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RESEARCH ARTICLE

EFFECTS OF CLIMATE CHANGE AND ANALYZING THE INDIGENOUS PRACTICES FOR ADAPTATION TO CLIMATE CHANGE IMPACTS IN CHITTAGONG HILL TRACTS (CHT) OF BANGLADESH

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ABSTRACT

Climate change is becoming a serious threat to agriculture, forests, fisheries and food security situation in Chittagong Hill Tracts (CHT) of Bangladesh. High temperatures and uncertain rainfall decreases the production of crops by reducing the length of growing period. Projections show that temperature would be increased by 2.5°C up to 2050 and the rise in temperature would cause frequent and prolong heat waves that can decline the crop production. The security of people, community and the nations is decreasing due to climate change. Expectation is that the consequences of climate change will increase livelihood insecurity, food insecurity, poverty, malnutrition, unemployment, lack of safe drinking water and water borne diseases in Bangladesh. Climate change equally affect all the people but indigenous people in CHT are going to be more vulnerable because of their more closeness to the natural environment and they are the first one to experience, identify and adapt to any climate related change. Temperature rise shall significantly reduce the yield of agronomic crops, water and natural resources. Sustainable crop production under changing climate is a key challenge to the hill people of Bangladesh. That's why, adaptation measures are required to reduce the climate vulnerabilities. The indigenous people of CHT may make the use of their own wisdom and accumulated knowledge gathered from the predecessor over time to adapt to changing climate. The negative effects of climate change may be minimized by developing heat tolerant cultivars and some modification in current production technologies.

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INTRODUCTION

Bangladesh is a small densely populated country but is one of the largest deltas in the world, formed by a dense network of the distributaries of the three mighty rivers namely the Ganges, the Brahmaputra, and the Meghna, and more than 230 major rivers and their tributaries and distributaries (DoE 2015). The total area is 147,570 sq. km and consists mostly (80%) of low flat land, terrace (8%) and the remaining 12% as hilly lands. As a low-lying country with a large area of deltaic floodplains, Bangladesh is well-recognized as vulnerable to the impacts of climate change (Sarker and Ahmed 2015). The climate of Bangladesh is characterised by high temperatures, heavy rainfall, high humidity, and fairly marked seasonal variations (DoE 2016). The climate is tropical in nature because of the effects of the Himalayan mountain chain, with a warm, almost uniformly humid climate throughout the year (Ahmed 2020). Chittagong Hill Tracts (CHT) is the only extensive hill area in Bangladesh, and it is located in the south-eastern part of Bangladesh (Bala and Hossain 2013). The area of CHT is about 13,295 km^2, of which 92 % is highland, 2 % medium highland, 1 % medium lowland and 5 % homestead and water bodies (Bala et al. 2010). CHT is facing some challenges arising from climate change. Flash flood, drought leads to water scarcity, prolonged rainfall triggered landslide, dry up of water bodies due to lack of rain, soil erosion is some of the examples of recurrent climate related hazards. These hazards are impacting life and livelihoods of local community severely as they are mostly inhabited in remote rural areas and living in extreme poverty condition. Watershed is the lifeline of local peoples in CHT but due to some human induced activities compounded by climate change is drying up day by day leaving peoples under water scarcity, low ground water table for crop irrigation, lack of fish resources, and hampering waterway transportation. Climate change with admixtures of anthropogenic impacts are slowing down the development

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works in CHT, which are having serious consequences on normal daily life and livelihoods of local peoples. Hills and mountains are often regarded as areas with less potential and are less favoured for investment in economic growth and development, so that the potential they have remains underused. The result is that these areas have slower growth, more limited economic opportunities, and worse socioeconomic conditions including poverty than in the adjacent plain areas. The paper is in an aim to find out the impacts of climate change to CHT people emphasizing the food security of the local community.

