is necessary for examining the extent to which climate change can increase risks of tension and violence for Bangladesh and with its neighbours.

**Environmental Scarcity and Impacts on Livelihood**

*The Fourth Assessment Report* of IPCC indicates some primary observations of climate change induced extreme events like average temperature increase, increased intensity of cyclones, irregular rainfall, rising sea-level, increasing salinity of river water, river bank erosion, increasing drought during dry season etc. for Bangladesh (Cruz *et al.* 2007). Bangladesh was, in fact, considered most vulnerable for tropical cyclone in the world and sixth most vulnerable to floods (UNDP, 2004). The secondary effects like physical and environmental stresses on resources, agricultural production, economy, and human activities of these climatic events are visible as a threat to human security. A house hold survey conducted in 2008 highlighted vulnerability to natural disasters as one of a top five human security concerns (Saferworld, 2008). Changes in weather, a result of climate change, has to a great extent contributed to exacerbating droughts in northeastern Bangladesh. Nevertheless, as a consequence of river flooding and coastal flooding of saline water in agricultural land, many farmers shifted their agricultural production to shrimp cultivation in the Southeastern part of the country, which actually has benefited large land owners in food production rather than marginal poor farmers (BIISS and Saferworld, 2009).
Marginalization can contribute to increase tensions between marginal poor farmers and powerful shrimp enterprises in areas where fish-farming is common like in some areas of Khulna division. Such kind of phenomenon could create personal insecurity to some people, and could lead to direct violence (ibid: 14). This situation is unlikely to lead to open warfare between parties. Referring to other contexts, Salehyan (2008) argued in this regard by saying, “while interpersonal violence is more or less common and may intensify under resource pressures, sustained armed conflict on a massive scale is difficult to conduct” in such condition due to structural power imbalance in the society. However, the overall impact of climate change increases poverty, reduce food productivity when coupled with other probable risk factors and could be harder for authorities to ensure human security of all people living in such areas where fish-farming is common.

There has been a projection that one meter sea level rise in Bangladesh will displace around 40 million people of the country. Moreover, coastal flooding and river bank erosions are two common issues connected to climate change and environmental degradation in Bangladesh. River bank erosion, for instance, in many ways make people vulnerable and undermine their livelihood pattern. Once they lose their land and habitat, there is hardly any means left to them for continuing a normal life. However, such kind of impacts of natural disasters does not lead to political stability. This, nevertheless, can intensify unemployment situation if there is not adequate attempts undertaken by state authority to address such conditions. This can also force people to leave their regular habitat for better livelihoods, often to urban areas or to areas where population density is less. The main potential for conflict remains on population movement to an area, and thus putting pressure on resources linking with other factors in that area.

**Migration and Conflict in Destination Area**

Movement and settlement are two basic characteristics of human being. Migration, on a temporary or permanent basis, is one of a best survival strategy for people who are vulnerable to natural disasters
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and climate change effects. There is an assumption that every year many people, affected by climate change and its associated impacts in Bangladesh, migrate from rural to urban areas and sometimes beyond the border, particularly to India. Bengali domestic displacement from plain and settlement to the Chittagong Hill Tracts (CHT) and migration to neighbouring Indian state of Assam are two commonly referred cases to find a causal links between environmental degradation induced migration and conflict. Nevertheless, this causal link is not straightforward. To project these migration and relating them with conflict has to be understood by considering complex other issues of identity based CHT conflict, and structural and political conditions in Assam.

An influx of migrant people in urban destination area can create competition over livelihood resources, which have potential for trigging violence like disputes over land, job competition and competition for access to water (BIISS and Saferworld, 2009) when these issues are not well handled by the state institutions with due attention. There are claims, for instance, that rural to urban migration brings people to big cities, and often they land in urban slums, which suffer from lack of facilities and amenities in many respects.

Reuveny (2007) argued that climate change induced migration can promote conflicts in destination areas from four channels like competition, ethnic division, distrust and fault line when coupled with other auxiliary socio-economic and political factors. Many of the unemployed displaced people end up in urban slums, which are often considered as hubs of urban crimes and illegal activities. As a consequence, many of migrated people finding no other alternatives can engage in illegal drug trafficking and gun running that can significantly contribute to increase urban violence, crime and criminal activities.

Mostly cited environmental degradation-induced migration lead internal conflict in the CHT of Bangladesh does not comply with the simple equation of migration and violent conflict, as mentioned earlier. The identity and culture of people of ethnic communities living in the CHT as well as state-sponsored transmigration policy

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brought plain Bengali settlers to that areas, which when coupled with real politik issues that brought a new dimension to existing CHT conflict in late 1970s and early 1980s (Mohsin, 1997). Thereafter, an inter-community dimension was added in already existing political conflict (Nasreen and Togawa, 2010).

Nevertheless, it is important to state that insensitive development project undertaken by the Pakistan government in early 1960s when the Kaptai Hydroelectric Dam was constructed to meet electricity demands of the country that created a condition of dissatisfaction of ethnic communities, particularly of the Chakma (Parveen and Faisal, 2002). This was partly because of inadequate compensation provided to victims of development project as more than 100,000 Chakma people left their houses and moved to India as a result of the construction of this dam that inundated a large portion of lands including cultivable land and homesteads of the CHT (Mohsin, 1997). However, state undertook a counter-insurgency operation to tackle insurgency movement of the PCJSS, and its military wing the Shanti Bahini. As a part of counter-insurgency operation, state-sponsored migration policy was undertaken to make a population balance in the CHT, and thus to reduce insurgency appeal of the SB amongst people of ethnic communities (Ibrahim, 1990). According to Homar-Dixon (1999), “environmental scarcities can spur group identity conflicts by contributing to large migrations and by intergroup segmentation” as observed by state-sponsored policies in the CHT during late 1970s and early 1980s. Therefore, we can consider that state-sponsored migration of poor, landless people was contributing factor to exaggerate existing conflict between the CHT ethnic communities and the state. However, climate change perhaps contributed to increase ethnic people’s hardship and insecurity as well as aggravate social tensions and violence in the region (Benesova, 2010). This has to be taken into care in relation to implementation of the CHT accord, signed in December 1997 between the government of Bangladesh and PCJSS to end conflict, so that tensions cannot be created, even if a situation is created to further informal migration to the CHT as a result of sea level rise and its associated impacts (BIISS and Saferworld, 2009). Such kind of migration process would not create tension
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unless there is any existence of fault line there. Nevertheless, regional political dynamics can play powerful roles to intensify any conflict, either political or environmental, in nature.

Potential of Inter-State Tensions
The speculation of climate change induced impacts on the relationship between India and Bangladesh has a great importance for international security. The basic assumption is that if sea-level rise, as predicted by the international scientific community that would produce a huge cross-border refugee influx, and that at worst could lead to an interstate conflict between these neighbors. The prediction perhaps has some value because environmental degradation in Bangladesh due to Ganges water diversion by India has created some uncomfortable experience of aggravating community relations in some parts of India, and worsens relations between these two countries. There are diverse analyses of the environmental degradation in Bangladesh and ethnic conflicts in Indian state of Assam and some other locations of India (Swain, 1996). According to Swain (ibid: 193-201), these conflicts took place in early 1980s and 1990s as a consequence of diverting Ganges water during dry-seasons by India since 1975, which had seriously affected livelihood patterns of ordinary people, and produced environmental refugees from South-West Bangladesh to India.

However, environmental degradation was only a proximate cause for large migration. There were some other crucial underlying factors that played crucial role for migration of people affected by environmental degradation. When environmental degradation leads to migration, it is generally considered as a proximate cause which has close links to the questions of economic growth, poverty, population pressure, and political aspects of existing conflicts (Hugo, 1996). Frequent natural calamities, droughts, population pressures and inheritance norms intensified land scarcity in Bangladesh. Along with these, Independence War of Bangladesh 1971 collectively forced a large number of Bangladeshi people to travel to India since 1950s (Reuveny, 2007). Moreover, a large portion of environmentally affected inhabitants, both Hindus and
Muslims due to Farakka Barrage in India, finding no other suitable and affordable alternatives were forced to cross Bangladeshi border to go to India since late-1970s (Swain, 1996).

There were claims that as a consequence of refugee influx, a number of native-migrant conflicts took place in destination locations. However, the causal link of the conflict was not very linear and straightforward. Conflicts originated due to diverse interplays amongst socio-economic, ethno-religious and political factors as Swain (ibid: 190) stated: “migrations may induce scarcity in the receiving areas, with the potential for mobilizing political actors and exacerbating existing incompatibilities. The perceived conflicting behavior of these organized actors towards each other may eventually turn into acute conflicts”. This implies that there are many crucial issues other than climate induced migrated people that contribute to violent conflicts in destination place.

Beyond the general scarcity and competition issues in receiving area, new Bengali migrants played a significant role in the political equation of the state, which further fragmented on religious line. Indian mainstream political parties, both Bharatiya Janata Party (BJP) and Indian Congress, had calculated political value of these migrant people who were considered as voters (ibid: 201). Nevertheless, religious promulgation of refugees by ruling political leaders and Hindu fundamentalist political organisations perhaps played crucial roles to spread inter-communal violence in many Indian states that mounted brutal massacres of Indian Muslims including Bengali Muslim migrants in 1990s (Swain, 1996: 201). Although the inter-communal conflict reached to extreme violent form, this did not turn into an interstate conflict between India and Bangladesh rather than worsening their diplomatic relations (ibid: 202). Two countries, moreover, managed the issue of sharing Ganges water through a bilateral agreement that signifies that “conflicts of interests over shared resources” can enhance cooperation between countries that exercise friendship and peace (Wolf et al. 2005). Bachlar (1998) argued that ethnic or political conflicts generated by environmental causes have potential to manage through government regulations, negotiations and
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However, India has been very concerned about sea-level rise and its subsequent aftermath related to possible migration and potential tensions. Climate change related migration has possible consequences on regional security and conflict dynamics, which has been predicted in different researches. According to Lee (2009), “shifting demographic pattern due to climate change will eventually force realignments in domestic, regional, and global power relations”. There has been a scientific prediction that one meter sea-level rise in Bangladesh will elevate 17 million people from the coastal area that could have significant implications on relationship of these two neighbouring countries (ACIASC, 2004).

Considering the long-term climate change accelerated migration and many other existing problems, India started fencing of 2,500 miles of its West Bengal border to tackle illegal immigrations from neighboring Bangladesh (Prasad, 2005). Moreover, every year a significant number of civilian Bangladeshi were shot by the Border Security Force (BSF) during crossing border (ASK, 2009). Bangladesh as a small, peace loving neighbor, which pursues a foreign policy principle of ‘friendship to all, malice to none’ in this region will not intervene in this issue other than engaging in diplomatic means. Being a natural disaster prone country, Bangladesh, which has by now developed some approaches of resilience against climate change and found some adaptation strategies, moreover, would act maturely to address such kind of situation, even if evolve anytime. Therefore, potential for armed conflicts will be minimum, unless there are any aggravating factors. Climate change impacts relating to other issues indicate that such effects could be factors to exacerbating existing contentious issues like water sharing and maritime claims between these two asymmetric neighbours (BIISS and Saferworld, 2009). Therefore, climate change and its associated impacts in Bangladesh may not be a cause of direct conflicting relations between countries like Bangladesh and India, instead could be a complex “threat multiplier” in a complex conjunction of multiple other factors and issued exists between countries (CAN, 2007: 1).
Climate change impacts increase human insecurity in different ways that enforce people to migrate, where local crimes increase and violent conflict has chance to take place if such issues are not well taken care off by the state. On the other hand, when state structure is weak and feeble to adapt with climate change effects and unable to absorb migrants sensitively, there is a high risk of tensions as noticed migrants and locals’ tension in Indian state of Assam. Moreover, other structural factors in the “context of poverty, weak governance, political marginalization and corruption” can contribute to “drive conflict and limit the capacity to adapt to climate change” (Smith and Vivekananda, 2009: 7).

Climate induced migration further more can transmit risk of violence from one place to another location, and can contribute to violent conflict in some localized contexts. However, the possibility of interstate war is often considered as a less proportionality only for climate change. This is partly because in such crisis situation parties often tend to share resources to cope up with the impacts of climate change. Therefore, they prefer to compromise rather than engaging in costly fighting. In contemporary world, international community is more aware than before both in terms of climate change and its consequences, and also play important roles to manage disputing issues effectively. There is a settled international mechanism to address bilateral conflicting issues. Bangladesh, for instance, settled its maritime disputes with India in due process, through the Permanent Court of Arbitration (PCA), based in The Hague, Netherlands. The PCA, a permanent judicial body established by the UN for facilitating arbitration and dispute settlement between states, heard argument and counter-arguments for five years, and delivered verdict which awarded 19,467 out of 25,602 square kilometers disputed areas in the Bay of Bengal (The Daily Star, 8th July 2014). Therefore, we can say that in the presence of an international system of dispute management and existing bilateral relations, potential risks of inter-state tensions between India and Bangladesh perhaps is less as long there is adequate adaptation mechanisms and climate change resilience process, and cooperation exists between them.
Climate Change and Violent Conflict

Conclusion

This paper has come to a conclusion that climate change, which has become a security issue, and its impacts in connection with other push and pull factors can force people to migrate from their regular habitat, either within the territory of a country or beyond. In such circumstances, conflict can arise in destination place due to scarcity of resources linking with other socio-economic and ethno-political factors. In worst case scenario, environmentally uprooted people can create space for some stakeholders and actors involved in political and decision-making process to aggravate existing conflicting situation as witnessed in the CHT insurgency of Bangladesh and in inter-communal conflict in Assam, India. This in other way means that climate change in its own may not be responsible for creating a condition of fresh conflict, instead can be a factor to undermine existing disharmonious relations of parties. Nevertheless, climate change, as a threat multiplier effects can weaken state capacity to fulfill people’s desire, which in turn could lead to violence.

A direct link between climate change and inter-state conflict is very weak and rare, as international mechanisms and diplomatic exercise between states can keep any tension at minimum level. However, over securitization of climate change is a big concern for its security implications. Homar-Dixon (24 April 2007) in this regard stated that “climate stress may well represent a challenge to international security just as dangerous” as arms race continued during the Cold War, when rough states carried nuclear weapons which brought the world to a brink of war. Therefore, we can assume that security and its associated issues have become an incompatible part of climate change process. Taking all above discussion in consideration, we can reach to an inference that climate change and its impacts when interacts with other structural, socio-economic and ethno-political conditions of a society can increase risks of instability, and aggravate existing internal conflicts in some contexts, but not all. Therefore, what is important to understand potential links between climate change and conflict is to recognize the ‘consequences of consequences’ in such complex situations wherein climate change meets with structural and other factors.
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State of the World 2005: Redefining Global climate change and conflict is to recognize the ‘consequences of implications. Homar-Dixon (24 April 2007) in this regard stated that between states can keep any tension at minimum level. However, weak and rare, as international mechanisms and diplomatic exercise a factor to undermine existing disharmonious relations of parties. This paper has come to a conclusion that climate change, which has become a security issue, and its impacts in connection with other violence (Smith and Vivekananda, 2009: 10). A vicious cycle conflicts and disputes" are main reasons for spreading outbreak of nevertheless, climate change can contribute to reduce the capacity the scarcity of water resources for increasing risk of conflict in

1 Associate Professor and Chairperson, Department of Peace and Conflict Studies, Climate change, resource scarcity, insecurity, and conflict, water resources may lead to international conflict and 2007). The conflicts, water resources may lead to international conflict and UN Secretary-General Ban conflicts, water resources may lead to international conflict and


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Climate Change and Violent Conflict

USE OF SCIENCE AND TECHNOLOGY IN DISASTER MANAGEMENT AND RISK REDUCTION

Amir H. Khan

ABSTRACT

Disaster causes severe damage to life and property of the community/society far beyond its ability to cope with the situation using its own resources. The scale and time of occurrence of disasters in this century has greatly increased, particularly, in Asia and America where huge number of population live in the coastal regions. It has thus become so imperative that the best available knowledge of science and technology (S&T) blended with social science and management science (SS & MS) is applied to reduce disaster risks. In applying such evidence based S&T knowledge to different stages of disaster management, the DRR activities shall be aiming at reducing human, economic and environmental costs of disasters. The progress in S&T knowledge in disaster risk reduction (DRR) across the world has reached such a state that even if we cannot prevent an earthquake or a hurricane from occurring, or a volcano from erupting, we can apply the scientific knowledge and technical know-how to issue early warnings on volcanoes and cyclones and organize proper community response to such warnings. In the context of DRR using science, the existing academic resources and scientific capabilities in terms knowledge and skill of the country are to be further enriched with improved education and training. In this note some of the achievements of the application of sciences and technologies to disaster risk reduction including a case study of cyclone in Bangladesh are discussed. In the discussion it has been emphasized that S&T alone cannot reach the desired goals of building the resilient planet. The decision makers at the highest level of governance

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are to be convinced that the applicable S&Ts are the validated research outcomes and they are “useful, usable used” to build the resilient future better. And this way broader integration of science into DRR policymaking could be achieved.

**Keywords:** Disaster, Science and Technology, Disaster Risk Reduction, Resilience, Bangladesh

1. **Background and the Context**
A disaster is an event or series of events that leads to sudden disruption of normal life, causing severe damage to life and property to an extent that available social and economic protection mechanism are inadequate to cope with the post event situation. Disasters could be natural, for example, geological (earthquake), hydro-meteorological (cyclone) and biological (epidemics) or induced by human activities, for example, environmental degradation (degradation of soil, water and air quality) and technological hazards (nuclear accidents). Science and Technology today has reached such a state that even if we cannot prevent an earthquake or a hurricane from occurring, or a volcano from erupting, we can apply the scientific knowledge and technical know-how to issue early warnings on volcanoes and cyclones and organize proper community response to such warnings.

1.1 **Science as an Enterprise**
The Science and Technology (S&T) knowledge based on experimentation and observations help us to understand the mechanism of natural hazards of atmospheric, geological, hydrological, and biological origins and to analyze how these hazards are transformed into disasters. As disaster is the act of the violent forces of nature, what is the nature of these forces, how are they gradually built up, this whole body of knowledge made up of orderly system of facts, should be learned through study, experiments and observations on floods, severe storms, earthquakes, landslides, volcanic eruptions and tsunamis, and their impacts on humankind (life and property) and his living environment.
1.2 Relevant S&T Disciplines

For the policy makers, science should be considered as the knowledge based enterprise vitally important not just for supporting mitigation, preparedness and response measures, but for the development of policy at the highest levels of government and providing the evidence of the benefits that are derived from investing in disaster risk reduction. The scientists, on their part, are to ensure that the science they are talking about is “useful, usable and used” in disaster risk reduction. To substantiate this assertion, a case study from Bangladesh is explained later.

![GIS-based Information Data for hazard mapping of SIDR Affected areas](image)

Figure 1: GIS-based mapping of SIDR affected areas in Bangladesh

The scientific and technological disciplines which are involved in disaster management include the basic disciplines of science (physics chemistry, biology) and engineering (civil, electrical, mechanical), earth science, social science and health science. They are generally applicable to 3 environmental situations, namely, (i) natural environment where from the hazards originate. The applicable science disciplines include hydrology, geology, geophysics, seismology, volcanology, meteorology, and biology, (ii) the man-made environment such as the human habitat and
ecology. The relevant disciplines are chemistry and materials, engineering, and architecture, and (iii) policy and administrative environment where the applicable disciplines are sociology, humanities, political science, and finance and management science.

1.3 Post-disaster Task (Immediate)
To combat the post-disaster situation, the basic task is to organize the humanitarian logistics comprising of acquisition and delivery of requested supplies and services, at the places and times they are needed. This chain of activities must ensure that the operation has made the best value of the money spent for the purpose, because in such situation resources are always in scarcity. And the supplies are only those which are essential for survival such as food, water, temporary shelter and medicine, among others like restoration of services like water and sanitation, roads and electricity, so that the community can return to normalcy at the earliest. This is achieved through the coordinated efforts of the government, non-government and international agencies/departments, particularly, IFRCS (International Federation of Red Cross Societies).

2. Nature of Disasters: Some Examples
2.1 Hydrological: The Cyclone Aila
The Cyclone Aila originating from the Northern Indian Ocean during 2009 hit 11 south western districts of Bangladesh coastal region on 25 May and it lasted for 15 hours. It brought with it tidal surges of up to 6.5 metres, affecting 11 coastal districts. This surge of water damaged and washed away over 1,742 km of embankments, the only protection available to many people along the coast. It was after 2 years of the Sidr event of 2007; so the impact far increased with longer time sufferings.

Impact of Aila
The direct and immediate impact of Cyclone Aila resulted in 190 deaths and approximately 7,100 injuries. In total, over 3.9 million people were affected. Some 100,000 livestock were killed, and nearly 350,000 acres of crop land were destroyed. It also caused considerable infrastructure losses. The economic loss from Cyclone Aila, which hit Bangladesh's southwestern coast on May 25, was estimated at 18.85 billion taka (about 269.28 million U.S. Dollars)
reported by the Disaster Management Ministry of GoB. The total international donor assistance was 44.25 million US Dollars. The post-event recovery, relief, rehabilitation and reconstruction phases of activities where relevant science and technologies are to be applied depends on the nature, areas and intensity of the damage that have been inflicted upon the people and their livelihood by the cyclone. Degradation of water quality caused by Cyclone Aila in 2009 resulted in salinity intrusion and a decline in access to safe water sources, especially during pre-monsoon seasons when frequency of waterborne diseases increase.

**Emergency Response Plan**

Take the case of about 100,000 people who were forced into slum-like settlements on damaged and broken embankments, where health and sanitation services were not available and nearly 350,000 acres of crop land were lost. The immediate response plan of the government is to provide relief and supplies to the affected people in the form of food, shelter, medicine and safe drinking water; in addition to restoration of other services like water and sanitation, roads and electricity, so that the community can return to normalcy at the earliest. This was achieved through the coordinated efforts of the government, non-government and international agencies/departments.

**Science and Technology**

The ultimate objective of disaster management plan in the reconstruction phase is to “build it better” to make a resilient future. Here, the science and technology blended with social science and management science do help support the national government, the policy and decision makers to build better and resilient future of the country, with their up to date knowledge required for disaster risks reduction.