MATERIALS AND METHODS

The paper is categorized as review paper in a sense that it reviews recent development of the scenario of climate change globally and particularly in Bangladesh and specifically on indigenous peoples in Chittagong Hill Tracts (CHT). It incorporates primary literature to produce relevant arguments on the matter of climate change and its affects in different sectors. The paper also involves both qualitative and quantitative analyses, especially in the introductory part to strengthen the reliability of the proposition. Qualitative analyses involve literature texts, data observation sourced from documents like newspaper and peer-reviewed journal articles, related government and NGO/INGO websites and academic discourses throughout the paper. Information also searched PubMed, CABI, Elsevier, Google Scholar, and Web of Science as well as the Websites of several international organizations, including the IPCC, the World Food Program and the Department of Environment (DoE).

RESULTS AND DISCUSSION

Climate Change in Bangladesh: Bangladesh is a disaster-prone country and is frequently refer as one of the most vulnerable countries to climate change (Huq 2001, Huq and Ayers 2007, Rahman and Alam 2003, UNDP 2007). The country possess disadvantageous geographic location with flat and low-lying topography, high population, poverty, reliance of many livelihoods on climate sensitive sectors, e,g, agriculture and fisheries (Climate Change Cell 2006). The existing and expected effects of climate change differ locally and nationally in Bangladesh. Climate change effects on the livelihoods, food and water security, ecosystems, infrastructure etc. of the country. The country has already facing many problems like increasing population, food security, human health, illiteracy, and so forth. The country is likely to be one of the most vulnerable countries of the world to climate change impacts and expectation is that almost every sector of socio-economic life in Bangladesh is likely to be affected by climate change (Karim and Mimura 2008, Khan et al. 2011, Pouliotte et al. 2009, Rahman 2008). In order to address the future vulnerabilities to climate change, it is necessary to understand the interrelationship between climatic regime and associated risks of disasters (Ahmed et al. 2009, Rahman 2008). Bangladesh is facing significant challenges in adapting to the impacts of climate change.

Impact of Climate Change in Bangladesh: Bangladesh is at the forefront of adverse impacts of climate change, because of its disadvantageous geographical location. The country has no control over its water resources as over 92 per cent of the annual run-off that flows through Bangladesh on to the Bay of Bengal enters the country from upstream outside the country. Another reason is that Bangladesh is the most densely populated country in the world. Therefore, per land unit impact falls on the largest numbers of people, who are mostly poor (Anon 2018).

Frequent natural disasters due to climate change make the food security system worsen which is already in crisis to meet the basic demands (Parvin and Ahsan 2013).

Climate change and its consequences in CHT: The CHT is already facing several challenges arising from climate change effects. Flash flood, drought leads to water scarcity, prolonged rainfall triggered landslide, dry up of water sheds due to lack of rain, soil erosion and land slide are some of the examples of recurrent climate related hazards in CHT (Hossain et al. 2019). The threats are impacting life and livelihoods of local community severely as they are mostly living in remote rural areas and with an extreme poverty (Barkat et al. 2009). Climate change with admixtures of anthropogenic impacts has an impact on the life and livelihoods of CHT community. Hills and mountains are often regarded as areas with less potential and are less favoured for investment in economic growth and development, so that the potential that does exist remains underused. As a result these areas have slower growth, more limited economic opportunities, and worse socioeconomic conditions than in the adjacent plains areas.

Agriculture: The agricultural sector contributes 16% to the country's GDP, but almost half (47%) of the population are engaged in the agricultural sector, where rice is the most important product. Within the agricultural sector, the largest sub-sector is crop cultivation (8.73% of GDP), followed by fisheries (3.29%), livestock (2.07%) and forestry (1.42%). Climate change effects are already being noticed by farmers in Bangladesh. One study found that 80% of farmers reported that they had noted changes in climate with unseasonable rain, a more intense dry season, and less rain (Ahmed 2020). Farmers reported lost to average 12% of their harvests to shock, half of which were attributable to flooding and related issues (including water logging and river erosion). The effect of rising temperature on agriculture in Bangladesh depends on a complex combination of factors including higher carbon dioxide levels, heat stress, higher evapo–transpiration, shorter growing seasons, soil moisture levels, soil salinity and so on (Islam and Shafi 2017). It is also expected that climate change may result in overall lower production of most foodstuffs such as most varieties of rice, wheat and potato (Challinor et al. 2007). Climate change has different impacts on different crops.