In the two cases mentioned above, the relevant S&T are embankment construction engineering to reconstruct the washed away protective embankments (Civil and Mechanical and Hydraulic Engineering) and crop and soil sciences for cultivation in saline soil (Agriculture). In the cyclone affected coastal region of Bangladesh, salinity in crop land with long standing stagnant water could be as
Use of Science and Technology in Disaster Management

deep as five feet. Space Research and Remote Sensing Organization (SPARRSO) developed this cyclone tracking technology and applied it to track Aila Cyclone movement (Figure 2).

Figure 2: Cyclone tracking by satellite imaging technology

2.2 Alaska Oil Spill in 1989: Environmental

Figure 3: Alaska Oil Spill clean-up operation
Impact assessment
Delayed efforts to contain the spill and naturally strong winds and waves dispersed nearly 11,000,000 gallons (41,640 kilolitres) of North Slope crude oil across the sound.

Water pollution
The spill eventually polluted 1,300 miles (2,092 kilometer) of indented shoreline, as well as adjacent waters, as far south as the southern end of Shelikof Strait between Kodiak Island and the Alaska Peninsula.

Cost of cleanup
Thousands of workers and volunteers helped to clean up after the oil spill, and Exxon provided $2.1 billion in funding. Government response: In 1990 the U.S. Congress passed the Oil Pollution Act in direct response to the Exxon Valdez accident.

2.3 Oil Spill in Pasur River in Khulna, Bangladesh, Dec 2014

Figure 3: Oil spill in Pasur River in Khulna

Impact Assessment
About 350,000 litre of furnace oil spilled in the river will cause serious ecological disaster in the biggest mangrove forest in the world. The oil tanker sank after being hit by another vessel spread around 20 kilometer of Shela River. The situation became worse because, the forest department and Mongla Port Authority had no tools to control or clean up the oil spill.

- Oil spills impact heavily water quality and coastal ecosystem, aquacultures and shoreline forest resources;
- Oil spills reduce the amount of oxygen in water, creating
crisis for all the aquatic animals including the dolphins;
- Plants and aquatic resources of the mangrove forest would be fatally harmed; and
- Tidal effect on spill spread is very critical, depending on the time of the occurrence, low tide or high tide to control downstream water flow.

**Approach to Disaster Management**
- Develop comprehensive contingency plans and emergency response plans;
- Develop water modeling for spill dispersion mapping, water quality assessment;
- Sensitivity mapping for flora and fauna;
- River flow measurements and wind flow study;
- Satellite imaging of oil spill;
- Environmental impact assessment for regulatory control of oil spill and pollution, etc.; and
- Prepare manuals for environmental management.

**Institutional Coordination:**
- **Ministries:** Ministry of Shipping, MoEFCC, LGRD Ministry.
- **Research Organizations:** IWM, SPARRSO.
- **Administration:** Administrative systems at the Thana and Upazilla levels, Community based organizations.
- **NGOs:** Local and International NGOs and Other Volunteer Service Organizations, etc.

**2.4 River Bank erosion in Padma River: Hydrogeological**

![River Bank erosion in Padma](figure4.jpg)

Figure 4: River Bank erosion in Padma, 2018
Impact
In 2018 the Centre for environmental and geographic information services reported land loss of 2,270 hectares due to river bank erosion. This loss comprised agricultural land, households, embankments and governmental and semi-governmental structures along the river banks.

2.5 Environmental Degradation: Shortage of Freshwater in Bangladesh

Figure 5: Per capita freshwater available in Bangladesh

Impact
Pollution of the rivers flowing around the Dhaka city has reached such a level that water from these rivers are not treatable ‘MOST OF THE YEAR’ to supply drinking water to the Dhaka city dwellers.

3. Application of Science and Technology in Disaster Management
Natural disasters had been occurring at different geological timeframes with different frequencies. So, they cannot be completely avoided. But with increasing S&T knowledge in the field, the suffering of the people can be minimized by creating proper awareness of the likely disasters and its impact by developing a suitable warning system, disaster preparedness and management of disasters through the application of information technology tools. Some of these examples are discussed in the following sections.
3.1 GIS Information and Remote Sensing Technology
GIS provides a tool for effective and efficient storage and manipulation of remotely sensed data and other spatial and non-spatial data types for both scientific management and policy oriented information. This can be used to facilitate measurement, mapping, monitoring and modeling of variety of data types related to natural phenomenon.

![Map estimating the levels of exposure of the different countries to natural hazards](image)

Figure 6: Mapping of global disaster exposure

The specific GIS application in the field of Risk Assessment is: Hazard Mapping to show earthquake, landslides, floods or fire hazards. Theses maps could be created for cities, districts or even for the entire country and Tropical Cyclone Threat Maps are used by meteorological departments to improve the quality of the tropical storm warning services and quickly communicate the risk to the people likely to get affected by the cyclone.

Remote sensing makes observation of any object from a distance. Remote sensing comprises Aerial Remote Sensing which is the process of recording information, such as photographs and images from sensor on aircrafts and Satellite Remote Sensing which consists of several satellite remote sensing system that can be used to integrate natural hazard assessments into development planning studies. These are: Land Sat, SPOT Satellite, Satellite Radar System, Advanced Very High Resolution Radio. Bangladesh SPARRSO has the Land Sat Satellite System of remote sensing. GIS
can also be used in carrying out search and rescue operations in a more effective manner by identifying areas that are disasters prone and zoning them accordingly to risk magnitudes.

### 3.2 Web Services: Internet

In the present era of electronic communication, the internet provides a useful platform for disaster mitigation communications. Launching of a well-defined website is a very cost-effective means of making an intra-national and international presence felt. It provides a new and potentially revolutionary option for the rapid, automatic, and global dissemination of disaster information. A number of individuals and groups, including several national meteorological services, are experimenting with the Internet for real-time dissemination of weather observation, forecasts, satellite and other data. In the most critical phase of natural disasters electronic communication have provided the most effective and in some instances perhaps the only means of communication with the outside world.

### 3.3 Warning and forecasting system

An advance system of forecasting, monitoring and issuing early warnings plays the most significant role in determining whether a natural hazard will assume disastrous proportions or not. Indian Meteorological Department (IMD) provides cyclone warnings from the Area Cyclone Warning Centers (ACWCs) where the centres are located. It has developed the necessary infrastructure to originate and disseminate the cyclone warnings at appropriate levels. It has made operational a satellite based communication system called Cyclone Warning Dissemination System for direct dissemination of cyclone warnings to the cyclone prone coastal areas.

### 3.4 Seismological Observations

Seismological observations in India are made through national network of 36 seismic stations operated by the IMD, which is the nodal agency. These stations have collected data over long periods of time. Flood forecasts and warnings are issued by the Central Water Commission (CWC), Ministry of Water Resources. These are used for alerting the public and for taking appropriate measures by concerned administrative and state engineering agencies in the flood...
hazard mitigation. Information is gathered from the CWC's vast network of Forecasting Stations on various rivers in the country

4. Case Study of S&T Application in DRR in Bangladesh

Cyclone: Bangladesh has a significant history of large-scale disasters including Cyclone Bhola in 1970, which resulted in approximately 300,000–500,000 deaths and Cyclone Gorky in 1991 with approximately caused 138,000 deaths.

The Government of Bangladesh worked in partnership with donors, non-governmental organizations, scientific and humanitarian organizations and coastal communities to develop:

- Multi-storied cyclone shelters, built in coastal regions, providing safe refuge from storm surges for coastal populations;
- A Storm Warning Centre with the capacity to detect the formation of tropical depressions in the Bay of Bengal and send early warnings and special bulletins to alert a wide range of user agencies; and
- A volunteer network to effectively disseminate cyclone warnings among the coastal communities, enabling time-critical actions on the ground such as evacuation to cyclone shelters.

In 2007, these resources were implemented prior to the landfall of Cyclone Sidr. Three million people were safely evacuated to cyclone shelters. Sidr resulted in approximately 4,200 deaths - a reduction in mortality from previous Cyclones.

5. Conclusion

5.1 In the new century it has been amply demonstrated that Information Technology in the form of Internet, GIS, Remote Sensing, Satellite imaging & communication, etc. can help a great deal in planning and implementation of hazards reduction plans. For maximum benefit, new technologies for public communication should be used and natural disaster mitigation messages should be conveyed through these measures.

5.2 GIS-based data information can improve the quality and power of analysis of natural hazards assessments, guide development
activities and assist planners in the selection of mitigation measures and in the implementation of emergency preparedness and response actions.

5.3 Remote Sensing, on the other hand, as a tool can very effectively contribute towards identification of hazardous areas; monitor the planet for its changes on a real time basis and give early warning to many impending disasters.

5.4 Communication satellites have become vital for providing emergency communication and timely relief measures. Integration of space technology inputs into natural disaster monitoring and mitigation mechanisms is critical for hazard reduction.

5.5 It is absolutely necessary to create awareness amongst the public as well as the decision makers for allocating resources for appropriate investments in information technology. Awareness and training in information technology in a much greater measure is required to develop human resources, particularly in the developing countries which chronically suffer from natural disasters.

5.6 The disaster mitigation programmes must be extensively taken up covering various aspects at national level to minimize the disaster damages. There should be a greater emphasis on development of new technologies in disaster mitigation. The disaster preparedness and awareness is the only effective way of mitigating the impact of future disasters.

5.7 To conclude, without science and technology and their blending with other disciplines such as social sciences and humanities, there can be no world safer from natural disasters.

5.8 Application of S&T knowledge can show and guide us the ways and means to avoid or reduce many of the effects of natural hazards. International Strategy for Disaster Reduction (ISDR) has been developed under UN STDR strategic program. Advanced computational science provides solutions to many disaster problems.
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A CRITICAL REVIEW ON WATER GOVERNANCE GAPS IN BANGLADESH

Syed Hafizur Rahman1, B M R Faisal2, Sheikh Tawhidul Islam3

ABSTRACT

This paper aims to outline the gaps regarding water governance for Bangladesh from the experience of Asia Water Governance Index (AWGI) which was proposed by Araral and Yu in 2010 and from country baseline survey on water integrity issues in 2014. Twenty indicators have been evaluated in the dimension of water law, water policy, and water administration in order to appraise the status of Bangladesh. It has been found that, among twenty variables, eleven variables like surface water property right, accountability of water sector officials, decentralisation tendency within water law, legal framework for integrated treatment of water sources, pricing policy, water law and water policy linkage, finance for water investments, functional capacity and balance, validity of water data and science and technology application have been in unacceptable status compare to the top countries (Australia, Singapore and Japan). The rest nine indicators have moderate upgrading scenario compare to the top countries. The country baseline assessment states that the existing law/policy/legislation and water institution covers the issues like water rights, equitable sharing and gender participation in the legislative frameworks and in organizational instructions but corruption, accountability and transparency aspects are not clearly specified or not pertinent in some cases. From the experience of AWGI and baseline water integrity survey, these identified issues should be prioritized to improve the water governance in Bangladesh.

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Keywords: Asia Water Governance Index (AWGI), Water Law, Water Policy, Water Administration

Introduction
Water governance is the compilation of political, social, economic and administrative system that is placed in developing and managing water resources as well as the water services at different levels of society (GWP 2002). Water governance incorporates the mechanisms, processes, and institutions by which all stakeholders such as government, the private sector, civil society, pressure groups by their competencies can give their ideas and express their priorities, rights, and obligations (Johannes and Van 2015). The good water governance perceives on the notion of equity, efficiency, participation, decentralization, integration, transparency and accountability (GWP 2001). According to Briscoe (2009), rapid population growth, increased water demand, dependency on agriculture, more frequent floods and droughts, the small donation of water infrastructure and fragile institutions and more uncertainties arising from climate change are the problems that are suffered by the developing countries. In this regards various water scholars, policy makers, and donors stated that improving water integrity is one of the key solutions to water insecurity in developing countries like Bangladesh (Rogers and Hall 2003; Rijsberman 2008; Biswas and Tortajada 2010).

Hence, the National University of Singapore launched the “Asia Water Governance Index (AWGI)” in 2010 which was constructed by weighting and aggregating twenty (20) components including legal, policy and administrative dimensions in the water sector. The purpose of AWGI was to assist water policymakers to learn from one another regarding water laws, policies and administration of the countries. In developing countries like Bangladesh, the problem of water governance is most acute where water management is an important issue due to the increasing demand for water in agriculture (for irrigation), the urban and the industrial sectors, fishery, inland navigation and salinity control (Chowdhury 2010). Therefore, the key challenges for water governance in Bangladesh
includes increased pressure on groundwater sources (Chowdhury 2010), alternation of availability of water for crop production due to the negative impacts of climate change (drought, flood etc.) and natural disasters (Asaduzzaman et al. 2010), and an alarming rise in pollution as well as poor sanitation conditions (World Bank 2005). Therefore, this review work has been initiated to address the water governance status and to find out the gaps of water governance in Bangladesh.

Methodology
The Asia Water Governance Index followed the framework and methods pioneered by Saleth and Dinar (2004) which employed five-step approach: ‘a) establish a theoretical framework, select individual indicators comprising the composite index and collect raw data; b) normalize raw data of varying scales into a commensurable one; c) assign the indicator weights; d) aggregate the weighted indicators into a composite measure and e) check the robustness of the results and extract the uncertainty intervals for empirical analysis’. Sample data based on a survey of hundred water professionals from twenty countries in Asia Pacific where questionnaire survey was concerned with water governance concerning water law, policy and administration (Table 1). Survey data was collected using both offline and online methods. Out of the total 100 data points, 51 came from the Asian portion of the Saleth and Dinar survey-2004 and remaining 49 data points were collected by Asia water governance study in 2009/2010. In total, twenty variables have been considered as the underlying components of water law, policy, and administration (Table 2). From Bangladesh, five water experts named a) Akanda Abdur Razzaque, Engineers Institution of Bangladesh; b) A.K.M. Shamsul Hoque, Bangladesh Water Development Board; c) Shirazul Islam, Bangladesh Engineers’ Institution; d) Nayeb Mond Nayeb Ali, Assistant Secretary, Ministry of Water Resources, and e) Mohammad Hanif Arifur Rahman, Assistant Chief, Ministry of Water Resources participated in this survey.
Table 1: Country coverage and survey response frequency in AWGI

<table>
<thead>
<tr>
<th>Region</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>South East &amp; South Asia</td>
<td>Bangladesh (5), Cambodia (6), India (12), Indonesia (8), Lao PDR (4), Nepal (6), Pakistan (6), Philippines (8), Singapore (3), Sri Lanka (5), Thailand (5), Vietnam (6)</td>
</tr>
<tr>
<td>North East Asia</td>
<td>Japan (5), Korea (1), China - People's Republic (7), Mongolia (1), Taipei-Taiwan (1)</td>
</tr>
<tr>
<td>Central Asia</td>
<td>Uzbekistan (3)</td>
</tr>
<tr>
<td>Oceania</td>
<td>Australia (6), New Zealand (1)</td>
</tr>
</tbody>
</table>

Note-Number in the parenthesis represents the survey response frequency; Source: (Araral and Yu 2010)

In addition, the country baseline assessment on water integrity issues of Bangladesh has been carried out by Rahman and Islam in 2014 following the mixed research techniques such as Key Informant Interview (KII), Group Meetings and Case study. In that study, twenty-two water sectors law/legislation/policy of Bangladesh have been evaluated based on the issues like equitable service provisions, rights to water, voice and choice, gender issues, civil society participation, corruption, transparency and accountability, environmental management, water resources management, monitoring and evaluation and institutionalization and decentralization processes. In a similar approach, seventeen institutions related to water sector planning, governance/management, and service delivery have been reviewed to examine the degree of integrity aspects that are followed in the operational processes.
Table 2: Components of Water Governance

<table>
<thead>
<tr>
<th>Dimension</th>
<th>ID</th>
<th>Component</th>
<th>Definition</th>
<th>Scale (0 to 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>Legal distinction of different water sources</td>
<td>Represents the degree to which varying water sources treated alike or differently by water laws</td>
<td>100 being “Very Different”, 0 being “Alike”</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>Format of surface water property right</td>
<td>Indicates the basis of general right in surface water</td>
<td>No right=0, unclear right=15, common or state property=30, multiple right=45, riparian systems=60, appropriate system=70, correlative system=90, and license or permits=100.</td>
</tr>
<tr>
<td></td>
<td>L3</td>
<td>Legal accountability of water sector officials</td>
<td>Represents the effectiveness of liability provisions by water laws for water officials</td>
<td>100 being ”Highly Accountable”, 0 being “No accountability”</td>
</tr>
<tr>
<td></td>
<td>L4</td>
<td>Decentralisation tendency within water law</td>
<td>Indicates the integration level of water laws with other laws on land, forest, and environment</td>
<td>100 being “Highly Integrated, 0 being “Disharmony”</td>
</tr>
<tr>
<td></td>
<td>L5</td>
<td>Legal scope for private and user participation</td>
<td>Indicated the criteria used in water projects selection and</td>
<td>Response=0, political dictates=15, equity factors=30, ecological</td>
</tr>
</tbody>
</table>
### A Critical Review on Water Governance Gaps in Bangladesh

<table>
<thead>
<tr>
<th>Dimension</th>
<th>ID</th>
<th>Component</th>
<th>Definition</th>
<th>Scale (0 to 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1</td>
<td>Project selection criteria</td>
<td>Indicate the criteria used in water projects selection and how extensively they are applied in irrigation, urban and multi-purpose projects</td>
<td>No response=0, political dictates=15, equity factors=30, ecological factors=50, benefit cost ratio=50, internal rate of return=80, and multiple criteria=100</td>
</tr>
<tr>
<td></td>
<td>L6</td>
<td>Legal framework for integrated treatment of water sources</td>
<td>Represents the extent of the influence of other policies on water policy</td>
<td>100 being “Highly Influential”, 0 being “No Influence”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>how extensively they applied in irrigation, urban and multiple-purpose projects</td>
<td>how extensively they applied in irrigation, urban and multiple-purpose projects</td>
<td>factors=50, benefit cost ratio=70, internal rate of return=80, and multiple criteria=100</td>
</tr>
</tbody>
</table>

### Water Policy

- **P2** Linkage with other policies
- **P3** Pricing policy

Note: Number in the parenthesis represents the survey response.
<table>
<thead>
<tr>
<th>Dimension</th>
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<th>Scale (0 to 100)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>P4</td>
<td>Private sector participation</td>
<td>Represents the level of promotion by water policy on private sector participation</td>
<td>100 being “Very Favourable and Extensive Participation” 0 being “Unfavourable and Low Participation”</td>
</tr>
<tr>
<td></td>
<td>P5</td>
<td>User participation</td>
<td>Indicates the level of promotion by water policy on user participation and decentralisation</td>
<td>100 being “Very Favourable and Extensive Participation” 0 being “Unfavourable and Low Participation”</td>
</tr>
<tr>
<td></td>
<td>P6</td>
<td>Linkage between water law and water policy</td>
<td>Represents the extent of the linkage between water legislation and water policy</td>
<td>100 being “Tightly Linked”, 0 being “No Linkage”</td>
</tr>
<tr>
<td></td>
<td>P7</td>
<td>Attention to poverty and water</td>
<td>Represents how well the concerns of the poor are reflected by water policy and</td>
<td>100 being “very attentive” o being “careless”</td>
</tr>
<tr>
<td></td>
<td>P8</td>
<td>Finance for water investments</td>
<td>Represents the adequacy of funding available for current and future water investments</td>
<td>100 being “Highly Adequate”, 0 being “Inadequate”</td>
</tr>
<tr>
<td></td>
<td>A1</td>
<td>Organisational basis</td>
<td>Shows the foundation upon which water administration is organised</td>
<td>Administrative division=25, on hydrological regions=75, on river basins=100 and mixture of all=50</td>
</tr>
</tbody>
</table>

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A Critical Review on Water Governance Gaps in Bangladesh

<table>
<thead>
<tr>
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<th>ID</th>
<th>Component</th>
<th>Definition</th>
<th>Scale (0 to 100)</th>
</tr>
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<tbody>
<tr>
<td>A2</td>
<td>Functional capacity and balance</td>
<td>Indicate whether or not functional specialisation within water administration is balanced</td>
<td>100 being “Highly capable and Balanced”, 0 being “Incapable and Unbalanced”</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Existence of independent water pricing body or apex body</td>
<td>Represents the existence of independent institutions for determining water price</td>
<td>100 being “Highly Existence”, 0 being “Non Existence”</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Accountability and regulatory mechanism</td>
<td>Represent the effectiveness of accountability and regulatory arrangements imposed on water administration</td>
<td>100 being “Highly Effective”, and 0 being “Ineffective”</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Validity of water data</td>
<td>Represents the adequacy and reliability of water data for planning purposes</td>
<td>100 being “Highly valid”, 0 being “Invalid”</td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Science and technology application</td>
<td>Indicates the extent to which the science and technology components are used within water administration</td>
<td>100 being “Very Extensive, 0 being “Very Low”</td>
<td></td>
</tr>
</tbody>
</table>

Source: (Saleth and Dinar 2004)
Given the objectives adopted for the present study, relevant information has been collected and collated from a range of sources like global and regional documentation related to water governance index, country-specific documentation in water management issues and various academic papers. Moreover, a wide range of books, articles, newspaper clippings, research documents, seminar papers, concepts notes and relevant websites have also been reviewed.

**Review Outcome**

The status of Bangladesh in terms of water integrity issues has been evaluated from the experience of AWGI (Figure 1) and water integrity country baseline assessment report (Figure 2). In the dimension of water law, water policy, and water administration the situation of Bangladesh in the context of water integrity issues have been discussed below:

**Water Law**

The legal distinction of different water sources (L1) represents the degree to which varying water sources treated alike or differently by water laws. In this issue, the position of Bangladesh is quite well in AWGI but not up to the standard mark because the water sources should be treated as very different. In terms of the format of surface water property right (L2), the surface water is considered as common or state property in Bangladesh whereas the top countries consider it as multiple rights and show improved scenario. In legal accountability of water sector officials (L3), the effectiveness of liability provision by water laws for water officials is not highly accountable but the top countries are improving their status though they are not highly accountable at present. The country baseline assessment also identifies the accountability of water sector officials as a gap of existing laws of Bangladesh (Figure 2). In the case of decentralization tendency within water law (L4), the integration level of water laws with other laws on land, forest, and the environment is substandard because the functional roles and responsibilities are not clear and the relationships between the stakeholders are not governed by written procedures, agreements or contracts. On the other hand, the top countries are improving their level. The status of Bangladesh in respect of legal scope for private
and user participation (L5) is the same compared to the top countries and presently ecological factors are considered for water projects selection. The baseline survey similarly found disappointing findings in project selection criteria and the extensiveness of application in irrigation, urban and multiple-purpose projects. The legal framework for the integrated treatment of water sources (L6) represents that the extent of the influence of other policies on water policy is not so persuasive compared to the standard level. The position of Bangladesh in terms of water law need to be improved because the many of the policies and governmental frameworks were introduced in Bangladesh when the water sector challenges were comparatively simple and less challenged but now a day’s problems and difficulties become complex and multidimensional nevertheless policies remain in the same state as it introduced in earlier times.

![Comparison of Bangladesh with Top Three Countries in Water Governance Scores](image)

Figure 1. Comparison of Bangladesh with top three countries (Australia, Singapore and Japan) in water governance scores

**Water Policy**

The review of water policy in Bangladesh from the 1950s to the present, states the absence of policy instrument to address the water governance (Chan et. al 2016). Besides several existing water related policies are out-of-date in terms of addressing rapid environmental change, although Bangladeshi water policies are
partly integrated with environmental issues such as agriculture and sanitation but the issues of climate change are completely ignored (Rahman and Islam 2014 Chan et. al 2016).

Concerning project selection criteria (P1), Bangladesh has modest upgrading scenario compared to the top countries though it requires shifting upward from present status. Bangladesh is now at the stage of considering the ecological factors and some sort of benefit-cost ration in irrigation, urban and multi-purpose projects but multiple criteria should be followed to improve the present status. In the case of P2, the influence of other policies on water policies is not up to the mark though Bangladesh has the better scenario than the others but we need to increase the linkage between water policy and other policies. The baseline survey also reported the communication gap among the legal bodies. Regarding the pricing policy (P3), the extent of cost recovery by tariffs is not highly influential whereas the top countries have improved the scenario. On the subject of P4, the level of promotion by water policy on private sector participation is reasonably unfavourable and low participatory as it is required to be favourable and extensive participation. The baseline survey also found the non-appearance of civil society in their study. In the case of user participation (P5), the status of Bangladesh and the top three countries is unacceptable and requires huge improvement to achieve the benchmark. However, decision making in Bangladesh is highly centralized whereas long-term and systematic stakeholders’ engagement for transparent decision making and effective water management is hardly practiced (World Bank 2010). The reviews of water-related policy/law/legislation also mention the ineffective public participation in several cases and pointed out as water sector integrity gap (Figure 2).

In P6, the extent of linkage between water legislation and water policy is quite satisfactory in top three countries whereas the status of Bangladesh is disappointing and requires a lot of improvement. In terms of P7, the concern of the poor are not reflected satisfactorily in Bangladesh as well as in top countries and are well below the standard. It means that the concerns of poor are not A
adequately redirected by existing water policy. In finance for water investments (P8), the availability of fund for current and future water investments is quite adequate in top countries whereas the status of Bangladesh is not apposite. Apropos water policy dimension, Bangladesh is found critical about pricing policy, the linkage between water law and water policy, finance for water investments. The reason may be the plans become overcrowded that stand as non-coordinated manner where the weakness of expertise of staff, unclear obligations, people's involvement and economic feasibility is absent. But on the topic of project selection criteria, linkages with other policies and attention to poverty and water Bangladesh have dependable improvement status than the others.

**Water Administration**

Organizational basis (A1) shows that in Bangladesh and top countries the water administrations are organized on the basis of the mixture of hydrological regions, river basin, and administrative region. But the water administration should be based on the specific region and it would be better if it totally related to the river basin. In terms of A2, functional specialization within water administration is not highly capable and balanced whereas the top countries have improved condition and heading towards achieving the expected standard. The baseline water integrity survey also indicates the imbalance situation of different water service organizations. In Bangladesh and top scored countries, the existence of independent institutions for determining water price (A3) is not functioning. In the case of A4, the effectiveness of accountability and regulatory arrangements imposed on water administration in Bangladesh seems to be ineffective but top countries show improving scenario. The baseline study also stated that many financial corruption issues have been reported in government internal audit reports but actions are rarely taken which paves the way to decrease the accountability and transparency of different water officials. However, Bangladesh has strong elements of democracy, e.g., freedom of the press and media but lacks of transparency and accountability in environmental decision-making processes have been recognized (Rouillard et al.)
Rahman et al.

2014). It needs to be highly effective as it would be helpful to decrease the corruption practices within the water administration. A5 shows that the adequacy and reliability of water data for planning purposes is quite satisfactory at the same time the status of Bangladesh is also improving. In terms of A6, the extent of using science and technology components within water administration in Bangladesh is not reasonable whereas the top countries are showing extensive application scenario.

In the dimension of water administration, severe gaps have found compared to the developed countries regarding functional capacity and balance, accountability and regulatory mechanism, a validity of water data, science and technology application. From the understanding of country baseline survey, it can be mentioned that the water sector agencies are performing multiple tasks with limited resources where insufficient human resources for certain tasks as well as skill gaps among the staff are major concerns for public companies which finally contribute to inefficient and ineffective water service delivery to the public. Besides many useful policies and acts are in existence but lacks useful guidelines that can translate the specific message for everyday practice by the employees. However, Bangladesh has acceptable realization concerning organizational basis and existence of independent water pricing body or apex body compare to others.

Discussion

Among the twenty AWGI indicators, eleven indicators have enormous gaps compared to the top countries though the status of these countries is not up to the standard. From the experience of AWGI, Bangladesh needs to improve the water governance issues in respect of A2, P6, P8, P3, L6, A4, L3, L2, L4, A6, and A5 indicators as the status of Bangladesh in these issues are critical compared to the top countries. On the other hand, nine indicators show modest scenario compared to the other countries. Among these nine indicators, five indicators L1, L5, P1, P2, and P4 shows improve situation than the developed one. The reasons behind this critical position may be the lack of water resource constraint, Critical
incompetency of the responsible person, absence of accountability and transparency of water sector officials, public participation in the decision-making process and institutional coordination gaps. Some reasons for this lack of coordination includes the lack of information and data sharing by the government, non-existence of guidelines or action plans for integrating water development projects with the major water consumers and the difficulties of harmonization and alignment of foreign aids from development partners and donor organizations (Chan et. al 2016).

In addition, the deterioration of water quality due to the uses of agrochemicals, industrial waste and arsenic contaminations of groundwater have been reported (MICS 2010). As anticipated, internal renewable water resources status of Bangladesh (less than 1700 m³/inhabitant) show the indication of water stress and total actual renewable water resources scenario point towards the slowly approaching a situation of chronic water scarcity (threshold 1000 m³/inhabitant per year) (Frenken 2012). On the other hand, Bangladesh is now widely documented as the most vulnerable countries to climate change and natural hazards (Rahman et. al 2016) which would likely to affect the accessibility of both surface water and groundwater and hence the investments are needed to ensure an uninterrupted and sustainable access to water resources (Frenken 2012). Multiple Indicator Cluster Survey 2009, presumed that the accesses to improved water sources are more likely to provide safe water equally access to safe drinking water is a basic necessity for good health.
Hence, in order to progress the accountability of water sector official’s water sector information needs to be made more versatile and easily understandable so that people can use it as a tool to demand efficient services from public agencies. In addition active supervision, regulation and management of water sector activity may help to promote anticorruption practices. Joint program among the water institution by developing proper operational guidelines may reduce the institutional gap which can contribute to improving the water governance score in some extent. Moreover, the lack of real implementation of most of the policies is a considerable burden to the holistic improvements in water governance as the policies are prepared on the basis of national ideals that lack empirical Critical
assessment (Mandal 2006). In Bangladesh, thus far no policy or act has been formulated related to the irrigation or water management, however, in recent years the minor irrigation and water management issues have been mentioned in national agriculture policy, national water policy and the national water management plan (Frenken 2012). Nevertheless, the government of Bangladesh has created policies to address water governance issues but very little attention has been paid to how these policies will be implemented at the local level (Pal et al 2011). Likewise, to stimulate economic development in South Asia, water could be effectively used as the engine but this has been stuck in the most populous part of the basin (Bangladesh, India, and Nepal) by their inability to agree to an integrated development plan (Biswas and Uitto 2001).

Therefore it is required to improve the water governance scenario of Bangladesh by improving the present difficulties and gaps which have been identified in this study. Hence, improve implementation practices, monitoring and evaluation mechanisms of different water project may increase the scope of water integrity improvement in developing countries like Bangladesh. Because the better water governance is the key to meet the social challenges (attaining equity in access to safe water, reducing the poor’s vulnerability to water-related diseases and disasters, equality for women); the ecological challenges (ensuring the sustainable use of water and protecting the resource to sustain lives on the planet); the capacity challenges (building the capacity of the decentralized, community-based structures to improve the effectiveness of service delivery) and the economic challenges (social and economic benefits from available water resources, efficient allocation and use of water resources, enhancing a significant expansion of services) (UNDP 2004).

**Conclusion**
The water governance status of Bangladesh in AWGI concludes that Bangladesh has significant lacking in terms of functional capacity and balance, water policy linkage, water investments, pricing policy, legal framework for integrated treatment of water sources, accountability of water sector officials, surface water right,
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decentralisation tendency within water law, science and technology and validity of water data. On the other hand, Bangladesh shows improvement scenario regarding legal distinction of different water sources, the legal scope for private and user participation, project selection criteria and private sector participation but still remain below the acceptable standard. The review from water sector policies and institutions resulted that water rights, equitable sharing, and gender participation are some extent covered in the legislative frameworks and in the organizational mandates but corruption, accountability and transparency aspects are not clearly spelled out or not applicable in some cases. Hence, to improve the present water governance status of Bangladesh the identified issues from AWGI and country baseline assessment need to be addressed in relevant sector ranges from policy formulation to the implementation.

Acknowledgement
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References
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In addition, the country baseline assessment on water integrity occupy more of Bangladesh's social space is not a mere conjecture. There are signs that the potentiality of the environment movement to ever take the form of political party and contest in elections. The environmentalist party of that country, example in this respect. The environmentalist party of that country, a) Ill conceived projects: Often the projects themselves are ill the environment movement emerged in Bangladesh in the nineties. environment-related projects. The flurry of activities generated by ecological challenges (ensuring the sustainable use of water and Bangladesh by improving the present difficulties and gaps which has been formulated related to the irrigation or water management, assessment (Mandal 2006). In Bangladesh, thus far no policy or act Water Policy


THE BROADER SIGNIFICANCE OF THE ENVIRONMENT MOVEMENT IN BANGLADESH

Nazrul Islam

ABSTRACT

The paper argues that unlike in some other countries, the environment movement in Bangladesh may have a broader significance. This is because there is a vacuum in effective representation of public interests in the country, resulting from degeneration of many traditional social organizations. The environment movement can fill up this vacuum to a certain extent and thereby have a broader influence on the social life. Apart from being inherently forward looking, the environment movement is displaying such appealing features as unity, self-reliance, spirit of volunteer work, and subordination of partisan interests to broader national interests. These are precisely the qualities that the people want to see in their representative social organizations. Together with certain recent positive changes in Bangladesh society, the environment movement can therefore conduce to a process of social regeneration.

Keywords: Environment Movement, Bangladesh, Significance

Background of the Environment Movement in Bangladesh

The effort to protect environment in Bangladesh is both old and new. As in other traditional, pre-industrial societies, the life of common Bangladeshi people was tied closely with the rhythm of nature. The economy was primarily agrarian, and agriculture was entirely organic. People had a deep reverence for nature, and they had a harmonious co-existence with the natural environment. There wasn’t much of the antagonism between nature and human economic activity that is characteristic of industrial production. In this pre-industrial sense, love for natural environment among the people of Bangladesh runs quite deep, has existed from before, and is nothing new.

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However, the environmental protection effort in its post-industrial sense is of recent origin in Bangladesh. The beginnings can be traced to the 1980s. Several developments took place in that period. First, a separate Ministry for Environment and Forests (MoEF) was created. This replaced the small Department of Environment and Pollution Control (DEPC) that existed before within the ministry of Local Affairs. Second, many non-government organizations (NGO) emerged with environmental protection as their main goal. Many general-purpose NGOs also incorporated environmental protection as one of their lines of activity. Third, some research and consulting organizations emerged with study of environmental issues as the main focus.

These developments took place in the backdrop of serious environmental degradation that Bangladesh was witnessing particularly beginning with the eighties. The quality of urban air began to plummet. The problem of chemical run-off to surface water bodies became rampant. The problem of appropriate disposal of household, industrial, and medical waste started to become acute. Forests, wetlands, and open spaces began to disappear fast. Loss of aquatic and terrestrial bio-diversity became marked. The problem of arsenic contamination of ground water began to surface. It was natural that some sections of the Bangladeshi society felt alarmed by these disturbing trends and came forward with some plans and activities.

However, as with many other recent phenomenon in Bangladesh, there was also an important donor-induced element in these developments. By the eighties, both the issue of environmental quality and the environmental movement have become prominent in developed countries. Accordingly, international aid agencies working in Bangladesh started paying attention to and earmark some of their resources for pro-environment activities. Also the UN sponsored several processes of inter-governmental deliberation for reaching agreements on environmental issues. For various reasons, Bangladesh government was enthusiastic to participate in these processes.

As a result of these international and domestic processes,
environmental protection emerged as a noticeable issue in the eighties. An important step in this regard was the formulation of the National Environment Management Action Plan (NEMAP) by the ministry of environment with participation by some NGOs and other organizations. The NEMAP led to the UNDP funded $26 million Sustainable Environment Management Project (SEMP) with twenty-one different components implemented by different Sub Implementation Agencies (SIA). In addition, the World Bank and the Asian Development Bank came forward with several environment-related projects. The flurry of activities generated by these projects and the involvement of a significant number of people with pro-environmental activities through their association with these projects were important elements of the background in which the environment movement emerged in Bangladesh in the nineties.

The Broader Significance of the Environment Movement in Bangladesh

The question that may rightly arise is, Given all the government projects, NGO activities, etc., why does Bangladesh need a civic environment movement? The answer lies in the fact that environment in Bangladesh continues to deteriorate, indicating that the above projects and activities are not proving adequate for meeting the environmental challenge that the country faces. There are a variety of reasons for this inadequacy. Among these are:

a) Ill conceived projects: Often the projects themselves are ill conceived. Instead of addressing the main problem, they often focus on peripheral aspects and are designed to a large extent to serve vested interests.

b) Improper implementation of projects: Even when environmental projects are well conceived, these are often not implemented well. Newspapers frequently report horror stories of mismanagement and misappropriation of project funds. Recently the government even had to suspend the UNDP financed SEMP project because of serious allegations of mismanagement and misappropriation.

c) Absence of right policies: Often solution to environmental problems does not require projects, which in Bangladesh generally involve foreign loans. Instead the solution often lies in right policies. There is however an in-built bias towards projects (and away from policies) because projects in their wake bring funds and thus create
opportunities to make money either legally or illegally.
d) Lax execution of policies: Even when right policies and rules are adopted, these are often not implemented properly because of inefficiency and corruption. In many cases necessary institutional arrangements, such as environmental courts, necessary for enforcing the adopted rules are lacking.
e) Fragmentation and weakness of authority: Often the authority necessary to deal with an environmental problem is fragmented across several government ministries and departments. Frequently, the environment ministry finds itself weak in power vis-à-vis other ministries such as of industry, trade, and communications.
f) Overlap and duplication: In some cases there are unnecessary duplication of activities by government agencies and NGOs.

This list of shortcomings of efforts to confront environmental degradation in Bangladesh can be made longer. However, it is clear that an underlying cause for all these shortcomings is the absence of a strong social movement for environmental protection. Until recently, environmental protection in Bangladesh remained a business mainly of the government agencies and some NGOs. There was little participation of broader sections of the society in pro-environmental efforts. Yet experience shows that good policies for environmental protection are not always adopted and implemented properly unless there is a social pressure to do so.

The experience of developed countries also vindicates this conclusion. The improvements of environmental quality in developed countries did not come about automatically. Numerous citizens’ groups had to work hard for these changes. It is because of their persistent efforts that a strong social pressure now exists in developed countries for environmental protection. A similar process has to unfold in Bangladesh.

The Genesis of the Bangladesh Environment Movement
It is encouraging that, by the turn of the century, a voluntary civic environment movement has taken shape in Bangladesh. There have been several forerunners of this process. One of these was the civic environmental organizations that emerged in early 1990s. The most
The Broader Significance of the Environment Movement in Bangladesh

important among them was Poribesh Rokkha Shopoth (POROSH), formed by a collection of important environment-conscious citizens of the country. By the second half of 1990s, POROSH was already organizing citizens’ campaigns for protection of Dhaka’s lakes, greenery, and air. POROSH earned some name recognition through these campaigns. Another such civic organization is Doctors for Health and Environment (DHE), formed to mobilize doctors and other health-care workers for environment protection efforts.

Several specific issue-based movements served as another forerunner of the environment movement. The most prominent among these was the movement to save trees of the Osmany Uddyan. This movement proved successful in persuading the government to change the venue of the Non Aligned Movement (NAM) Convention Center from Osmany Uddyan to Sher-e-Bangla Nagar. There were specific issue-based movements outside Dhaka too. One of these was in Jessore to save Bil Dakatia. Another example is the movement against adverse environmental consequences of shrimp cultivation in the coastal areas of Khulna district.

Alongside these civic and issue-based movements, the press and media played an important role in the emergence of environment movement in Bangladesh. Several newspapers indeed played a very positive role. Environment conscious journalists also formed their associations and became active in different ways.

Environment conscious non-resident Bangladeshis (NRB) played an important role in the genesis of environment movement of Bangladesh. In 1998 they set up Bangladesh Environment Network (BEN) to mobilize the NRB input and channel it to sincere pro-environment civic forces inside Bangladesh. It was BEN’s observation that pro-environment forces of Bangladesh were not proving effective, because they were too scattered. Accordingly, in 1999 BEN put forward the idea of holding a comprehensive conference on environmental problems of Bangladesh with the purpose of bringing all pro-environment forces of the country together. POROSH endorsed the idea, and BEN and POROSH together reached out to other pro-environment organizations of the country. The idea of the conference received widespread support,
and ultimately about fifty pro-environment organizations and establishments came together to hold the International Conference on Bangladesh Environment (ICBEN) on January 14-15, 2000 in Dhaka. About five hundred environmental experts and activists, including a sizable contingent of NRBs, participated in the conference as registered delegates. The conference was open to the public, and a large number of people took part in the conference without registering. The conference had a novel dual format consisting of Technical Sessions for discussion by experts and General Sessions for discussion by activists. The Technical Sessions, numbering twenty-one, covered all major environmental problems of the country. The General sessions, on the other hand, were participated by representatives of all sections of the society including political parties, trade unions, various mass organizations, cultural organizations, etc. Both the Prime Minister and the Leader of the Opposition attended the conference and announced forceful commitments for environmental protection. The conference drew national attention and generated considerable enthusiasm among the participants and in the public in general.

ICBEN-2000 served as the founding gathering for the broad based civic environment movement in Bangladesh. The success of the conference illustrated vividly the potential of pro-environment forces, provided they unite. ICBEN-2000 adopted the Dhaka Declaration on Bangladesh environment that summarized the recommendations of the conference. The Declaration also set forth the goal of forming an organization that would serve as the common platform of all pro-environment forces of Bangladesh. The Organizing Committee of ICBEN-2000 took up this task seriously and formed a Constitution Committee to draft an appropriate constitution for the proposed organization, which eventually came to be known as Bangladesh Poribesh Andolon (BAPA).

Initially, there were different ideas about possible structure of BAPA. One idea was to view BAPA as a federation of organizations. A shortcoming of this idea was that it could restrict direct participation of individuals who are not already members of some pro-environmental organization. On the other hand, having
both individuals and organizations (which in turn could be of different sizes) as members of BAPA posed a thorny problem of heterogeneity. The main constitutional challenge was to devise an appropriate structure that could accommodate this heterogeneity and yet prove functional and effective. This required considerable brainstorming and time. Ultimately a solution was reached through the concept of ‘individual-membership equivalence’ for the organization-members of BAPA. This constitutional format, allowing both individuals as well as organizations of different sizes to be its member, makes BAPA unique.

A draft of the aims and structural outline of BAPA was announced through a press conference in June 2000. The full version of the constitution was discussed and adopted in May 2001. The constitution provides for a three-tier decision making process, consisting of the General Assembly, the National Committee, and the Executive Committee. Following relevant provisions of the constitution, ad hoc National and Executive Committees were formed in June 2001, thus completing the formation of the basic organizational structure of BAPA.

The broad-based united environment movement that emerged from ICBEN-2000 started to function even before BAPA’s formal organizational structure was agreed upon and fleshed out. In accordance to ICBEN-2000 resolution, ICBEN-2000 Organizing Committee was initially steering this movement. This committee led the work of publishing the ICBEN documents. It next proceeded to form Task Forces, each of which was to focus on particular environmental problems. Several of these Task Forces have since proved very active. They chalked up specific programs and went forward to implement them. Among these are the Task Forces on air pollution, encroachment of the Buriganga river (Buriganga Bachao Andolon), surface water pollution, encroachment of lakes, parks, and other open spaces in cities, etc. In collaboration with Khulna University and the Khulna-based organization, Rupantar, the Committee also organized a conference (Sundarban Bachao Shommelon) in Khulna to draw attention to the plight of Bangladesh’s unique mangrove forests, Sundarbans.
The activities of the environment movement gained further momentum with the finalization of BAPA’s organizational structure and formation of its leadership committees. BAPA intensified its movement against air pollution, encroachment of rivers, pollution by plastic bags, etc. In several cases, BAPA’s efforts have yielded results. It is encouraging that Bangladesh government has now banned the use of the particular type of plastic bag (less than 20 micron in thickness) that was more widespread in use and was harming the most. Earlier, BAPA thwarted attempts by vested interests to let TSEVs to continue to ply in Dhaka’s streets. It is encouraging that the government is sticking to its commitment to eradicate TSEVs from Dhaka by 2003 and has taken concrete steps in that direction. These show that it is indeed possible to arrest and reverse processes of pollution, provided there is the will. These also show that environment movement in Bangladesh has great prospects. In order to understand these prospects, we first need to be clear about the scope of the environment movement.