Rice is the most important crop in Bangladesh occupying about 77% of all croplands, employ 65% of the country's labour force and provide 95% of all food grain consumption. In Bangladesh, yield would be reduced up to 17–28% for rice and 31–68% in wheat production (Karim et al. 1996). Several studies have been reported on climate change impacts on rice (Aggarwal et al. 1997, DeSilva et al. 2007, Karim et al. 1996, Saseendrain et al. 2000, Yao et al. 2007), wheat (Aggarwal et al. 2006a, Aggarwal et al. 2006b, Anwar et al. 2007, Hakala 1998, Ludwig et al. 2008, Magrin et al. 2005, Pathak and Wassmann 2008) and maize (Magrin et al. 2005, Mati 2000, Meza et al. 2008). The prediction is that climate change will affect most agriculture crop which is the major vehicle of ensuring food security (Anwar et al. 2007, Shahabuddin et al.

2015). World Bank (2009) predicts the country's rice production would decline under all the climate change scenarios during the 2005-2050 periods. On the basis of the IPCC Assessment Report, Basak et al. (2010) finds considerable yield reductions (1.5%, 2.5%, 4.4% and 5.4% in the years of 2020, 2030, 2040 and 2050 respectively from the effects of temperature on the yield of boro rice. Evapotranspiration and loss of soil moisture content due to warmer weather will be most severe during the post–monsoon and pre–monsoon seasons especially considering already diminishing rainfall in winter and erratic rainfall patterns, particularly in the northwest of Bangladesh (Ahmed 2006). Pre–Karif or Rabi crops, growing season from December–March, will be mostly affected (Ahmed 2001).

Fisheries: The fisheries sector in Bangladesh contributes to about 3.5 per cent of the GDP, and people rely on fish resources to make up the majority of daily protein dietary requirements. The fisheries sector may also be adversely affected by climate change.Increased temperatures in water bodies will affect fisheries sector in Bangladesh (Adger et al. 2003, Ali 1999, Allison et al. 2009, Huq et al. 2004). With a temperature rise over 32^0C, the death rates of small shrimp will become higher. Moreover, shrimp growth will be reduced due to increased algal bloom in warmer water (Ahmed 2006). The availability of important fish foods such as plankton and snails will be decreased and marine fish habitat and growth of fish species will be impeded because of factors including increased ocean temperature, changing ocean currents, and increased water acidity due to more dissolved carbon dioxide (Board and Council 1999, Jennings et al. 2009, Pender 2008). As a result, fish resources of CHT will sustain significant loss by reducing catch size.

Water resources: In Bangladesh, water is used in different sectors where 50% demand is met from ground water and 50% from surface water (WARPO 2004). Global warming or climate variability changes the water balance like the timing and magnitude of runoff and soil moisture (Jakimavicius and Kriauciuniene 2013). During the past 40-years the temperature increased within the range of 0.4 - 0.65^{o}C and created both positive and negative impacts on hydrological balance in Bangladesh. The effects of change are most vulnerable in the hilly areas due to lack of capacity. In a survey in Komolchari VCF, most of the respondents (93%) believed that temperature was increasing and 92% respondents thought that rainfall pattern was also changing (Chowdhury et al. 2017). However, the hills people are sustainably use the water resources through water harvesting and drinking as it is scarce in hill areas. People dug a hole on the toe of the hill to store seepage water from the hill which was locally known 'Kua' (Chowdhury et al. 2017).