The Scope of the Environment Movement

The goal of the environment movement is clear. It is to stop the process of environmental degradation in Bangladesh and to repair the damage that has already been done. However, the environment movement does not view itself as just a pressure group geared toward putting up demands on the government. That would be a too reductive view. Instead, the environment movement takes a broader view of its task. This was made clear in the Dhaka Declaration adopted at ICBEN-2000. The Declaration identifies three distinct levels of pro-environmental efforts. These are as follows:

a) Individual level: People can do much at the individual level to protect environment. Every citizen can set examples of caring for environment in one’s own home and immediate surroundings. For example, he or she can refrain from harmful types and levels of consumption and can teach the value of good environment to the children, relatives, and friends. Such pro-environmental activities do not always require governmental or community’s help.

b) Community/local level: Much can be done at community and local level without having to wait for help from the government. For example, people in a given community can band together to save
The Broader Significance of the Environment Movement in Bangladesh

the trees, water bodies, open spaces, etc. in their locality. c) National level: The major sources of environmental deterioration are often rooted in government policies at the national level. It is therefore necessary to influence national policies in order to protect the environment.

There are important connections among efforts at these three different levels. First, it would be irrational on the part of citizens to demand pro-environmental measures from their government unless they themselves take similar measures at levels that are under their direct control, namely the individual and community levels. For example, if people want the government to stop deforestation, then they themselves should protect trees in their own homesteads and localities. Second, government policies cannot be successful if individuals and local communities do not back up those policies with their own actions. For example, the government policy to ban the use of plastic bags cannot work fully unless citizens themselves refrain from using these bags. Third, unless people are sensitized about their duties at individual and community level for protection of environment, it cannot be expected that they will come forward to participate actively in campaigns to influence national policies. In this sense, environmental efforts at local and community levels are a pre-requisite of environmental efforts at the national level.

However, the connections run in the reverse direction too. For example, pro-environment measures at the national level may help raise general awareness about the necessity of environmental protection at individual and community levels. Similarly pro-environment initiatives at the community level may induce people to be attentive to environmental protection at the individual level.

These two-way connections show that the scope of the environment movement has to be conceived broadly. Given the importance of national policies in determining environmental quality of the country, the main goal of the environment movement is to influence these policies in appropriate directions. However, even to be effective at influencing governmental policies, a broad view of the scope of environment movement is necessary.
The important question is how Bangladesh environment movement can hope to succeed with such a broad mission. In answering this question, it is first necessary to take note of some of the salient features that Bangladesh environment movement has displayed so far.

**Some Salient Features of the Bangladesh Environment Movement**

Unity: One important feature of the emerging Bangladesh environment movement is unity. As mentioned earlier, about fifty pro-environment organizations and institutions of Bangladesh joined hands to organize ICBEN-2000, the founding gathering of the Bangladesh environment movement. These included major universities and research institutions of the country, government environmental agencies, major pro-environment NGOs, media organizations, socio-cultural organizations, etc. It is rather rare for Bangladesh to have so many organizations to come together to do something positive. In this respect ICBEN-2000 and the environment movement that arose from this conference have the remarkable characteristic of being able to unify people instead of dividing them. Broad unity therefore has been the birthmark of Bangladesh Poribesh Andolon.

Non-partisan character: In another manifestation of unity, the environment movement of Bangladesh is non-partisan in character. Party politics is inevitable in a parliamentary democracy. However, party politics should not hinder people of different political leanings from coming together and working for national interests. Protection of environment is necessary no matter what economic model of development is preferred. Environment movement can therefore appeal to and has place for people of different political persuasions.

Participation by NRBs: A notable aspect of Bangladesh environment movement is the involvement of Non-resident Bangladeshis (NRB). As mentioned earlier, NRBs, through their organization Bangladesh Environment Network (BEN), played a crucial role in the genesis of Bangladesh environment movement. Through their remittances, NRBs have all along been playing an important role in the economic development of Bangladesh.
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However, revolutionary changes in communications technology have now made it possible for NRBs to play a more direct role in the social life of Bangladesh. The role played by NRBs in developing the environment movement in Bangladesh is a realization of that potential.

Self-reliance: Another important feature of the Bangladesh environment movement is self-reliance. For example, BAPA relies primarily on its members’ contributions for financing its activities. This provides BAPA the independence it requires to make objective assessment of various environmental problems and their proposed solutions. An independent BAPA can evaluate critically government’s environmental policies and the way these are implemented. A self-reliant BAPA can also judge objectively the role of donor agencies in controlling pollution in Bangladesh. Environmental problems always involve vested interests. Donor financing of environmental projects often adds an additional layer of vested interests. A self-reliant environment movement can cut through these different layers, reach to the essence of the problems, and take correct position regarding their solutions.

Voluntary spirit: A companion (to ‘self-reliance’) feature of the environment movement is its voluntary spirit. For example, to the extent that it shuns donor financing, BAPA’s financial resources are meager, and hence it cannot depend on paid work for its functioning. The environment movement therefore relies on voluntary labor of its members. It appeals to the noble sense of responsibility of the citizens towards their country and provides an untainted sphere for them to display their initiative, talent, and commitment. The environment movement presents an arena where people can have their voluntary spirit recharged by seeing other people working voluntarily.

Forward looking: The environment movement is inherently forward looking. Instead of remaining fixated on issues of the past, the environment movement is focusing on a problem that is inevitable in the future and is already glaring at the present. As Bangladesh progresses further in its drive to industrialize, the importance of
environmental issues will only increase, thus increasing in its wake the importance of the environment movement. From this point of view, it is not surprising that environment movement is the first social movement in Bangladesh in which RB-NRB cooperation came to fruition. Environment is an issue of the future, and NRBs, particularly those living in advanced industrial countries, are more likely to be tuned to such future issues. This also means that NRBs can serve as a conduit for the flow of advanced technological processes and ideas that are necessary to confront environmental problems of Bangladesh.

We next consider how these features of the environment movement can enable it to have a broader influence on Bangladesh’s social life.

The Special Situation of Bangladesh
A confluence of circumstances has created a vacuum in effective representation of public interests in Bangladesh. This is because of the following reasons.

Disappointment with traditional politics: Generally political parties serve as the main vehicle for expressing public discontent with the prevailing order of things. However, a certain amount of disappointment has developed in public’s mind regarding the main political parties of the country. One reason for this disappointment is increasing dependence of these parties on money and muscle. The crass influence of money has made politics often akin to another line of business to make money. In addition, dependence on muscle men and/or armed cadres has made politics very unsavory. A second reason for disappointment with traditional political parties is their excessive partisan attitude. Often broader national interests become casualties of their partisan actions and behavior. Third, the political parties often seem to be fixated with issues of the past and less concerned with challenging issues of the future. These and other related processes have caused frustrations regarding political parties as effective representative of public interests.

Disappointment with other traditional organizations: The frustration is not limited to political parties and in fact applies to many other organizations. It is probably the most poignant with regard to students’ organizations, which were traditionally considered to be
the most idealist-minded and selfless organizations of the society. Unfortunately many student organizations have now degenerated into almost criminal organizations engaged in extortion, intimidation, and even killing.

Erosion of the spirit of voluntary civic work: Alongside degeneration of traditional politics, Bangladesh has witnessed serious erosion of the spirit of voluntary civic work. Many contend that the advent of NGOs has contributed to this erosion, because NGOs have taken on for paid work many activities that traditionally belonged to the domain of voluntary civic work. According to this view, people now feel discouraged from doing voluntary work, because they see others getting paid for the same type of work. Some may also contend that there is now less necessity for volunteer activities, because NGOs are already performing these activities. None of these contentions need to be true. First of all, NGO activities do not lessen the necessity and importance of voluntary civic work. This is because there are limits to NGOs activities. Most importantly, NGOs do not have the independence that can go with voluntary work. This independence imparts voluntary work an entirely different quality that paid NGO work cannot match. Second, spread of NGOs should not necessarily lead to reduced voluntary activity, because people working in various NGOs can themselves also participate in voluntary activities. In fact by the nature of their job, NGO workers should be more tuned to voluntary activities. In view of the above, erosion of the spirit of voluntary work remains a disconcerting development of Bangladesh’s social life in the recent period.

Erosion of the spirit of self-reliance: The erosion of the spirit of voluntary work has gone hand in hand with erosion of the spirit of self-reliance. There was a burst of the spirit of self-reliance and self-less social work immediately after the victory of the Liberation War. Unfortunately Bangladesh could not hold on to that spirit for long. Very soon the country gravitated to an economic regime of aid-dependence, which then pervaded all aspects of social life. As a result of this aid-dependence, the search for own and local resources for undertaking any development and social work has waned. This
tendency has now spread to various social organizations’ internal financing too. Instead of depending on members’ subscriptions and contributions, social organizations increasingly look for donor funds to finance their activities. This however robs them of the precious independence that they need to be sincere and effective.

This list of negative developments of Bangladesh’s social life may be made longer. However, it is clear that these processes together have created a vacuum in effective representation of public interests in the country. This also creates the scope for the environment movement to have a broader significance in Bangladesh.

**Environment Movement and Social Regeneration in Bangladesh**

The environment movement offers precisely the qualities that people are looking for in their representative social organizations. They want to see organizations that are not beholden to vested interests and not mired in narrow partisan concerns. They want to see organizations that are self-reliant and have the backbone to stand up for greater public interests even if that implies conflict with certain private interests, and sometimes with the government and foreign donor agencies. To the extent that its features resonate well with these popular aspirations, the environment movement can play a wider role.

In this regard Bangladesh’s situations differ from that of many other countries, where the usual representative social organizations, such as political parties, etc. have not undergone the kind of rapid negative transformation that has occurred in Bangladesh. Also those countries have not witnessed as radical erosion of traditional values of self-reliance, volunteerism, and philanthropy as Bangladesh has. In those countries, the environment movement therefore does not have any additional burden to carry and can keep itself limited to the narrowly defined goal of environmental protection. In Bangladesh, however, the environment movement has a potential broader role.

This does not mean that the environment movement of Bangladesh can or should aspire to compete with or replace traditional social organizations of the country, such as political parties, etc. In some countries environmentalists have indeed organized themselves in
the form of political parties. Germany is probably the most notable example in this respect. The environmentalist party of that country, the Green Party, is a partner of the ruling coalition for two consecutive terms now. The Green Party of the USA also participates in election as a political party. It is not necessary to say at this point whether environmental movement of Bangladesh will ever take the form of political party and contest in elections. However, as of now such transmutations do not seem to be on the agenda.

The important thing to realize is that, by occupying more of the social space, the environment movement can exert a salutary effect on the political climate of the country, even if it does not itself become a political party. Under parliamentary politics, traditional political parties will have to rely on popular vote for getting elected. As environment movement draws more people to its fold, political parties will have to modify themselves in the light of the goals and features of this movement in order to garner its adherents’ votes. A strong popular environment movement will also help modify the behavior of other social organizations, including students’ organizations.

There are signs that the potentiality of the environment movement to occupy more of Bangladesh’s social space is not a mere conjecture. It is this potentiality that explains why the environment movement, as represented by BAPA, has been able to garner national attention so soon and why so many sincere, patriotic, accomplished people have rallied under BAPA’s banner in such a short time. Spreading out of Dhaka city, the environment movement is now poised to extend rapidly to the districts. In many districts and Upazilas, people are getting mobilized on local environmental issues even without waiting for BAPA to arrive. These are all indicative of the wider appeal of the environment movement in Bangladesh.

There are some encouraging signs in Bangladesh’s social scene too. In recent months, various university campuses, including that of Dhaka University and Bangladesh University of Engineering and Technology (BUET), have witnessed considerable student activism outside of the orbit of the traditional students’ organizations. This
shows that general students are uniting and are no longer waiting for traditional student organizations to represent their discontents. (Actually, often their discontent is directed precisely against the activities of these organizations!) Similar examples of superseding the traditional organizations can be seen elsewhere. In Natore, for example, common people and small businessmen united themselves in a new type of organization in order to protect themselves from extortionists. Even large businesspeople, as assembled in Bangladesh Garments Manufacturer and Exporters’ Association (BGMEA), have become impatient with traditional political parties and are embarking on street agitation of their own.

There are some changes of deeper nature and broader scale too. Due to export of labor-power and expansion of export industries, the economy of Bangladesh is now less dependent on foreign aid than it used to be before. Whereas previously almost the entire development budget depended on foreign aid, this dependence has decreased in recent years to about half. This reduced dependence on aid and more reliance on own earnings (from either remittance or export) is gradually percolating through the social consciousness. In this sense, Bangladesh may be turning a corner. The expansion of micro-credit schemes by Grameen Bank and other organization is also helping rural people to rely for their livelihood more on business activities and less on alms, charities, and government relief programs. All these processes will certainly help in a revival of self-reliant social behavior in general in Bangladesh.

These changes are still very much in the working. However together they are creating a more receptive ground for environment movement’s message of unity, self-reliance, and priority of public interests. These nascent changes and spread of the environment movement can prove mutually reinforcing. Together they may therefore conduce to a process of social regeneration, whereby Bangladesh society will shed many of the negative attributes that it has unfortunately acquired over the last decades and will emerge not only with a cleaner environment but also with a healthier body politic. The hypothesis of a broader significance of the environment movement in Bangladesh will then be borne out.
The Broader Significance of the Environment Movement in Bangladesh

Concluding Remarks
The environment movement in Bangladesh has made significant progress in recent years. ICBEN-2000 led to the formation of BAPA as the common platform of pro-environment forces of the country. The campaigns and agitation conducted under the auspices of BAPA have contributed to the adoption by the government of several important pro-environmental measures in the recent period.

In a sense, there has been a qualitative change in the attitude toward environmental issues in Bangladesh. For a long time it used to be held that acting on environmental issues is not good for a government, because by doing so it will antagonize powerful forces. Antagonism of these forces, so the argument went, outweighed whatever gain a government would make in pleasing pro-environment forces. However, the environment movement has changed that equation. By raising awareness and mobilizing the public on environmental issues, it has brought the public into the equation. As a result, Governments currently know that public appreciation that it can now get from taking pro-environment measures outweighs the dissatisfaction these measures may evoke from vested interests. From liability, pro-environmental measures have therefore become an asset for governments.

Bangladesh can seize this shift in attitude and make further progress in protecting her environment. There were skeptics who used to argue that emphasis on environmental issues was a luxury of rich, post-industrial countries, a luxury that a poor country such as Bangladesh could not afford. Just a few years’ experience has proved them wrong. Bangladesh needs to emphasize environmental issues not in spite of possible dampening effect on growth but in order to accelerate economic growth. The popular support for recent governmental measures to ban the use of certain type of plastic bags and to eradicate TSEVs shows that the common people of Bangladesh are much ahead of the skeptics. They realize the importance of environmental issues from their own day to day experience.

By making rapid progress in environmental protection, Bangladesh can gain international admiration. She has already earned some
praise by showing that fertility rates can be brought down even at low per capita income levels. Bangladesh can attain a similar positive distinction in the international arena by showing that a country can take good care of her environment even if her per capita income is low.

However the environment movement in Bangladesh can do more than just protect physical environment. It can fill up some of the vacuum caused by degeneration of traditional social organizations. It can conduce to a process of social regeneration by reviving such healthy features of a society as self-reliance, deference to public interests over narrow partisan interests, forward outlook, etc. Some recent developments indicate that Bangladesh may indeed be ready for a social regeneration. By providing further impetus to the environment movement of Bangladesh, ICBEN-2002 can prove to be an important milestone in this regeneration process.
PRESENT AND FUTURE RIVER MICROBIAL WATER QUALITY IN BANGLADESH

M. M. Majedul Islam¹

ABSTRACT

The current river contamination level is a serious public health concern in Bangladesh and needs to be addressed immediately. Climate change induced projected increase in precipitation and higher temperatures are likely to exacerbate the problems of faecal contamination. This could be further compounded by the rapid change in socio-economic conditions in Bangladesh. Therefore, to reduce future health risks, understanding the influence of socio-economic conditions and climate change on microbial dynamics is very important. Despite the high relevance for public health, very few studies currently exists on surface water microbial water quality in Bangladesh, and the studies have been based on indicator bacteria. Other harmful pathogens (e.g. infectious bacteria, viruses, and protozoa) have not been included in the studies due to difficulty of measuring variety of pathogens. A recent study has reported that in Bangladesh socio-economic factors have stronger influence on river fecal contamination compared to climatic factors. A combined modeling and scenario analysis approach is a useful tool to assess river microbial dynamics and can provide a basis for the water managers to reduce the risks of waterborne disease outbreaks.

Keywords: Faecal contamination, Faecal indicator bacteria, Waterborne pathogens, Water quality modelling, Health risk assessment

Introduction

Consumption of water that is contaminated with pathogens still cause high numbers of death and diseases in developing countries.

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Understanding the factors that influence the dynamic distribution of waterborne pathogens is important to improve the water quality. Such understanding is particularly important in a developing country like Bangladesh, where access to clean water and adequate sanitation remains a problem despite recent improvements. Due to the country’s poor economic conditions and lack of adequate water management infrastructure, most people rely on highly contaminated surface water for household purposes, irrigation and bathing. This makes the population vulnerable to waterborne diseases.

Despite the high relevance for public health, very few studies currently exists on the microbial water quality in Bangladesh. At present there have been few studies focused on ground water or drinking water supplies (e.g. Wu et al., 2016, Acharjee et al., 2011), while the surface waters have been ignored. Before our study in the Betna river (Islam et al., 2017) in southwestern Bangladesh, only one study have studied microbial water quality in the Karnaphuli river estuary in Bangladesh (Alam and Zafar, 2012). Some studies have been conducted in the shrimp farms/ponds, those are primarily PCR based genetical/cellular level analysis for bacteria (e.g. Ahmed et al., 2010, Roy et al., 2013). Some other studies have been based on the waterborne diseases (diarrhea and cholera in particular), focused on occurrence of diseases after flooding (e.g. Qadri et al., 2005, Hashizume et al., 2010, Ali et al., 2013).

While regular monitoring of river microbial water quality is expensive and time consuming, process-based mathematical modeling can save time and resources. Modelling is useful to generate spatially and temporally continuous data, and helps to better understand the sources, fate and transport of the faecal contamination (Islam et al., 2018a). However, process-based modelling of microbial water quality is very rare worldwide, particularly in the developing countries. Although some recent studies have been based on hydrodynamic (floods, cyclone) modelling (e.g. Mark et al., 2015, Zaman et al., 2016), to my knowledge our study on the Betna river (Islam et al., 2018a) is the first microbial water quality modelling study in Bangladesh.
Microorganisms are susceptible to shifts in water flow and quality. The predicted increases in rainfall and floods due to climate change will exacerbate the faecal contamination scenarios in Bangladesh. This could be further compounded by the rapid change in socio-economic conditions (population growth, urbanization, sanitation and agricultural management) in Bangladesh. Future waterborne pathogen concentrations and consequent health risk are also associated with future socio-economic developments along with climate change impacts. Therefore, to reduce future health risks, understanding the influence of changes in socio-economic conditions and climate on microbial dynamics is important. Model-based scenario analysis is a useful tool to assess future microbial water quality.

We did a comprehensive modelling and future scenario analysis (Islam et al., 2018b) in the Betna river to better understand how climatic variables (e.g. floods, precipitation and temperature) and socio-economic developments (population growth, urbanization, land use and sanitation) affect Faecal Indicator Bacteria (FIB) concentrations and dynamics. While some earlier studies focused on only assessing climate-change impacts on microbial water quality, this study for the first time in the world assessed the influence of combined climate and socio-economic scenarios on river FIB concentrations. This combined modelling and scenario approach enables the assessment of faecal contamination sources and dynamics at present and in the future. The method has provided a basis for the water managers to reduce the widespread faecal contamination and the risks of waterborne disease outbreaks, which are still a leading cause of deaths in Bangladesh.

This article presents a short review on the studies conducted on microbial water quality in surface waters in Bangladesh. The review includes studies based on microbial monitoring, modelling, and scenario analysis along with health risk assessment. This article highlights some of the present knowledge gaps and suggests some potential new directions for research in this domain.

**Sources and pathways of surface water faecal contamination**

Surface water can be contaminated with the variety of
microorganism from various sources including untreated waste water discharges, septic tank leakage, agricultural or urban runoff, wildlife or nonpoint sources of wastewater (An et al., 2002). In Bangladesh, wastewater is not treated and untreated wastewaters are discharged directly into rivers and canals. Manure is applied to agricultural fields as organic fertilizer and can enter surface water after heavy rainfall events. Surface water may subsequently become contaminated by runoff from agricultural lands and manure storage areas. Additionally, manure can be deposited directly to stream water from open defecation by livestock and wildlife (Coffey et al., 2013, Parajuli et al., 2009). Occasional leakage of septic tanks and open defecation from humans also contaminate river water. The sources and pathways of waterborne pathogens/FIB in Bangladeshi surface waters are presented in Fig. 1.

Figure 1: Sources and pathways of micro-organisms in surface water of Bangladesh with the impact of climatic and socio-economic factors

**Waterborne pathogens and faecal indicator bacteria**

Water quality and human health are seriously affected due to variety of pathogens. Outbreaks of diarrhoea are related to the
concentrations of major waterborne pathogens (infectious bacteria, virus and protozoa) in surface water. There have been few studies in Bangladesh (Ali et al., 2013, Hashizume et al., 2010) that have tested waterborne pathogen (rotavirus, *V. cholera*) infection in the hospital patients, but no such study have assessed the surface water pathogen concentrations in Bangladesh. Assessment of major waterborne pathogens (e.g. rotavirus, cryptosporidium) that are mostly responsible for diarrheal diseases is lacking worldwide. Globally enteric viruses such as rotavirus, noroviruses and adenovirus are important causes of abdominal complaints like gastroenteritis (Prez et al., 2015). Rotavirus, is the most common cause of severe diarrhea among infants and children under-5. Urban areas of Bangladesh are hotspots with high rotavirus emissions. In Bangladesh, rotavirus-related infection accounts for over 40% of hospitalizations for infantile diarrhea.

Since viruses are highly infectious, traditional wastewater treatment process cannot prevent enteric virus transmission. Even the presence of few viruses in surface waters can cause serious public health risks (La Rosa et al., 2012, Prez et al., 2015). It is very important to understand the dynamics of gastroenteritis viruses in river water and assess the impact of these etiological agents on human health. However, the detection and enumeration of pathogens are very difficult due to the great variety of pathogens, the low numbers of each species and the absence of standardized methods to detect them (Bruhn and Wolfson, 2007, Ouattara et al., 2013). As the detection of virus is quite difficult, microbial water contamination is often assessed by measuring concentrations of FIB (Ouattara et al., 2013; WHO, 2008). In addition, although FIB are generally not pathogenic, their presence in the water body indicates the possible presence of other pathogenic microorganisms (Burres, 2009) and pathogens are expected to respond to climate change in a similar way as FIB. Therefore it has become the most common method in monitoring microorganisms. *E. coli* and enterococci have been used most widely as indicators of faecal contamination in water sources (Lata et al., 2009, Ouattara et al., 2013). The absence of FIB does not exclude the presence of enteric viruses which are generally more resistant than bacteria to wastewater treatment (Prez
et al., 2015). In the study of Prez et al. (2015), enteric viruses were identified in recreational waters with low bacterial loads. Therefore, to assess microbial water quality direct detection of viruses, infectious bacteria and protozoans are needed. The detection and quantification of viral pathogens are very challenging and are therefore monitoring of viruses are very limited worldwide and until now microbial monitoring study in Bangladesh has been limited to FIB only.

**Environmental variables and FIB concentrations**

Access to an adequate quantity of clean and safe fresh water is essential to all living creatures. Deterioration of water quality has been a major concern worldwide as a result of population growth, intensive land use and increased industrial activities. Rivers have been treated as a convenient recipient of untreated wastewater, particularly in the developing countries. Besides, due to close linkage of climatic and surface water systems, water quality is affected by different climatic and environmental variables, such as air and water temperature, precipitation, and salinity. However, knowledge on the impact of environmental variables on microbial water quality in surface water sources are lacking worldwide, particularly in developing countries and in (sub)tropical climate. Most of the existing studies regarding the impact on pathogens/FIB have been conducted in developed countries and in temperate region. Although few studies have assessed the impact of climatic variables and flooding on cholera disease in Bangladesh (Ali et al., 2013, Hashizume et al., 2010), our previous study (Islam et al., 2017) was the first comprehensive microbial study in Bangladeshi surface water. The study revealed that 88% of the *E. coli* and all enterococci samples were violated the USEPA bathing water quality standards (*E. coli*: 235cfu/100ml and enterococci 104 cfu/100 ml). Such violation indicates that the river Betna is unsuitable for bathing throughout the year. The potential health risks associated with the river water’s use for domestic, bathing and irrigation purposes are too large. The frequent standard failures is not surprising for Bangladesh as the sewages enter directly to the river without treatment. The correlation between environmental variables (water temperature, precipitation and salinity) and FIB concentrations was
also determined. A positive correlation was found with water temperature and precipitation, and a negative correlation with salinity. The positive correlation with temperature is due to the co-occurrence of high summer temperature with abundant monsoon rainfall. The positive correlation with precipitation can be explained by the increased runoff from agricultural lands and urban areas. This runoff contains many bacteria. In the study area, during the rainy season (July to September) precipitation increases and as a result water salinity decreases. The observed negative correlation with salinity is more likely due to the typical weather patterns during the rainy season when low salinity coincides with increased precipitation and high temperature, than to salinity dependent die-off of bacteria.

**Microbial water quality modelling**

Although some recent modelling studies have focused on flooding (e.g. Mark et al., 2015, Zaman et al., 2016) and salinity intrusion problem (e.g. Dasgupta et al., 2014), no such studies have been focused on surface water microbial water quality in Bangladesh. The study of Islam et al. (2018a) is the first study in Bangladesh that models microbial water quality of a surface water source. The study revealed that wastewater treatment can result in considerable improvement of microbial water quality of the Betnariver. The study also found that primary and secondary levels of wastewater treatment was not sufficient to reach the standards most of the time, and discharges from sewer drains and incoming concentrations from the upstream boundary were found to be a major cause of water contamination (Islam et al., 2018a). Major investments to construct wastewater treatment plants are necessary to treat the increased volume of wastewater from rapid population growth. Although the current level of contamination is already too high, without wastewater treatment the water quality will further deteriorate. In the Betnariver, the FIB concentrations become very high after a heavy rainfall event and decrease after three to four days, although still remain noncompliant with the bathing water quality standards (Islam et al., 2017). The study recommended avoiding bathing for at least three to four days after a heavy rainfall event, as long as wastewater treatment facilities with adequate capacities are not
established. The government of Bangladesh has already made it mandatory for industries to establish effluent treatment plants (ETPs). However, there is a lack of strict regulation and initiative to establish domestic or sewer wastewater treatment plants (STPs) to treat before disposal of wastewater into rivers. The establishment of ETPs is essential to reach the Sustainable Development Goal (SDG) 6 target 3 ‘to halve the proportion of untreated wastewater’ (UN-Water, 2017) by 2030.

**Impact of climate and socio-economic changes on FIB concentrations**
Concerns over surface water quality have been growing in recent years due to widespread faecal contamination of surface water sources. The Betna river is already highly contaminated and this is expected to deteriorate further due to climate change. Future waterborne pathogen concentrations and consequent health risk are also related to socio-economic conditions. However, quantitative study on surface water microbial water quality under socio-economic and climate changes scenarios was unavailable. To reduce this knowledge gap Islam et al. (2018b) applied the same model to explore the future impacts of socio-economic and climate changes on FIB concentrations in the Betna river. The scenarios comprised changes in population, urbanization, land use, sanitation, sewage treatment, temperature, precipitation and sea level rise for the 2040s and 2090s. The results revealed that by the 2090s, FIB concentrations are expected to decrease by 98% or increase by 75% for the sustainability scenario and uncontrolled scenario respectively. An uncontrolled future resulted in a deterioration of microbial water quality due to socio-economic developments, such as higher population growth, land-use change and increased sewage discharges and changes in rainfall patterns. Microbial water quality strongly improved under a sustainable climate and improved sewage treatment. In general, FIB concentrations were found to be more sensitive to changes in socio-economic factors (e.g. human and animal population growth, urbanization, change in sanitation and land use) than to the climatic factors (e.g. precipitation, discharge and temperature). In other words, climate change has little overall impact and socio-economic developments drove most
impacts on the FIB concentrations in the river water. This underlines the importance of socio-economic factors in assessing and improving microbial water quality. Since the climatic factors have a lower influence on the concentrations, microbial water quality in the river can be improved substantially by applying adequate wastewater treatment both in the Betna basin and upstream areas.

**Outlook for further research**

Considering the growing consensus on the need for improvement of microbial water quality and managing consequent health risks, an extension of the modelling framework to other water quality parameters such as salinity, dissolved oxygen, nutrients and chlorophyll-a could be an important next step. Such model can also be applied in related fields, such as water pollution caused by heavy metals, nutrients, industrial effluents etc. A multi-pollutant (nutrient, plastic, chemical and pathogens) modelling approach as proposed by Kroeze et al. (2016) could be an advanced next step to explicitly address the combined exposure of surface waters to multiple pollutants and to better understand and manage surface water resources. Future studies may also consider accumulation of pollutants (e.g. microplastics, phosphorus and metals) in soils and sediments.

The developed model can also be applied for a quantitative microbial risk assessment by combining inputs of pathogens, faecal indicators, and microbial source tracking markers. The obtained concentrations along with dose-response and exposure data can be used to determine health risks associated with the use of untreated surface water. To quantify and model waterborne pathogen distribution and dynamics and to perform such risk assessment for climate change by incorporating pathogens instead of relying solely on indicator bacteria should be an interesting next step. Antibiotic resistance bacteria/genes (ARB/ARGs) in the aquatic environment are a serious concern for human health in recent years in Bangladesh. Efforts are needed to perform a comprehensive health risk assessment that can include health risks associated with antibiotic resistance.
Improvement of microbial water quality

Water quality can be improved by several ways including source control, applying wastewater treatment, and by natural process, such as by artificial or constructed wetlands (CWs). Wastewater treatment is done by establishing STPs and ETPs. It can be primary (mechanical), secondary (chemical) and tertiary (biological) level. Usually primary treatment can remove one log unit (90%) of FIB concentration from the sewage, secondary can remove two log unit (99%), and tertiary can perform three log unit (99.9%) removal (George et al., 2002). In the Bangladesh context at least secondary treatment plants should be established with utmost priority. CWs have been widely applied for reduction of nutrients and contaminants in wastewater as environmental friendly ecosystems and are affordable technology. The reuse of properly treated wastewater using CWs has become more attractive in recent years to compensate for increasing water demand worldwide, particularly in arid and semi-arid regions (Wu et al., 2016). CWs are engineered wetlands that utilize natural processes involving soil, wetland vegetation and microorganisms to assist the treatment of wastewater (Almeida et al., 2016). CWs have been introduced at a rapid pace in the developed countries, whereas there have been very few cases in developing countries. CWs can be installed extensively all over the world where availability of land is not a problem, because high-cost treatment systems cannot be maintained due to sharp decline of population in most developed countries and lack of economic resources to run ETPs in developing countries. CWs can be installed in Bangladesh as a low cost option in purifying our highly contaminated surface water sources.

Conclusions

Given the high numbers of mortality caused by the consumption of contaminated water it is important that we have enhanced understanding on the factors that control the fate, transport and dynamics of waterborne pathogens and FIB. Despite high relevance with public health, at present little work exists on fate, transport and dynamics of these pathogens and FIB in Bangladesh. Microbial surface-water quality is expected to change with socio-economic development and climate change. The projected increases in
precipitation and floods combined with population growth, urbanization and agricultural intensification will likely to exacerbate the problems of contamination. Therefore, identifying trends and understanding the link between human activities, natural process and microbial activities are required to assess health risks and effectively manage and mitigate the health the risk of the population. The future scenarios for microbial water quality caused by climate and socio-economic changes are also important to assess future health risks. The studies should include all forms of pathogens including infectious bacteria, notable viruses and harmful protozoans. Treatment of wastewater before it is discharged into the rivers and a canals is very important to reduce health risks and to achieve SDG 6.3. Process based models are proved to be effective in assessing the impact of land-use changes and wastewater-treatment planning on surface water microbial water quality. The insights and information on surface water condition is helpful to formulate policy and to reduce the elevated health risk caused by faecal contamination. The findings on present and future river faecal contamination would be useful for formulation and implementation of water safety plan for Bangladesh.

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HOSPITALITY WASTE MANAGEMENT IN BANGLADESH: A CRITICAL REVIEW

Selimuzzaman Sikder¹

ABSTRACT

The main objective of this study is to provide a review of key concepts and issues relevant to hospitality waste management (HWM) in Bangladesh. The following data collection methods were used in this study- review of documents and literature, interviews, surveys and field observations. Planning for HWM is complex, involving the consideration of multiple and interconnected issues. Therefore, in addressing HWM issues, it is appropriate to use an integrated approach that recognizes the various stakeholders, activities, and perspectives involved. In addition, concepts such as hospitality waste appropriate technology, cleaner production, and environmental management systems can be useful for improving how solid waste management is approached. A local environmental non-governmental organization, waste hauler, and hotels in Dhaka city developed a program to improve the management of solid waste from five-star hotels. The history, planning, management and stakeholders involved in the development of this waste management program are described in this study. Various issues pertaining to the achievement of social, environmental and economic objectives are investigated to provide a view of realities and the range of challenges faced by participants. Conclusions and lessons learned from the case study are presented and links between concepts in the literature and findings from the case study are discussed. Recommendations concerning topics such as planning, management, stakeholder involvement, health and safety and source separation are suggested and future research directions are outlined.

Keywords: Waste Management, Solid Waste, Five Star Hotel, Technology, Challenges

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Introduction
Hospitality waste management is a key aspect of the environmental management of establishments belonging to the hospitality sector. In this study, it reviewed literature in this area, will examine the current status of waste management for the hospitality sector, in general, with a focus on food waste management in particular. It will specifically examine the for-profit subdivision of the hospitality sector, comprising primarily of hotels and restaurants. An account is given of the causes of the different types of waste encountered in this sector and what strategies may be used to reduce them. These strategies are further highlighted in terms of initiatives and practices which are already being implemented around the Dhaka city to facilitate sustainable waste management. Generally, it was found that not many scholarly publications are available in this area of research. More studies need to be carried out on the implementation of sustainable waste management for the hospitality industry in different parts of the megacity Dhaka and the challenges and opportunities involved (Chandrappa and Das, 2012). According to Food and Agriculture Organization of the United Nations (FAO, 2017), one-third of the food produced in the world for human consumption every year, approximately 1.3 billion tonnes, gets lost or wasted. Meanwhile, there are 795 million hungry people out of 7.5 billion people living on this planet, which means one out of nine people in the world suffers from chronic malnutrition (Webster, 2000). The contradiction here is that in the meantime, while a huge amount of food gets discarded every day, that amount can feed enough the hungry of the world. This is an alarming issue; thus, food waste should be handled with a better approach. As important as food safety and hygiene, food waste should be taken more seriously into consideration. Certainly, it is very critical that hospitality managers need to give prominence to the quality of the products delivered to the customers; nonetheless, risking all the expenses to replace old production with freshly made products all the time is an abnormal spoilage. Reducing food waste can not only contribute to several environmental benefits but also numerous financial and social impacts (Chandrappa and Das, 2012). After working in the food and beverage industry for a considerable amount of time, it is
noticed that food waste became an unavoidable problem in every restaurant and food service provider. However, it was an issue that most of the time got neglected or dissembled due to various reasons. While it might be a concern to a lot of managers, yet, not everyone is ready to bring it on and take it seriously. Since waste management in general and food waste management particularly are a crucial part of protecting the environment, raising awareness as well as presenting proper handling approaches among the public is a necessity. Yet, food waste in general and in hospitality industry particularly still covers a broad spectrum. It is very challenging to direct food waste in the hospitality industry as a whole. And so forth, the thesis only plans to address this issue on a small scale of a case study (Afroz et al., 2011).

Tourism brings and sustains benefits on employment and economic value to society. However, tourism activities also have negative influences on the environment, in which solid waste is one of the most significant impacts indicated that solid waste accumulation and littering was a negative indicator which highly impacted on the tourism industry of Dhaka city, Bangladesh. It should be considered in formulating policies for the tourism development. In the tourism business, the accommodation is considered as an essential element to attract tourists, and also a primary source of waste. Therefore, for tourism cities the higher the number of arrivals, the more critical the solid waste management (SWM) of the hospitality industry. The establishment and gradual implementation of sustainable SWM. Additionally, presented waste sorting practice of residents, revealed some positive driving force and negative factors of separating behaviors. Also, this study suggested solutions to enhance the effectiveness of waste segregation at source from selected five-star hotel in Dhaka city residents. After all, the accommodation business is one of the significant sources of waste in Dhaka City.

**Importance and Objective**
Waste production from hotel industries is one of the major issues in Bangladesh because waste is not treated well. Therefore, developing a holistic framework for waste management has an important role in
the optimization of each waste material in the hotel industry. Most of the wastes in hotels are recyclable or compostable. The study shows that hotels can not only make environmentally friendly contributions but also make profits out of a proper recycling practice in a long-term. Waste elimination at source and recycling can save GHG emission to a large extent. Therefore, it can decrease pollution and slow down global warming, which is a major problem mankind is facing nowadays. The main objective of the study is to provide a review of key concepts and issues relevant to hospitality waste management (HWM) in Bangladesh. Hospitality Waste Management aims to examine the improving waste management system in selected Hotel in Dhaka. Critical analysis of the present situation of hospitality management in Dhaka city will point-out the drawbacks and reasons, in general, with a focus on food waste management in particular so that an environmentally friendly waste management system can be put in work. Poorly managed waste can pose a threat to health, the quality of our environment and places a burden on businesses and national economies. As a result, the management and minimization of hospitality waste have moved up the agenda for any efficient commercial operation. Most of the manufactured items we throw away have involved the use of natural resources (materials, energy, and water) and some degree of pollution during their production. Cutting consumption reduces these impacts and cuts down on waste, as well as the time spent handling it. Often it is more resource-efficient to manufacture new products through recycling old ones, as in the case of aluminum cans or glass containers. As landfill sites are being used up, they are becoming more and more expensive and will represent an even greater percentage of operating cost in years to come. Despite a massive increase in recycling rates over recent years, consumer society continues to generate large quantities of waste. Waste tends to be a by-product of a more affluent lifestyle. People in a less developed country as Bangladesh does not have the purchasing power to generate waste in the first place, and poverty forces them into reusing as much as they can for other purposes.
Waste of Hospitality Industry

Generally speaking, waste from the hospitality industry consists of both wet and dry waste. The wet waste consists primarily of food waste (Ahmed and Ali, 2006), which can account for more than 50% of the hospitality waste and up to one-third of all the food served within the hospitality sector (Will, 2007). Hotels are one of the major sources of solid waste generation, for reducing the volume of the waste, Sufian and Bala (2007) focused on purchasing policies (develop partnership, products with sensible packing), waste management (minimize waste in the operation, reuse and recycle) and waste disposal (partnership with disposal companies, sound disposal methods) by hotel to meet environmental responsibility and reduce the burden of waste. Considering the significant role of the hotel industry in terms of waste generation (half a pound to 28.5 pounds of trash per day per room) and the fast growth of the industry, adopting a number of environmental best practices with quantifiable measures, including areas of benchmarking and auditing, financial analysis to facilitate informed decision making, and operational training, becomes important due to certain factors such as increasing regulation and rising utility costs (Hai and Ali, 2005).

The expansion in hospitality sector operations is complemented by an expansion in its waste management operations. More waste usually translates into a greater environmental footprint and therefore more harm to the ecosystem. For example, a hotel guest is estimated to generate up to 1 kg of waste per day on average (International Hotel Environmental Initiative, 2002), and this amounts to millions of tons of waste being generated worldwide annually. Therefore, the importance of studying the hotel management in order to minimize the waste cannot be overemphasized. Various studies have shown some light on the typical waste types generated at hotels. For instance, aluminum, plastics, glass, steel, cardboard and food waste were cited as being the main components of hotel waste in some studies (Papargyropoulou et al., 2016). As per another study, the components of hotel waste (Huq et al. 2002).
Solid Waste Management
Solid waste is a key concern in the hospitality industry. Typically, a hotel guest can produce 1 kg of waste a day that accumulates to thousands of tons of waste annually (Olsen et al., 1998). Many small hotel operators have very little interest in reducing and/or recycling waste, believing that such activities are too expensive and time-consuming (Rahman et al., 2017). For a hotel business, the cost of solid waste is not only the cost of disposal but includes other hidden costs, i.e. staff, resources, and energy developed a hierarchy model of hospitality SWM. It is essential to educate and train staff about waste minimization practices, along with providing incentives to enhance their commitment to the programme. Afroz et al. (2011) indicated that customers can play an important role in a hotel's waste recycling programme by not contaminating waste with food. A range of methods can be used to encourage customers to segregate their recyclable materials, i.e. providing another bin in the room or near lifts for recyclable materials.

Waste Hierarchy
The waste hierarchy provides order for the best environmental options, which have the least impact on the environment, and supports sustainable waste management (UK Government Strategy Unit, 2002). This model was given by the European Union (EU) strategy on waste. The waste hierarchy introduced by Waste provides a range of options to handle different waste streams (prevention, minimization, reuse, recycle, energy recovery and disposal).

![Figure 1: The SWM hierarchy](Image reproduced, courtesy of Cardiff County Council)
Prevention is the elimination of waste before it is actually created. Minimization is the reduction of waste during the life cycle of the product. Reuse is a process of putting waste materials back into use so that they do not go into the waste stream. Recovery is the retrieval of a part of the value of the materials through recycling and energy recovery. Disposal, at the bottom of the hierarchy, usually involves landfill and incineration of waste. However, the waste hierarchy did not address composting, which was an essential SWM option for handling organic waste in a sustainable way.

The purpose of the waste hierarchy is to give priority to waste prevention. Failing that, it aims to promote the re-use and recovery of waste. Food waste collection and composting fit into the recycling stage of the waste hierarchy. Only when all other options have been considered, should waste be disposed of, usually in the form of the landfill. The higher up the waste hierarchy a waste management strategy is, the more sustainable it is.

**Impact of Municipal Solid Waste Generation in Dhaka City**

Population growth and rapid urbanization means bigger and denser cities and increased MSW generation in DNCC and DSCC five-star hotels. The data compiled for this article indicates that Dhaka city in Bangladesh was generating 3.6 million tons of waste in 2014 and generated 5.3 million tons in 2015. MSW Rules 2000 mandate “landfills should always be located away from habitation clusters and other places of social, economic or environmental importance”, which implies lands outside the city. Therefore, increase in MSW will have significant impacts in terms of land required for disposing of the waste as it gets more difficult to site landfills.

**Treatment of Hotel Compostable Waste**

Hotel organic waste can be reduced by composting as the best alternative. It is a biological process of decomposition of organic wastes within certain condition like proper ventilation, temperature, moisture and carbon and nitrogen ratio (DNCC, 2005). Composting is basically depending on the nature of 119 waste and its decomposition process. In the manual of municipal solid waste...
management, there are two methods of composting describes i.e., aerobic and anaerobic. Apart from that, another form of composting is vermin-composting, in which various species of earthworm are used to convert organic waste into manure. Here waste material work as a profit enhancer. These waste items can generate some handsome amount of revenue; the two major source of profit is an organic waste and recyclable waste. This is the first outcome phase of the model of waste management for the hotel industry. Profit can be generated from bio-degradable waste and non-biodegradable waste and we can estimate the monetary and non-monetary value of waste. If the volume of waste and land for waste treatment is limited then the best suit option is biogas. Otherwise, if the volume of waste is higher or there is the availability of land than composting is appropriate for waste treatment. Similarly, once the waste is sorted in the form of recyclable waste again recyclable waste is categorized into sub-category like metal waste, plastic waste, paper waste etc. Now the subcategorized waste is sold to concerning recycling units or scrap dealers to get salvage value of each material.

Food Waste in the Hospitality Industry
Meanwhile, food waste tends to be food that has fine quality and is suitable for consumption but does not get consumed because it gets discarded either before or after it is left to perish. Food waste typically takes place at the retail and consumption stages in the food value chain. The cause can be the negligence or a conscious decision to throw food away. Although both food loss and waste happen all over the world, food loss tends to be more prevalent in developing countries, while food waste tends to be more prevalent in developed countries. As the drivers that generate food waste and the solutions to it are different from those of food losses, food waste is recognized as a distinct part of food loss (FAO, 2017).

In the case of the food and beverage industry, a food item becomes waste when it failed to be used by a customer or an employee of a food service or restaurant operation. Food waste consists of both food and beverage for customer’s consumption and kitchen waste such as eggshells, fresh food trimming waste, oils, spoiled or
expired products. Food waste falls into two categories: Pre-consumer food waste and post-consumer food waste. Pre-consumer food waste includes overproduction, spoilage, expiration, and trimming waste. Post-consumer food waste often referred to as plate waste, is the food items left or discarded by the customers. These often include food left on the plates or unused seasoning part or leftover beverages.

**Causes of Food Waste in the Hospitality Industry**

Food waste generation does not indicate poor operating practices, since it takes place due to various comprehensible and sometimes, inevitable reasons. As food waste is categorized into two groups: pre-consumer and post-consumer food waste, the causes of them are different. According to (Baldwin and Shakman, 2012), pre-consumer food waste is often caused by the reasons stated in Table 1. This table below is the summary of the main causes of food waste in the hospitality industry introduced by Baldwin and Shakman in the book “Greening Food and Beverage Services”. The causes are categorized into two types: pre-consumer and post-consumer.

**Table 1: Causes of pre-consumer and post-consumer food waste**

<table>
<thead>
<tr>
<th>Causes of Food Waste</th>
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<tbody>
<tr>
<td>Pre-consumer</td>
<td>Post-consumer</td>
</tr>
<tr>
<td>Unidentified demand</td>
<td>Large portion size</td>
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<tr>
<td>Overstocking</td>
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<tr>
<td>Inefficient Production</td>
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<td>Poor communication</td>
<td>Inefficient service model</td>
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<td>Staff behavior</td>
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<tr>
<td>Unskilled trimming</td>
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<tr>
<td>Over-merchandising</td>
<td>Customer's menu acceptance</td>
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<tr>
<td>Food Safety</td>
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</table>
The first and most common cause of food waste is unidentified demand. Kitchen operators sometimes have problems to estimate the number of guests they are going to serve and guess what menu will be the most suitable and cost-effective. If the restaurant offers a wide range of menu and changes them very often, this can be a struggle. In order to improve the forecast, studying the customers’ preferences and other factors such as seasonality, weather patterns, and local competition is very necessary. Besides, inefficient production procedures also create a great amount of food waste in restaurants. Chefs often refer batch cooking to a method to food waste reduction; however, it depends on the time of the day as well as the size of the batch. The first reason to address food waste in restaurants is over-production. Restaurant managers and chefs prefer not to run out on all food items, thus, they often stock up and produce in large amounts. Even though the purpose itself is positive, this usually leads to food waste. Besides, food service operations tend to over-merchandise, which can lead to food excess. In addition, confusing food safety policies in different food service operations may produce unexpected food wastage footprint. In many five-star hotel indoor restaurants, false labor/waste trade-offs is another reason why food is created excessively and ended up in the trash. For the sake of minimizing labor cost, food service operators provide food in large batches without realizing that while trying to save on labor cost, they are wasting on resources, food, and money when they toss out food not eaten later. Another reason why restaurants are wasting food is it because operations always try to live up to customer options and choices. Many foodservice operators wish to provide their last customer of the day the same menu and services that the first customer gets. While keeping various menus and services from open till close ensures good customer’s experiences consistently, every day is not the same and waste is generated.

**Impacts of food waste**

Every year a third of food produced for human consumption gets lost or wasted (FAO, 2017). A study in 2014 by the Food Waste Reduction Alliance points out that only 14.3 percent of food waste
gets recycled and 1.4 percent of food gets donated. Up to 84.3 percent simply just get discarded. (Business for Social Responsibility (BSR), 2014, 19) Needless to say, the huge amount of food waste sent to the dumpster certainly have various impacts on the environment, economy, and society. The environmental footprints that food waste create include both upstream and downstream impacts. Upstream environmental impacts refer to the environmental footprint of a food item before reaching the food service operation. These impacts are relatively invisible since they are not obvious for operators and other stakeholders to see. However, they account for a comparatively huge amount of food wastage. According to (FAO, 2013), upstream food wastage, occurring during production, post-harvest handling and storage, make up more than fifty percent (up to 54 percent) of total food wastage.

In terms of upstream impacts, when a food item gets discarded, all resources that are used to produce them go to waste, too. These resources include natural resources that the farmers use for food production such as land, water, fertilizers, pesticides, and the fuel for the tractors; as well as the carbon footprint that the transportation phase costs. At this stage, the food item needs to be refrigerated, which costs energy, water usage, along with the emission of air and water pollutants. At the same time, food waste that occurs during processing, distribution, and consumption damages the environment dramatically as it hits the landfills or incinerators, leading to many downstream environmental consequences. First of all, since approximately seventy percent of food waste content is water, the activity of transporting food waste to the landfill heavily requires a huge amount of fossil fuels and creates air pollution from the emissions. Whereas, this could be prevented by reducing the amount of food waste during different stages of the food supply chain.

Needless to say, food waste costs in many ways to the food service operators. Just for the pre-disposal phases of food waste, there are three different types of expenses: raw material costs, labor costs, and the costs of energy used for food preparation and storing.
However, the costs do not end here. Food waste continues to cost even after disposal, due to the fact that it costs the operators to hire labor to handle the trash disposal and garbage hauling service.

**Challenges of Food Waste in the Hospitality Industry**

Food waste requires thoughtful administrations, yet, it is true that handling food waste in the food service industry is easier said than done due to the fact that there remain many obstacles. About 63 percent of food manufacturers claim that there are barriers that keep the businesses reluctant from recycling food waste. Likewise, in terms of food waste for donation, up to 60 percent of manufacturers admit that barriers to food donation are what keep them being cautious. Moreover, the diversity in food service operation concepts and styles make it more challenging for operators to deal with food waste management. Another most significant challenge is the consumer behavior. A survey conducted on 5000 customers in the UK shows that over a quarter (27%) of respondents left food at the end of their meals when they ate out. In order to reduce post-consumer waste, restaurants are encouraged to provide various portion sizes at different prices accordingly to customers’ options. Food service operators should also train their service staff to address portion sizes and information on the meals to customers when ordering.

**Study Area**

The study was conducted in Dhaka City including its two city corporations, DNCC and DSCC. The Dhaka City Corporation total area is 127.63 sq km, DNCC 82.63 sq km & DSCC 45 sq km respectively with a population of 120 million (BBS, 2011). Three five-star hotels (Pan Pacific Sonargaon, InterContinental Dhaka, Radisson Blu Dhaka Water Garden) were selected for the study.

*Pan Pacific Sonargaon Dhaka:* With a lush garden setting, this refined hotel is 2 km from the Bangladesh National Museum and 3 km from Jatiyo Sangsad Bhaban, the Bangladesh National Parliament. The subdued rooms feature flat-screen TVs and free Wi-Fi. They also include 24-hour room service, and upgraded
rooms feature sitting areas. Suites have separate living/dining rooms. Club-level rooms and suites offer lounge access with free breakfast and cocktails. There are 7 restaurants and bars, including formal dining, an Italian bistro, and a cafe. Other amenities include an outdoor pool and a fitness center with hot tubs, as well as a beauty salon and a business center.

**InterContinental Dhaka (Hotel & Resort):** InterContinental Dhaka is in the most prestigious location, beside famous Ramna Park and National Museum. It's addressed Minto Road, GPO Box 504: Dhaka-1000. It was the first international five-star hotel in the country and opened in 1966, architected by William B. Tabler.

**Radisson Blu Dhaka Water Garden:** Situated on seven acres of luscious gardens in the heart of Dhaka’s primary commercial hub, the Radisson Blu Dhaka Water Garden provides a serene escape from the bustle of the city. The hotel provides the perfect balance of supreme comfort and business-minded functionality, with five-star resort amenities and incredible conveniences, such as the short ten-minute drive to Hazrat Shahjalal International Airport.

**Methodology**
The methodology of this study is based on the survey of the opinion of selected hospitality industries management communities. For this purpose, an easily understandable questionnaire was prepared. A total of 47 questions were placed before the employee, visitor and guest staff, customer, product seller, waster, product distributor, waiter, cleaner, indoor sweeper of selected hospitality company people to get the information regarding the hospitality waste management condition. The questionnaire was prepared in the Bengali language. These questionnaires were analyzed using SPSS Software.

**Analysis and Findings**
The number of respondents was 108. The survey has illustrated that the age of respondents varied from 18 to above 60 years, about 69.44% respondents previously worked in five-star hotel, about 64.81% had knowledge about hospitality waste management,
74.07% didn’t take any training on waste management, 64.81% confirmed the existence of specific policy for waste management in their hotel, 80.56% respondents informed that the waste of existing hotel is properly managed, 53.70% respondents opined that the waste of five-star hotels is possible to reuse, 50.93% informed about the availability of awareness Piccard for guests to keep waste properly, immediate measures were taken in 45.37% cases to remove the waste and liquid waste and 49.07% cases alternative measures were taken, 52.78% confirmed that hotel own car for waste management, 53.70% hotel authority constantly communicate with local government agencies for proper management of waste, about 60.19% respondents opined for special room to keep wastage, 54.63% opined to train staff, 60.19% opined to reuse hotel waste through technology, 47.22% opined to adhere to environmental law, 55.56% opined for the arrangements for refining used chemical products, 55.56% opined to check hotel waste disposal system regularly, 58.33% opined to involve organization in waste management system.

It is important to categorize the types and quantity of waste produced by every department of the hotel industry so that it is managed properly. Office waste (like papers, documents, brochures), household waste (jars, bottles, cardboard), organic waste (vegetable and fruit peels, flowers) can be segregated in color-coded bins for easy and hassle-free waste management. Staff
training is imperative to handle food waste and keep it under control. A synchronized food waste prevention and reduction plan should be created and made available to the employees. Conduct codes and rules should be discussed and followed for the common sake of food wastage prevention in the kitchen, during and after the service. Understanding waste hierarchy is main for manage the waste of hotel. Recovery is the most important part of the process because some value of the material is retrieved through recycling. The last step is disposal which generally involves landfill and incineration of waste. The first step in managing the data analysis of waste is to perform the waste audit. Waste auditing is identifying the process of productivity from waste management practices in hotels. With the help of trash compactors or industrial balers wastes can the volume of waste can be immensely reduced which makes it easier to handle and cost of waste disposal reduced. Right from hospitals to hotel chains compactors of different sizes, shapes and convenience will prove to be perfect as a waste disposal tool.

Conclusions and Recommendations
The HWM program provides a model for learning about the conditions pertaining to Hospitality waste management in five-star hotels. The complexity of issues associated with waste management makes waste planning and management a challenging task. The case study of the HWM program helps to clarify the problem situation by providing a description of the various stakeholders, elements and issues involved with program implementation, and discussion of the conceptual and theoretical understandings relevant to the program. The study concludes that 100% of the hotels are committed to improving already existing waste management practices since they have positive effect on operational performance. The study also concludes that the method of waste management used depends on the size of the hotel, its target market and its level of operation. The HWM program helped improve the management of hotel waste and thereby contributed towards sustainable tourism development in DNCC and DSCC. However, pressing five-star waste problems in Dhaka city still, need to be addressed. Replication and adaptation of the model in other locations and for waste producers other than
hotels are needed. Lessons learned and recommendations based on
the program’s experience can help others replicate and adapt the
model to other locations, or pursue areas for further research.

- From the findings of the study recommends that the s should
adopt HWM that includes waste collection and disposing of,
reduction, appropriate dusting, recycling and reuse
and waste composting.

- The study also recommends that there is a need to
understand the best waste management practices to reduces
its negative effect on operational cost, efficiency, speed of
service delivery and quality of products and services offered.
Government agencies and hotels need to develop policies
and waste management guiding principles/framework and
communicated to all stakeholders for implementation.

- The framework will guide hotel employees on best HWM
and the role these practices play in hotel operational
performance. Hotels should partner with external
stakeholders such as DNCC and DSCC, local communities,
NGO’s and other government agencies to promote waste for
energy technology, reuse, and recycling of waste as well as
developing waste composting systems and water treatment
plants.

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Waste management projects gone to waste,

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EFFECTS OF CIGARETTE SMOKING ON ENVIRONMENT AND HEALTH

Salek Ahmed

ABSTRACT

Use of tobacco is as old as civilization, which has been enjoyed as a part of social custom in increasing the enjoyment of life or as an aid in coping with some of its day to day problem. It imposes a great risk for health, environment and for economy also. Cigarette smoking causes environmental pollution by releasing toxic air pollutants into the atmosphere. The cigarette butts also litter the environment and the toxic chemicals remain deep into soils and waterways therefore causing soil and water pollution respectively. Animals and plants that come into contact or absorb the toxic substances from the cigarette residues are affected as well. As such, it’s not only the cigarette smoke that causes manifold impacts on people and the environment but also the cigarette butt and other wastages released during the entire production process of cigarettes. Interestingly, when people hear about cigarette smoking, they often think of the health risks it has on the human body. Many fail look at the critical side topic which pertains to how it harms the environment. Nicotine, a colourless oily compound is the principal alkaloid contained in cigarette smokes is responsible for adverse effects on the functions of various organs of the body. Also the use of tobacco has negative impact on economy.

Keywords: Cigarette, Nicotine, Environment, Pollution, Health, Risk, Soil, Water, Consumption

Background

The word ‘cigarette’ was derived from the Spanish word “Cigar”. The use of paper made cigarette began during the early part of 16\textsuperscript{th} century in Spain. Gradually it was introduced in Italy, Portugal and...

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Russia. In 1814 French and English soldiers became acquainted with smoking during the Napoleon war. Machine for cigarette was invented in 1880 and thereafter production of cigarettes gradually increased. During the 12th century, the factory made cigarette have come to be by far the commonest means of tobacco use. The production and smoking of cigarette has so increased and their ill effects have been so remarkably well documented, especially in last 30 yrs, that it has been able to attract medical and public attention. Health agencies of many developed countries have demonstrated their serious concern and side effects, and have taken determined effort to discourage smoking through various measures. It has been clearly shown by many epidemiological studies on cigarette smoking supported by Laboratory investigations, that smoking is serious health hazard – ‘the most lethal instrument man has innovated for peaceful use.’ Not only is the health, our environment being also polluted by smoking absolutely. The average consumption of tobacco person is about 1.80 pound and is smoked in cigarettes, bidi and Hukkah (hubble-bubble), pipes and cigars.

**The Ominous Substances We Breathe**

Ominous substances we breathe in such stupendous clouds in a mixture of gases and tiny suspended particles of solid matter produced by any process of burning. When cigarette smokes comes in contact with the moist membranes that lines the air passage leading into the lungs the particles of solid material contained in the smoke adhere to it. As more smoke is inhaled more of the solid material is deposited until a film of tar results. The composition of tar varies, depending on the composition of tobacco and the temperature of which it burns. The average cigarette contains about 25 milligrams of nicotine, most of which is liberated into the smoke when the cigar is burned. Hotter the burning surface, the more nicotine is taken into the systems. The smokers who inhale, absorbs about 90% of nicotine contained in the smoke. The amount of nicotine actually carried into the blood stream of a smoker while one cigar is smoked, will be somewhere between 0.25 milligrams and 2.5 milligrams.

**Nicotine** is also a lethal drug and powerful toxin too. One drop
applied to the tongue of a guinea pig or the shaven skin of a rabbit is sufficient to cause its death. A pin dipped in pure nicotine can kill a dog within seconds. The nicotine content of a little more than 2 cigarettes injected into blood stream would kill a smoker swiftly. When nicotine is so deadly, how does the heavy smoker get by without being acutely poisoned?

So far at least eight chemical substances demonstrated to be carcinogens have been isolated in the condensate of cigarette smoke. The best known is Benzopyrine a dangerous, highly irritant chemical formed at the incomplete combustion of tobacco during smoking. Cigarette smoke contains several gases. Carbon monoxide accounts from 1-5% of total volume of cigarette smoke, each cigarette delivers 12 ml of Co, an amount sufficient to reduce the oxygen carrying power of the smoker’s blood. Experiments have indicated that, smoking of one pick cigar within a seven hour period results in a 5 to 10% carbon- monoxide saturation of the blood. This reduces the amount of available oxygen by depleting the carrying capacity of the blood. Thus it imperils both heart and brain which have large oxygen demands. Carbon-monoxide also increases vascular permeability with significant increased transcapillary escape. Phenols account for almost 1% of total condensate & their presence are said to intensify the effects of the carcinogens which are present in the smoke. Volatile acids like Formic acid, Acetic acid, Benzoic acid in the smoke cause throat irritation & is known to have a promoting effect on the carcinogens. Aldehyde, an irritating substance present about 2 milligrams in the smokes from one cigarette. In the usual technique of smoking about half the total amount of tar is deposited on tissues of the air passages & lungs & the amount contained per cigarette vary from 9 to 40 milligrams.

Effects on Environment
1. Air pollution through industrial production process and farming: The industrial processing and smoking of cigarette add huge volumes of air pollutants into the atmosphere. Second hand pollutes the air directly and the manufacturing process releases air pollutants in many ways. It starts right in the tobacco farms where
the machines used emit greenhouse gases from the fossil fuel combusted to produce energy. Wood burning fires or special furnaces are also required in the curing process, releasing noxious chemicals into the atmosphere. The transportation and shipping for industrial processing and to consumer markets across the world further increases environmental foot print from greenhouse gas emissions.

2. Deforestation: The key ingredient in the manufacture of cigarettes is tobacco & the reality is that of it is planted in rainforests areas. Accordingly, it has contributed to major deforestation in the areas where it is planted. Areas where tobacco planting began on small lands are now extensively covering large fields and some of such places were covered by very dense forest. A prime example is Tabora village in Usenge, Tanzania where local tobacco farmers attest to this phenomenon. In Bangladesh, at Kushtia district extensive tobacco cultivation is observed at Meherpur. In Bandarban also tobacco cultivation is destroying the forest. Paddy and vegetable lands are using for tobacco plantation which is a great threat for our environment and health as well. Deforestation also has its additional ripple effects to the environment such as reducing availability of plants for foraging, loss of biodiversity, soil erosion and increasing global temperature. An hour cigarette manufacturing unit needs about 4 miles of paper for rolling and packing which translates to the destruction of one tree for every 30 cigarettes made. Additionally, many of the producing countries have to burn lots of wood used to create fire for drying the tobacco leaves.

3. Generation of huge amounts of toxic waste: The entire process of cultivating, curing and transporting tobacco needs the use of large amount of chemical & other toxic materials. At the same time, the production process generates huge amounts of wastes such as harmful chemical pesticides and fertilizers. One of the habitually used substances in the production is known as Aldicarb which is very toxic to humans, plants and animals and can seep into waterways and intoxicate the soil for several years. Other toxic wastes generated from cigarette production include DF, Effects of
Cigarette Smoking on Environment and Health

imidacloprid, Dichloropropane, Chlorpyrifos and methyl bromide which can harm plants, humans & animals. In as early as 1995, it was reported that nearly 2300 million kilograms of manufacturing waste is generated from cigarette manufacturing process annually including additional 209 kilograms of chemical waste.

4. **Soil and land pollution through farming and from cigarette butts:** The high scores of pesticides, fertilizers and other toxic chemicals used in tobacco cultivation introduce volumes of hazardous pollutants to the land and soils. These chemicals accumulate and eventually hamper the fertility of the soils and make the lands unsuitable for supporting and other crops. Most of the ingredients present in cigarette butts, on the other hand, are non-biodegradable and take years to break down. The filters are made of cellulose acetate, sourced from plastic, are photodegradable can be broken by UV light but still take an extended period to break down. The filter ingredients therefore remain in the soil for a long period of time, up to 10 yrs. As long as they are present in the soil, the soil remains polluted. In a study at tobacco cultivation in 3 villages of Meherpur, Bangladesh shows that, COPD is 52% and lung cancer is 25% was found among the tobacco farmers.

5. **Air pollution through smoking:** Carbon-dioxide, methane, carbon monoxide and other noxious chemicals are present in second hand smoke which caused air pollution through smoking. As much as methane and carbon-monoxide are not deadly to smokers, the gases do add to the general atmospheric pollution. Smoking globally emits nearly 2.6 billion kilograms of carbon-dioxide and 5.2 billion kilograms of methane into the atmosphere each year. This provides a clear picture of how smoking alone contributes to climate change. Second hand smoke also poses indirect health risk such as cancer, COPD, lung infection to other people & animals.

6. **Cigarette butts and the contamination of waterways:** Cigarette butts are increasingly becoming one of the biggest concerns with regards to littering. It is common to find cigarette butts scattered all over the ground, and they often find way into
waterways when washed by storm water or when they end up along shorelines or on wetlands. Ocean Conservancy points out that cigarette butts are the most common waste matter and a huge no. of ends up in international water systems namely oceans. In 2008, International Coastal Cleanup program managed to clear about 3.2 million cigarette butts from waterways & beaches. This was almost twice the amount of all other trash. Upon contaminating the waterways, they seriously harm aquatic animals, plants and even pollute ground water.

7. Impact on aquatic fish: Fish have particularly been impacted by cigarettes in countless ways. Whenever cigarette filters find way into water systems, they can be ingested by fish because they resemble fish food like insects. The filters remain within the fish reducing their stomach capacity, thus affecting their eating habits. Research in the US also found that the runoff from just a single cigarette butt can kill a fish in a 1 liter jar of water.

8. Forest fires (Wildfires): The forest fires started by burning cigarette butts worldwide are countless. About 17,000 people worldwide die each year because of fires started by cigarette lighters or discarded burning cigarettes. In terms of property damage, the losses are more than 27 billion US Dollar every year. Further such forest fires are damaging to the environment causing biodiversity loss, habitat loss, air pollution, deforestation & the death of humans & the wild animals. A forest fire started by smoking in the year 1987 in China killed 300 people, left 5,000 other homeless and destroyed approximately 1.3 million hectares of land. In Bangladesh, villages like Fulpur, Mirpur in Meherpur and at Bandarban lands are being destroyed by tobacco cultivation. Health hazards like COPD, Lung cancer, Asthma, are also noticed in 2008 (Ubinig’s health study in tobacco cultivation).

9. Health impacts on pets: When pets are outdoors they do so many things like sniffing through garbage & the streets. This puts the pets, dogs and cats at a high risk of ingesting cigarette butts lying on the ground as litter. The consequence can be damaging and may
even kill the pet. Second hand smoke may also make the pets to asthma or other lung problems.

**Direct Risks to Human Health**

Surveys and clinical studies prove that smoking cigarettes regularly cause several health risks for human as following:

1. **Cancer:** Smoking is one of the leading causes of cancer deaths in the world. The smoke contains carcinogenic particles which increase smokers’ risk of developing cancers of the Lungs, Esophagus, Throat, Tongue and Larynx. Smoking is also associated with cancers of the Bladder, Pancreas, Lips, Kidney, Uterus and cervix. In Bangladesh a hospital study shows that, smoking is responsible 48% for Lung cancer, 22% for Throat and oral cancer and 30% for Bladder cancer (April/2011 –My/2013) at Al-Rajhi Hospital.

2. **Lung Disease:** Apart from lung cancer, smoking is responsible for COPD, Emphysema & chronic Bronchitis. In Bangladesh about 80% COPD cases are due to smoking. In other countries also smoking are responsible for COPD & other lung diseases. In heavy smokers, lung cancer is 15 to 30 times as great as non-smokers. Several epidemiological studies shows that the risk of lung cancer there exists a cause directly relationship of smoking. In developed countries smoking is linked to 80% of all deaths from lung cancer, 75% from chronic Bronchitis. In a study in University hospital of Norway (2008 -10) reflected that - smoking is related to 69% cases of Lung cancer with COPD, Emphysema with COPD 59%, only Emphysema 39%. Smokers cough is also a common lung problem & a slow form of suicide.

3. **Heart Attack and Stroke:** Smoking narrows blood vessels hence restricting blood circulation to the heart, brain and other critical organs. It also increases the blood clotting in the legs and lungs. Nicotine causes atherosclerosis and there is high possibility of smokers becoming vulnerable to heart attack and stroke in brain. In UK 25% death was from heart disease. People under age of 44 who
smokes more than 25 cigar a day are nearly 15 times more likely to die of heart disease than non-smokers.

4. Kidney and Bladder: Smoking also affects the urinary organs. Adenocarcinoma is formed in bladder & kidney among the smokers. Even tobacco chewers may develop bladder cancer.

5. Autoimmune Disorder: Smoking suppresses the body’s immune system thus increasing vulnerability to infections and diseases. For this reason smokers are vulnerable to respiratory infections. Further it causes autoimmune diseases including Rheumatoid arthritis and Crohn’s disease. It equally plays a role in the periodic flare-ups of autoimmune diseases.

6. Diabetes Type 2: The most clinical research reveals the existence of a link between type 2 Diabetes & smoking. The smokers are 30% to 40% more likely to suffer from type 2 diabetes compare to non-smokers.

7. Premature Deaths: Smoking leads to premature death because of the associated health risks including respiratory, cancer and vascular diseases. Smoker’s lives are shortened by at least 10 yrs compared to non-smokers. According to WHO cigarette smoking is responsible for more than 5 million deaths each year.

8. Smoking in Pregnancy: Low birth weight babies are born in women who smoke during pregnancy. There is some evidence that the children of mothers who smoked during pregnancy may still be slightly smaller and show slightly lower levels of achievement by the time they are 7 years old.

9. Effects on Eyes: Smoking may have two effects on the eyes; a simple irritation on the membranes beneath the eyelids, and a toxic effect which damages certain of the cells of vision within the retina of eye. Tobacco Amblyopia a serious involvement of eye which affect vision some times. The toxic effects of nicotine affects on certain sensory cells within the eye.
10. **Effects on Mouth and G. I system:** Tobacco chewers are known to have a high incidence of oral cancer and pipe smokers to develop lip cancer more commonly. Smoking suppress digestive power and increases high acidity in the stomach and develops Gastric and Duodenal ulcer. A clear association twice as high between smoking and the prevalence of both Gastric and Duodenal ulcer. The rate of healing of gastric ulcer is low even after anti-ulcer therapy.

11. **Shorten Life:** Greatest excess mortality from tobacco is in productive middle age and one quarter of smokers die prematurely from the habit. As it play a major part in development of many diseases, several studies have demonstrated that - life expectancy of a two pack a day or more smoker at age 25 is 8.2 years less than that for the corresponding non-smokers. Cigarette smokers as a whole, have an approximately 30 -80% greater mortality then non-smokers. The average loss of life in UK by male smokers who die from all causes is about 15 years, from coronary heart disease, about 18 years, chronic Bronchitis 14 years, Lung cancer 11 years. The mortality is lower in smokers who stopped smoking. The excess mortality is greater in those who start smoking at earlier ages than in those who start later in life. In Bangladesh, also mortality rate is higher among the chain smokers than non-smokers.

**Conclusion**
Smoking is a great threat for our health and environment undoubtedly. It has negative impact on economy also. Regular awareness program and advertising about the bad effects of smoking has to be ensured by the health authority both from the public and private sector. From the grassroots level to community wised awareness program must be established through the whole country. Government, non-government, educational institutes, social organization and other organizations have to be involved to prevent smoking by regular meeting, workshop, seminar, health education and monitoring the situation and evaluation also. It is very tough to motivate the chain smokers, but close regular counseling may be helpful for them. The younger and adult groups are more
vulnerable. So, they would be the target for counseling and close motivation. Different groups in the community must take initiative to work against smoking. The people who are involved directly in tobacco cultivation in the rural areas must be motivated about the hazards of tobacco cultivation. Taxation on tobacco has to be increased, so use of tobacco products are discouraged. Through implementation of legislation and comprehensive efforts for tobacco control there would be a reduction of tobacco use in our country and globally as well.

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ENVIRONMENT CONSERVATION VIS-À-VIS DISASTER MANAGEMENT IN BANGLADESH

Mohammad Quamruzzaman

ABSTRACT

Environment conservation is directly linked with disaster management. The more we can protect our environment the lesser will be the disaster risks. Government of Bangladesh plays the lead role in environment conservation to reduce the disasters. People of our country grew resilience facing disasters very frequently. We could reduce the fatalities significantly adopting indigenous methods and adapting to the unfriendly situations during disasters. Bangladesh is the largest delta situated between the Bay of Bengal and Himalayan Range, the largest Bay and the highest Mountains in the World. The Tropic of Cancer passes through her. The very location of our country makes it vulnerable to environment protection and disaster reduction. The Environment Conservation Act 1995 and the Disaster Management Act 2012 along with our best practices made us a positive example to the whole World on the burning subject of environment conservation, climate change and disaster management.

Keywords: Environment, Disaster, Conservation, Management, Reduction, Risk, Act, Relief, Adaptation

Introduction

Bangladesh is in Between 20 degree 34 minute and 26 degree 38 minute north latitudes and between 88 degree 01 minute and 92 degree 41 minute east longitudes. Bangladesh is a disaster prone country located on the conical constricted end of the largest Bay of the World – the Bay of Bengal. On the other hand the highest mountain range of the World the Himalayas stands still on the

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northern edge of Bangladesh. The two mighty rivers of the World the Ganges (the Padma) from Gongotri glacier and the Brahmaputra (the Jamuna) from Manosh glacier made part of Bangladesh the largest Delta of the World. Sundarbans, the biggest mangrove forest in the World is estimated to cover an area of almost 4100 sqkm. The longest unbroken sea beach of the world is Cox's Bazar Beach, running 120 km. The Tropic of Cancer passes through the central region of Bangladesh where the June Solstice occurs, when the Northern Hemisphere is tilted toward the Sun to its maximum extent. The word Tropic itself comes from the Greek trope, meaning turn or change of direction or inclination, referring to the fact that the Sun appears to turn back at the June and December Solstices making summer and winter respectively.

West Bengal, Assam, Meghalaya, Tripura and Mizoram States of India and Rakhine (Arakan) State of Myanmar surround Bangladesh from three sides. Bangladesh and India share a 4,156 km (2,582 mi)-long international border, the fifth-longest land border in the world. Border with Myanmar is 170 miles only. Bangladesh and India together have some of the most intricate and complex river systems in the World. There are 54 river systems in this region with most of them flowing into the Bay of Bengal. The pride of Bangladesh is its rivers with one of the largest networks in the world with a total number of about 700 rivers including tributaries, which have a total length of about 24,140 km. They consist of tiny hilly streams, winding seasonal creeks, muddy canals (khals), some truly magnificent international rivers and their tributaries and distributaries. These great rivers are inseparable from the environment and disaster management of the region, and are of fundamental importance to the people who depend on them for their well-being. The Farakka Barrage diversion of the Ganges water by India has raised salinity levels, contaminated fisheries, hindered navigation, and posed a threat to water quality and public health in Bangladesh. Lower levels of soil moisture along with increased salinity have also led to desertification.

The basic elements of environment are soil, water, air, sunlight with its flora and fauna which know no international boundaries. Thus
Environment conservation vis-à-vis disaster management is studied regionally and globally (internationally) after fixing the local and national issues. The 1962 publication of Rachel Carson's book *Silent Spring* against Dichlorodiphenyltrichloroethane (DDT) was a seminal event for the environmental movement worldwide. Environmental conservation is a broad philosophy, ideology, and social movement regarding concerns for disaster reduction and improvement of the state of living, particularly for future generations. The United Nations Conference on the Human Environment known as the Stockholm Conference 1972 marked a turning point in international environmental politics. Many international talks took place on environment and disaster in capital cities: Paris, Seoul, Accra, Rio de Janeiro, Nairobi, Dhaka, etc. This paper aims to provide information, analyses and recommendations from secondary sources so that the readers can understand and utilize it towards devising plans and implementing those on environment conservation and climate change both adaptation and mitigation for disaster risk reduction in Bangladesh.

**Disaster Management in Bangladesh**

Natural disasters hit Bangladesh, the eighth most populous country in various forms: flood, cyclone, tornado, tidal surge, hailstorms, thunderstorm, riverbank erosion, landslide, coastal salinity, earthquake, drought, arsenic contamination, land degradation and desertification etc. 1970 Bhola Cyclone, Cyclone Aila, Cyclone Sidr, Hurricane Katrina etc took a great toll in our national life. 2011 Sikkim Earthquake, 2015 Imphal Earthquake, 2016 Myanmar Earthquake, 2017 Tripura Earthquake are recent examples, seismic waves of which caused tremendous shaking from very near of us. The major tectonic and seismic elements lie in Bangladesh. It is an integral part of Cretaceous to Holocene geologic period Bengal Basin situated at the juncture of the Indian and Burmese tectonic plates. Bangladesh is one of the seismically and tectonically most active areas of the World. Dauki Fault and Madhupur Fault ruptured our region number of times in past one thousand years. The study popularly known as ‘Dhaka Profile and Earthquake Risk Atlas 2014’ was conducted in two phases by Comprehensive Disaster Management Programme CDMP I (2007-2009) and CDMP II
(2012-2014). It assessed that if an earthquake of 7.5 Richter scale magnitude strikes the capital, it will kill at least 50,000 people, injure 200,000 more, and cause damages worth as much as $5.7 billion. The green activity in all sectors is thought to be the panacea of all types of disaster risk reduction. The green dome over our Prophet’s holy grave in Medina may be a spiritual indication of adopting green activities for benefit of mankind.

Department of Disaster Management (DDM) under the Ministry of Disaster Management and Relief (MoDMR) was set up in November 2012 following enactment of the Disaster Management Act 2012. The Department has the mandate to implement the objectives of Disaster Management Act by reducing the overall vulnerability from different impacts of disaster by undertaking risk reduction activities; conducting humanitarian assistance programs efficiently to enhance the capacity of poor and disadvantaged as well as strengthening and coordinating programmes undertaken by various government and non-government organizations related to disaster risk reduction and emergency response. DDM is responsible to execute the directions, recommendations by the Government in connection with disaster management as well as the national disaster management principles and planning. The Standing Orders on Disaster (SOD) describes the detailed roles and responsibilities of committees, ministries and other organizations in disaster risk reduction and emergency management, and establishes the necessary actions required in implementing Bangladesh’s Disaster Management Model.

A natural hazard is an extreme event that occurs naturally and causes harm to humans – or to other things that we care about. Combining the risk factor the natural hazard can be the probability of a change in the natural environment of a given magnitude occurring within specified time period in a given area of Bangladesh while the associated risk is the consequent damage or loss of life, property and services. The frequency of major hazard appears to have increased since 1960 and the number of people killed each year has decreased at a rate of about 6% and the loss or property has also decreased steadily. This has taken place owing to increased
awareness and better hazard management. The increase in the frequency of hazard can be assigned to such factors as better global and local news coverage, increasing population, increasing urbanization and increasing natural degradation. Natural hazards are now being considered as of global and regional importance and combined global and local efforts are being made to mitigate them. The vision of the Government of Bangladesh about hazard is to reduce the risk of people, especially the poor and the disadvantaged, from the effects of it whether natural, environmental and human induced hazard, to a manageable and acceptable humanitarian level, and to have in place an efficient emergency response system capable of handling large scale disasters.

![Bangladesh Flood Affected Area Map](image)

**Figure 1: Bangladesh usual Flood Map**

More than 80 percent of the population of Bangladesh is potentially exposed to floods, earthquakes and droughts, and more than 70 percent to cyclones. On average, the country experiences severe tropical cyclone every three years, and about 25 percent of the land
mass is inundated with flood waters every year. Severe flooding occurs every 4-5 years and covers 60 percent of the land mass. Following the devastating cyclones of 1970 and 1991, Bangladesh has made significant efforts to reduce its disaster vulnerability and is today considered a global leader in coastal resilience due to its significant long-term investments in protecting lives. Since disasters hurt the poor and vulnerable the most, damages caused by such events can substantially roll back development progress. Disaster Risk Management (DRM) is therefore central to poverty reduction and development efforts. Integrating DRM into development planning and investments in Bangladesh will better protect people and assets from rising disasters impacts. For over two decades, United Nations Development Programme (UNDP) has helped Bangladesh shift from reactive disaster relief to proactive Disaster Risk Reduction (DRR). Resilience through effective rehabilitation aim to restore emotional, social, financial and physical well-being as well as ensuring that physical reconstruction takes place appropriately.

**Environment Conservation for Disaster Mitigation**

Environment is the aggregate of conditions affecting the existence of life and nature, synonym is habitat. The overall global environment is declining fast and for Bangladesh it has been doing so more rapidly during the last few decades because of many obvious reasons. Bangladesh passed an act on environmental conservation in 1995. However, the environmental problems of the country are becoming acute because of population explosion, lack of adequate forest areas and absence of pollution controlling measure on the part of industry or the transport system. The Disaster Management Act 2012 was enacted to mitigate overall disaster, conduct pre and post disaster rescue and rehabilitation program with more skill, provide emergency humanitarian aid to vulnerable community by bringing the harmful effect of disaster to a tolerable level through adopting disaster risk reduction (DRR) programs. Bangladesh possesses rich biodiversity, especially in the forested and wetland areas. Approximately 5,000 species of flowering plants are found in Bangladesh. The country has 266 inland and 442 marine fishes, 22 amphibians, 109 inland and 17 marine reptiles,
Environment Conservation vis-à-vis Disaster Management in Bangladesh

388 resident and 240 migratory birds, 110 inland and 3 marine mammals.

Biodiversity positively impacts human health in a number of ways. The natural species, or biota, are the caretakers of all ecosystems. The main reasons for the loss of biodiversity in Bangladesh are: (i) disruption of wetland habitats through encroachment on and destruction of fauna migration paths; (ii) human encroachment on forest lands for agricultural, settlement and commercial purposes; (iii) indiscriminate felling of trees for fuel and construction resulting in a reduction of tree cover areas and habitats; (iv) over-exploitation of particular resources such as medicinal plants, bamboo and cane leading to loss of protective habitat; (v) over-exploitation of wildlife; (vi) monoculture of high yielding varieties (HYVs) or less diversified cropping leading to agrochemical build-up; (vii) destruction of mangrove forests; and (viii) shifting (slash and burn) agriculture in Chittagong Hill Tracts. Due to the high population density and influence of agriculture based livelihood, pressure on the country's limited land is tremendous. People are even living and using the land in the very low-lying coastal areas that are much exposed to cyclones and storm surges.

The effort for the formulation of an Environment Conservation Strategy began in 1984 and much progress has been made since then. Further, the National Environmental Management Plan: An Action Plan for Bangladesh (NEMAP, 1991) was prepared with the objective of addressing vital environmental concerns, taking into consideration the activities that would arrest further degradation. NEMAP, as claimed, is the logical follow-up to the National Environmental Policy and the National Conservation Strategy (NCS), with the objective of providing guidelines for the preparation of various activities necessary for structuring socio-economic development of Bangladesh on a sustained basis. Bangladesh Environment Conservation Act (BECA) 1995 is set of laws enacted by the government of Bangladesh in 1995 to conserve the nation's environment. Its main goals were to provide for conservation of the environment, improvement of environmental standards, control of environmental pollution and thus disaster risk
reduction and mitigation. Bangladesh Climate Change Trust (BCCT) is formed under Climate Change Trust Act, 2010 to administer Climate Change Trust Fund (CCTF).

Bangladesh is a founding member of South Asian Association for Regional Cooperation (SAARC), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), the Bangladesh-China-India-Myanmar Forum for Regional Cooperation and the Bangladesh Bhutan India Nepal Initiative. Two important SAARC Agricultural Centre and SAARC Meteorological Research Centre are located at Dhaka. Bangladesh receives assistance from SAARC Disaster Management Centre located at Gandhinagar, India. Excessive air- and water-borne nitrogen from overuse of chemical fertilizers in agriculture may cause respiratory ailments, cardiac disease, and several cancers. Pesticides, herbicides and insecticides pollutes air, water and soil. They do extreme harm to non-target species. In an attempt to feed people by a more easier and productive manner, the food has become full of chemicals that are harmful to our health leading to many of the diseases we are faced with today; obesity, cancer, heart disease, high blood pressure and diabetes.

![Image](image_url)

**Figure 2: Bangladesh Urban Area Plastic Pollution**

The call to action for the World Environment Day 2018 was ‘Beat Plastic Pollution’. Plastic pollution is a pressing environmental
concern that requires our collective action. Plastics have become a part of our everyday life. In last few years, production and consumption of diversified plastic products have been extended from households to industrial purposes. The range of thrown away plastic waste has increased significantly. In Dhaka city, about 14 million pieces of polythene bags are thrown out every day, often ending up in rivers and oceans causing biohazards to marine life. Bangladesh experienced floods in urban areas in 1998 and 2008 where polythene and plastic materials were one of the major causes for the blockage of the drainage systems. A recent report published by Earth Day Network (2018) ranked Bangladesh 10th out of the top 20 plastic polluting countries in the world. Plastic contributes eight percent of the country's waste which is equivalent to 800,000 tonnes, of which around 200,000 tonnes go into the ocean through rivers and bays. The Ministry of Jute and Textiles are close to making jute-derived poly bags which can be an effective replacement for polythene bags making people alert and conscientious on environment. “...And do not commit abuse on the earth, spreading corruption.” (Qur’an, 2:60).

**Conclusions**

Bangladesh is a low-lying deltaic country in South Asia formed by the Ganges, the Brahmaputra and the Meghna rivers. More than 700 rivers with distributaries and tributaries have made this country a land of rivers. Bangladesh has a tropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and high humidity. The geographical location, land characteristics, multiplicity of rivers and the monsoon climate render Bangladesh highly vulnerable to natural hazards. Inland water or limnology of Bangladesh is very unique because of its location in between Himalayan range and the Bay of Bengal. The coastal morphology of Bangladesh influences the impact of natural hazards on the area. Bangladesh suffers from floods, cyclones, storm surge, riverbank erosion, earthquake, drought, salinity intrusion, fire and tsunami. Cyclones, tornadoes and floods particularly cause massive damages in frequent intervals. Indian barrages on major rivers raised salinity levels, contaminated fisheries, hindered navigation, caused land degradation and
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desertification, and posed a threat to water quality and public health in Bangladesh.

Bangladesh is an important promoter of regional connectivity and cooperation. Bangladesh is a founding member of South Asian Association for Regional Cooperation (SAARC), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), the Bangladesh-China-India-Myanmar Forum for Regional Cooperation and the Bangladesh Bhutan India Nepal Initiative. Environmental cooperation among South Asian countries may be made effective by reducing political mistrust among countries. Environment and disaster know no international boundaries; thus platforms to be made to set in place new institutions besides the existing ones to work for regional environment conservation and joint efforts on DRR. Greening the economies and achieving the ambitious 2030 Agenda for Sustainable Development in South Asia will require a major shift towards sustainable consumption and production, sustainable management of natural resources and fast action on building resilience to climate change.

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UNDERSTANDING THE CAUSES OF SCHOOL DROPOUT AMONG POOR HOUSEHOLDS IN BANGLADESH

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ABSTRACT

This paper examines the causes of school dropout and not enrolling at the school among the poor households residing in the Greater Rangpur region. The paper analyzed information of 6,402 individuals aged between 6 to 15 years. The survey was conducted in 2014. Among all school going aged individuals, more than 7% individuals were found dropped from school and close to 4% individuals were found never enrolled. Majority of the school drop children dropped from school after passing class five and majority of them were male. Involvement in the wage labor market is identified as the primary reason of their school dropout. Annual household income of school dropped individuals increased due to higher number of earner in the household, and some of those households moved out of poverty as well, still their physical and financial asset base is poor. On the other hand, household poverty is found to be the primary reason of not enrolling in the school at all. Households of not enrolled individuals had lower income and poor asset base. Also living in the char area was found another important reason for not enrolling in the school.

Keywords: School dropout, Labor market, Poverty, Education

1. Introduction

Bangladesh has achieved great advancement in increasing equitable access to education, reducing dropouts, and implementing a number of quality enhancement measures in education at all levels. Government has formulated National Education Policy 2010 which promotes education as a basis for holistic development.

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In this regard, government strongly contributes in facilitating pre-primary education, primary, inclusive education, higher education, reducing illiteracy and other education related initiatives. The Constitution of Bangladesh has facilitated for free and compulsory primary education under the Primary Education (Compulsory) Act 1990. In achieving MDGs in the sphere of education Bangladesh has also shown a significant progress. The country has formulated National Plan of Action I and II to realize the goals of Education for All. Since January 2013, Government has nationalized all non-government primary schools of the country. In terms of enrollment of children to primary schools, the country is well on track of the MDG target as the net enrollment ratio in 2014 was 97.7 percent. The free distribution of all books to all the students up to SSC, introduction of Primary Education Completion (PEC) and Junior School Completion (JSC) examinations, holding examinations timely and providing results in stipulated times are some of the important measures taken by the Government to improve the quality of education in the country. In addition to these initiatives government has launched various stipend programs for the children at risk of dropout due to poverty such as Primary Education Stipend Project (PESP) and School Feeding Program (SEP) and Reaching Out of School Children (ROSC) project as a compliment of Primary Education Development Program. (UNICEF, 2015).

However, in spite of these significant efforts dropout rate from school has not declined at expected level. MDG report (2015) showed that the primary school grade 5 dropout rate in 2014 was around 20 percent (Boys: 23 percent, Girls: 16 percent) which indeed indicates a considerable but significant decrease from 43 percent recorded in 1991 however, since 2000, there has been a declining tendency of the primary school completion rate. Dropout rate at secondary education level is even higher. BANBEIS report (2016) shows that the overall dropout rate at secondary level is around 38 percent and moreover, the girls’ dropout rate at secondary level is around 42 percent.
With this background, objective of this paper is to measure the causes of school dropout in a specific poverty prone region of Bangladesh. Data on 6,402 children aged 6 to 15 years from 5 districts of Greater Rangpur Region is used for this analysis. The paper is structured as follows: section 2 reviews the background literature on causes of school dropout; section 3 describes the source of data and analysis technique, section 4 presents the results and discussion on the findings. Lastly the paper finishes with some policy implication to reduce dropout.

2. Literature Review

Literature suggests that there are many factors that influence the dropout behavior of children from school, some of which are associated with the individual characteristics, such as age, poor health or under-nutrition, child labor, socio economic characteristics of households such as race-ethnicity, sex, family type, family income, family attitude towards children education, size of family and school level factors such as teacher’s absenteeism, school location and poor quality educational provision. For the purpose of this study we intend to review only individual characteristics and household characteristics of the dropped out children.

Child labor affects the probability of dropping out. Several studies found that students who work while in school are more likely to drop out (Rose et al., 2001; Khanam, 2008). Other activities, such as household activities, taking care of younger members in the household, are labor intensive and time consuming and may reduce children’s ability to undertake school work (Dar et al., 2002).

Several studies have pointed out that family income has a major influence on dropout. UN taskforce report on education and gender equality on low and middle income countries shows that dropout rates are high for children from poor households and less than half of the poorest children complete even the first year of school (Birdsall et al., 2005). At a micro-level, family income is directly related to the affordability of education and thus has an impact on dropout (Hadley, 2010). If children do attend education, changes in the financial situation of parents, as reflected by the volatility of
family income, may push some children out of education. (Kane, 2004; Hadley, 2010). Another important household characteristic is parental education level (Chowdhury et al., 2002; Nath et al., 2008). Children having parents with low levels of education are more likely to dropout from school (Blick et al., 2000; Brown et al., 2002) and engage in more income generating activities than children of parents with high levels of education (Duryea, 2003; Ersado, 2005).

Gender plays a very important role while deciding whether the child will continue school or not. Different social norms, values, beliefs, traditions and practices have strong discriminatory elements mitigating against girl’s educational persistence and performance (Colclough et al., 2000) and in many areas drop out from education is disproportionately experienced by girls (Bandyopadhyay et al., 2008; Hossain, 2010b) though there are an increasing number of locations where boys drop out more frequently, especially where there are income earning opportunities. However, it is also found that early marriage, girl child trafficking, and multiple household duties for girls are the influencing factors for girls to discontinue education more than the boys (Vavrus, 2002; Tuwor et al., 2008).

Sabates et al. (2010) conducted a study on 9047 children aged 4 to 15 and investigated factors associated with school dropout using panel data collected over a three year period in Bangladesh from 2007-2009. They found that those who dropped out were on average older, had repeated more school grades, came from lower income families, had parents with lower levels of education, had more household responsibilities, and significantly received less support from parents for their school work.

Empirical evidence in the context of Bangladesh is very limited in the literature. This study thus attempts to examine the causes of dropout particularly among the poor households living in the Greater Rangpur region of Bangladesh.

3. Methodology
Data used for this paper was surveyed by Institute for Inclusive Finance and Development (InM) in 2014 to examine the impact of
 Hasan and Muneer

a special anti-poverty program of Palli Karma-Sahayak Foundation (PKSF) named, “Programmed Initiative for Monga Eradication” (PRIME), targeted for the extreme poor people living in five monga prone districts of Greater Rangpur. The survey was funded by PROSPER project of DfID. Total of 5,602 households were surveyed. All these households were identified by PKSF as extreme poor in 2006-07 and eligible to participate in PRIME program. By 2014, some households became non-poor. However, even the households who were found non-poor in 2014 may have crossed the poverty line just marginally. Apparently, these non-poor households could be still characteristically similar in some indicators in comparison to poor households. So, this is worth examining whether poverty status and food consumption behavior of these households have any significant impact on the school dropout of their children.

Among these households, information on 6,402 children (aged between 6 to 15 years) was available. These children are considered as unit of observation. From the literature review, we observed that, both individual and household specific characteristics may determine the dropout decision of individual. Accordingly, while investigating the factors of dropout, we intend to examine the role of different individual factors such as age, gender, years of schooling and household factors such as poverty condition, pattern of food consumption, asset accumulation, family size, parent’s education, occupation and other indicators. We classified all children into three categories based on their education status in 2014: (1) Currently enrolled, (2) Dropped from school, and (3) Never enrolled in school. All analysis comprises comparison among these three groups of children.

4. Result and Discussion
4.1 Identification
First, we need to understand the characteristics of children in terms of their gender, age and education status. This is observed that percentage of male and female individual does not differ much. Percentage of individuals in the age group of 6 to 10 years is comparatively higher than that of individuals in the age group of 11
individual living in char is highest among never enrolled individuals
individual is the lowest among three groups. Percentage of
however, their income does not differ much from that of school
facilities such as electricity. Physical and financial asset value of
the decision regarding education of their child. Households with
studying individual is higher than that of currently not studying

survey data postulate that percentage of early marriage is not much
higher age.

Finance and Development (InM) in 2014 to examine the impact of
Data used for this paper was surveyed by Institute for Inclusive
Greater Rangpur region of Bangladesh.

mitigating against girl’s educational persistence and performance
parental education level (Chowdhury et al., 2002; Nath et al., 2008).

Another important household characteristic is

2004; Hadley, 2010). Another important household characteristic is

Cultural practices.

(2002). Renewed Hope Daunting Challenges: State of

ndividual factors such as age, gender, years of schooling
both individual and household specific characteristics may

market, annual income of these households increased and some
households of school dropped individuals is that –since the children
school has not declined at expected level. MDG report (2015)
some of the important measures taken by the Government to

country has formulated National Plan of Action I and II to realize
education, reducing illiteracy and other education related initiatives.

Finding is that those who are currently studying, and are still at the
area, male individuals are more likely to get involved in the wage

 dropout (Hadley, 2010). If children do attend education, changes in

household activities, taking care of younger members in the

Next we examine the education status of individuals. Education
status of individuals is used to identify currently enrolled, dropped
and never enrolled individuals. Among these 6402 individual, 89%
individuals were studying during the survey time and rest of the
individuals were not studying. Table 2 report the education level of
all individuals by their current study status. Education level of
currently studying individual present their current (survey time) education status.

Based on the years of schooling of currently not studying
individuals, they can be classified into two categories: individuals
who dropped from school and individuals who never enrolled.
Individuals listed in the last row of Table 2 are those who never
enrolled. Rest of the individuals who are not studying currently have
dropped from school at some education level.

### Table 1: Distribution of school going aged individual by gender and age

<table>
<thead>
<tr>
<th>Gender</th>
<th>School going aged individual (N=6,402)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>3,310</td>
<td>51.7</td>
</tr>
<tr>
<td>Female</td>
<td>3,092</td>
<td>48.3</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 to 10</td>
<td>3,478</td>
<td>54.33</td>
</tr>
<tr>
<td>11 to 15</td>
<td>2,924</td>
<td>45.67</td>
</tr>
</tbody>
</table>

3. Methodology
Greater Rangpur region of Bangladesh.

Among these households, information on 6,402 children (aged 5 to 16 years) was found. The study was conducted over a period of time to understand the factors influencing school dropout. The research involved a survey of 6,402 children, of which 4,700 were currently studying, 702 were never enrolled, 247 were dropped from school, and 455 were still enrolled but never started school. The survey was conducted in the Greater Rangpur region of Bangladesh.

Table 2: Distribution of school going aged individual by current education status and education level (% of total individual)

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Currently studying (n=5700)</th>
<th>Currently not studying (n=702)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolled in Class 1 to Class 5 passed</td>
<td>82.28</td>
<td>58.12</td>
</tr>
<tr>
<td>Class 6 to Class 10 passed</td>
<td>16.28</td>
<td>6.41</td>
</tr>
<tr>
<td>Informal education</td>
<td>1.44</td>
<td>0.28</td>
</tr>
<tr>
<td>No education/never been enrolled</td>
<td>0</td>
<td>35.19</td>
</tr>
</tbody>
</table>

Years of schooling of currently not studying individual presents the education status of school dropped individuals when they leave school. Individuals who have dropped from school have dropped in different years, however, the exact year cannot be identified as there was no specific question on this in the survey questionnaire. From Table 2 this is observed that majority of the individuals who were dropped from school have completed class five or below. This indicates that dropout tendency increase after the completion of class 5.

Table 3: Distribution of school going aged individual by current education status

<table>
<thead>
<tr>
<th>Education Status</th>
<th>School going aged individual (N=6,402)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently studying</td>
<td>5700</td>
<td>89.03</td>
</tr>
<tr>
<td>Currently not studying</td>
<td>702</td>
<td>10.97</td>
</tr>
<tr>
<td>...Never enrolled</td>
<td>247</td>
<td>7.11</td>
</tr>
<tr>
<td>...Dropped from school</td>
<td>455</td>
<td>3.86</td>
</tr>
</tbody>
</table>
Understanding the Causes of School Dropout among Poor Households in Bangladesh

Based on the current status of study and years of schooling, all school-aged individuals are categorized into three groups as mentioned in Table 3.

**Individual specific characteristics**
Among the currently studying individuals there is no difference in terms of gender distribution. However, among the currently not studying individuals percentage of male is much higher than female individuals (Table 4).

Majority of the individuals who are currently studying belong to lower age group (6 to 10 years old). On the other hand, individuals belonging to higher age group (11 to 15 years) are more likely to belong to school dropped individuals. This is observed that, a large portion of never enrolled individuals are aged 6 (not reported in the Table). Though many children get enrolled in school at this age, still children belong to poor households may start their schooling in delay (Table 4).

A large proportion of school dropped individuals (almost 58%) reported some income generating occupation as their primary occupation. Involvement in income generating activities is comparatively lower among never enrolled individuals. Involvement in daily wage labor activities is the most frequently reported primary occupation of currently not studying individuals (Table 4).

Percentage of married individual is comparatively higher among the dropped from school individuals. However, the percentage of early marriage, in general, is very low among all school-going aged individuals. (Table 4).
Table 4: Distribution of school going aged individual by current education status and individual specific characteristics (% of total individual)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Currently studying (n=5700)</th>
<th>Never enrolled (n=247)</th>
<th>Dropped from school (n=455)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 to 10</td>
<td>58.16</td>
<td>56.69</td>
<td>5.06</td>
</tr>
<tr>
<td>11 to 15</td>
<td>41.84</td>
<td>43.32</td>
<td>94.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary occupation</th>
<th>Currently studying (n=5700)</th>
<th>Never enrolled (n=247)</th>
<th>Dropped from school (n=455)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day labor/servant</td>
<td>0</td>
<td>16.19</td>
<td>34.36</td>
</tr>
<tr>
<td>Other income generating activities</td>
<td>0</td>
<td>8.1</td>
<td>23.35</td>
</tr>
<tr>
<td>Domestic work or no occupation</td>
<td>100</td>
<td>75.71</td>
<td>42.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marital status</th>
<th>Currently studying (n=5700)</th>
<th>Never enrolled (n=247)</th>
<th>Dropped from school (n=455)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmarried</td>
<td>99.93</td>
<td>99.6</td>
<td>97.14</td>
</tr>
<tr>
<td>Married</td>
<td>0.07</td>
<td>0.4</td>
<td>2.86</td>
</tr>
</tbody>
</table>

From the above discussion, we can identify some important characteristics of school dropped individuals. First of all, male individuals are more likely to drop from school early. They dropped from school at higher age, mostly after passing class 5. Primary reason of dropping out from school is that they get engaged with some sort of income generating activities. This also explains why male individuals dropped more than female individuals. In the rural area, male individuals are more likely to get involved in the wage labor market than a female individual. Hence, male individuals are more likely to drop from school and get involved in the wage labor market than their female counterpart. Another implication of this finding is that those who are currently studying, and are still at the
lower age group, are at the risk of drop out from school in their higher age.

Contrary to the popular belief that female individuals drop from school early because of social insecurity and early marriage, our survey data postulate that percentage of early marriage is not much among the dropped individuals. So, early marriage cannot be a significant determinant of school dropout among the surveyed individuals.

**Household specific characteristics**

Household characteristics of individual of different education status are presented in Table 5. Education of household head of currently studying individual is higher than that of currently not studying individuals. This indicates that, education of parents may influence the decision regarding education of their child. Households with currently studying individuals have higher access to infrastructural facilities such as electricity. Physical and financial asset value of currently studying individual is higher.

Household annual income of currently studying individual is higher, however, their income does not differ much from that of school dropped individuals. Household annual income of never enrolled individual is the lowest among three groups. Percentage of individual living in char is highest among never enrolled individuals and lowest among currently studying individuals. Household size is almost identical between the groups.
Table 5: Household characteristics of individual by education status

<table>
<thead>
<tr>
<th></th>
<th>Currently studying (n=5,700)</th>
<th>Never enrolled (n=247)</th>
<th>Dropped from school (n=455)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education of household head</td>
<td>1.4</td>
<td>1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>(Years of schooling)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household have electricity</td>
<td>25%</td>
<td>16%</td>
<td>15%</td>
</tr>
<tr>
<td>access (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Asset Value of</td>
<td>190.3</td>
<td>143.3</td>
<td>127.8</td>
</tr>
<tr>
<td>household (‘000 Tk.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial asset of household</td>
<td>8.5</td>
<td>5.1</td>
<td>5.6</td>
</tr>
<tr>
<td>(‘000 Tk.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Income of household</td>
<td>75.6</td>
<td>66.4</td>
<td>72.0</td>
</tr>
<tr>
<td>(‘000 Tk.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of earning member</td>
<td>1.8</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Household living in char (%)</td>
<td>24%</td>
<td>39%</td>
<td>28%</td>
</tr>
<tr>
<td>Household size</td>
<td>5.0</td>
<td>5.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Average age of household</td>
<td>23.9</td>
<td>23.8</td>
<td>26.0</td>
</tr>
<tr>
<td>members</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Poverty status of all households is measured using Cost of Basic Need (CBN) method. A household is considered as poor if per capita total expenditure of the household is below the Upper Poverty Line (UPL). Poverty rate among currently studying individual and dropped from school individual does not differ much. Poverty rate is highest among never enrolled individuals. Calorie consumption of households of dropped from school individual is even higher than the currently studying individual (significant at 5% level). Calorie consumption of household of never enrolled individual is lowest among all individuals (Table 6).

Hasan and Muneer
Table 6: Household poverty status and food consumption status of individual by education status

<table>
<thead>
<tr>
<th></th>
<th>Currently studying (n=5,700)</th>
<th>Currently studying (n=5,700)</th>
<th>Currently studying (n=5,700)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poverty rate (%)</td>
<td>47%</td>
<td>64%</td>
<td>50%</td>
</tr>
<tr>
<td>Food calorie consumption (per capita per day)</td>
<td>2,195</td>
<td>2,139</td>
<td>2,262</td>
</tr>
</tbody>
</table>

From the above discussion, some important household specific characteristics of school dropped and never enrolled individuals are observed. In general, households of currently studying individuals are economically better off and belong to less vulnerable areas with better access to infrastructural facilities. Households of school dropped children had less access to electricity with comparatively smaller asset base than households of currently enrolled individuals. Surprising findings is that, household annual income of school dropped individuals does not differ significantly from that of currently studying individuals. Also these two groups of individual does not differ much in terms of poverty rate—which is actually an outcome of their income level. We further investigate what determine the income of households of school dropped children. We found that average number of earning member of school dropped individuals’ household is significantly higher than other two groups (Table 5). As we have already found in Table 4 that more than 50 percent of dropped out individuals get involved in the income generating activities, hence, number of earner of their household is higher. Higher number of earning members explains comparatively higher income of these households than expected. Higher income results into higher per capita expenditure and hence comparatively less poverty rate than expected.

Does this finding imply that poverty has no impact on school dropout? We need to carefully look at the characteristics of the sample households to answer this question. We have mentioned earlier that all these households were extreme poor in 2006-07. Poor
households decide to engage their school going child into wage labor market because of their low income level and poverty. If these children have had not get involved in income generating activities, annual income of these households would have much lower. Since we does not have any information on in which year the individual have dropped from the school, hence we cannot measure what was the income of the household when the children dropped from the school. However, poor asset base of the households of school dropped individuals (Table 5) suggest that majority of these households were poor in the near past. After the children of these households get involved in the labor market, annual income of the household increase immediately at the aggregate level and with the higher spending ability, some of the household could spend amount higher than the poverty line. Hence, the proposition that children of poor households dropped from school still exist.

Table 6 also reveals that per capita calorie consumption of households of school dropped individuals was higher than that of currently studying individuals. We found that average age of the household members of school dropped individual is significantly higher than other groups of individuals. Higher calorie consumption is thus the outcome of presence of more aged household members. Hence, this findings does not conflict with the proposition that school dropout is an outcome of inadequate food consumption behavior.

This study also found two important household characteristics of never enrolled individuals. First, households of never enrolled households are economically vulnerable. Their annual income, physical asset and financial asset is lower than groups of individuals. As a result, poverty rate is highest and per capita calorie consumption is lowest compared to other groups of individuals. Because of such poor economic base, the household could not send their children to the school. Second important characteristics of not enrolled individuals are that many of them were living in the char areas. Many char areas in Bangladesh does not have education institutions in the proximity. Children living in the char area sometime need to go to mainland to attend the school, which is not
easy and costly for many of them. Hence, living in the remote area is one of the important determinants of not enrolling in the school for number of children.

5. Conclusion
In this paper, we have examined the individual and household specific characteristics that determine school dropout and not enrolling at the school among the poor people living in the Greater Rangpur region of Bangladesh. This paper identified number of individual specific characteristics that determine the dropout of children from school. This is found that individuals mostly dropped from school at higher age, particularly after passing class five. This is also found that percentage of female among the dropout individuals is comparatively low. This contradict with the popular proposition that female are more likely to drop from school due to social insecurity and early marriage. Very small number of dropped individuals was found married. Instead, our survey data found that majority of the school dropped individuals are male. A large portion of the individuals who dropped from school joined in the labor market. Daily wage labor is found to be the major primary occupation of these school dropped individuals.

By examining household specific characteristics of school dropped individuals, this is found that their asset base is significantly lower than that of currently studying individuals. However, households of school dropped individuals had income very close to that of currently studying individuals. Reason of such higher income of households of school dropped individuals is that –since the children of these households get engaged in the labor market, number of earner of these households is higher than other groups of households which contributed to more income for the households and this in turn contributes to move out of poverty by number of households. Though, low income and poverty was the reason why their parents get their children out of school and involve them into the labor market, annual income of these households increased and some households even moved out of the poverty status after being involved in the labor market. In brief, participation in the labor market by male individuals is found to be the primary reason of
school dropout among the poor households in Greater Rangpur. The study also examine why some individuals do not enroll at all in the school. This was observed that many six years old individuals have not enrolled in school yet. In rural area of Greater Rangpur, many households start sending their children to school at their seventh or eighth years. However, the primary reason of not enrolling the children into school is households’ poverty. This is found that households of not enrolled individuals have poor asset base and their annual income is much lower. Also many of these households live in the char area which is another major reason of not enrolling in the school.

Based on the nature of school dropout among the poor households, this study would like to provide some suggestion for the policymakers. Since majority of the individuals dropped from school after passing class five, hence incentive from government is required to encourage them to continue their study. Incentives could be provided in the form of stipends for the students or special benefits (e.g. providing seeds or livestock or health care services free or in subsidized rate) for their parents. Also establishing primary and secondary schools in the char area will contributes to enrollment and continuation of study for char dwelling children.

References
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Understanding the Causes of School Dropout among Poor Households in Bangladesh


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Rahman (2003) described, or As described previously (Rahman, 2003). In case of more than two authors, mention only the first


Though, low income and poverty was the reason why their parents could not send their children to school. Because of such poor economic base, the household could not send their children to school. However, poor asset base of the households of school dropped individuals was higher than that of never enrolled individuals. First, households of never enrolled individuals moved out of poverty as well, still their physical and educational status of individuals is used to identify currently enrolled, dropped and never enrolled individuals. Among these 6402 individual, 89% of the individuals who are currently studying belong to the income of the household when the children dropped from the school. However, poor asset base of the households of school dropped individual does not differ much. Poverty rate around20 percent (Boys: 23 percent, Girls: 16 percent) which is indeed indicates a considerable but significant decrease from 43 percent (UNICEF, 2015).

Majority of the individuals who are currently studying are categorised into three groups as those who are currently studying, and are still at the seventh or eighth years. However, the primary reason of not transferred to the secondary school is the cost. Incentives could be effective to encourage them to continue their study. Incentives could be provided to the household in terms of enrollment of children to primary schools. However, incentives could be provided to the household. Rewards to the student and to the households could be effective to encourage them to continue their study. Incentives could be provided to the student and to the households. This study would like to provide some suggestion for the government to improve the quality of the education. The government is required to encourage them to continue their study. Incentives could be given to the student and to the households. The government will contributes to child labor affects the probability of dropping out. Several studies found that average number of earning member of school dropped individuals, this is found that their asset base is significantly lower compared to non-poor households. Also living in the area will contributes to smaller asset base than households of currently enrolled individuals. From the above discussion, we can identify some important individual specific characteristics that determine the dropout of the children. Whether poverty status and food consumption behavior of these non-poor households have any significant impact on the school dropout of these individuals (Table 4).

Table 4: Distribution of school going aged individual by current education status

<table>
<thead>
<tr>
<th>Current Education Status</th>
<th>Not at all</th>
<th>Partially</th>
<th>Fulltime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents' Education Level</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Enrollment Status</td>
<td>10%</td>
<td>30%</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Units, Tables and Figures**

Metric units should be used. Number all Tables and Figures consecutively with Arabic numerals and give each clear descriptive caption on separate sheet. Type/draw them on separate descriptive pages. Presentation of figures should be absolutely clear.

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