Threats to Biodiversity: Changing temperature and precipitation pattern may exert a strong direct impact on both natural and degraded forests (Kirilenko and Sedjo 2007). Forest dependent indigenous communities depends on natural resources for their livelihoods, but these are currently under threat due to many factors including the adverse impact of climate change. The biodiversity of the country is already threatened by habitat destruction and other human induced stresses and are facing new challenges from climate change (Pender 2008, DoE 2015). Some species will not survive the transition, and 20-30 per cent of species are likely to face an increased risk of extinction. Bangladesh has a diverse forest ecosystems, including savannah, bamboo, freshwater swamp forests, hill forests and mangroves. The changes in temperature and water resources may result in direct pressure on many climate-sensitive species, and cause increased erosion and deterioration of soil quality in hill forested areas. Increased rainfall intensity will cause enhanced erosion in the high hills and cause sedimentation. Flash floods and erosion due to heavier rainfall will damage hill forests ecosystems in Chittagong region.

Flooding: Bangladesh is known to be a "Land of water" and water problems fall between the extremes of flood during monsoon and scarcity during the dry season (Sarker and Ahmed 2015). Flooding affects every aspect of livelihoods, including natural resources, physical resources, social resources, economic or financial resources and human resources. Climate change will increase about 18% of current lowly flooded areas will be susceptible to higher levels of flooding, and about 12–16% of new areas will be at risk of flooding of various levels, while in an average year flood prone areas will increase from 25% to 39% (Ahmed, 2006). Other types of floods include flash floods, caused by the onrush of hilly rivers in Eastern and Northern Bangladesh, and storm surges induced by coastal floods. Flash floods occur in the eastern and northern rivers, along the borders of Bangladesh and they are caused by exceptionally heavy rainfall occurring over neighboring hills and mountains in India (Nayak 2014), and tend to occur between April–May and between September–November. Climate change is likely increase flash flooding in the Sylhet and Chittagong Divisions as heavy rainfall leads to a rapid rise and fall in river levels as it flows quickly down from the hills.

Diseases: Climate change will increasingly alter the distribution of malarial mosquitoes and other carriers of infectious diseases. It also affects the seasonal distribution of some allergy-causing pollen and increases the risks of heat waves. People in CHT are highly vulnerable to climate change induced diseases such as increasing mosquitoes and mosquito-borne diseases (Fardous 2011, Sharma 2012). People in climate-sensitive areas of Bangladesh are suffering from water-borne diseases (e.g., diarrhoea, dysentery and skin diseases), vector-borne diseases (e.g., malaria, vomiting, dengue fever, etc.) as well as mental disorders (Gunter et al. 2008, Climate Change Cell 2009). Warmer weather will have direct correlation with child- and old-age mortality due to overheating and dehydration (Patz et al. 2005). Warmer weather and changing rainfall patterns will result in the outbreak of water borne diseases (Githeko et al. 2000, Hales et al. 2003, Haq 2005, Kovats and Alam 2007, Patz, et al. 1996). Death cases of malaria will be significantly increased due to temperature rise (Rahman et al. 2007). Climate change is accelerating the spread of Dengue Fever (Guha-Sapir and Schimmer 2005, Hales et al. 2002, Patz et al. 1996). Increasing sea surface temperatures with favorable growth of phytoplankton along coast of Bangladesh will facilitate the survival and spread of infectious bacterial diseases such as cholera (Colwell 1996, Cruz et al. 2007, Hales et al. 2003, Patz et al. 2005).

Drought : Drought also reduces availability of biomass for fuel and significantly loss biodiversity. It affects the state of health and nutrition of the population, and above of all,

drought intensifies poverty. There will be significant increase in the intensity or duration of drought (IPCC 2013). Droughts and aridity have caused considerable economic loss and human sufferings in Bangladesh and study shows that drought is more devastating than floods to aggregate production (World Bank 2009). Inadequate pre-monsoon showers, a delay in the onset of the rainy season or an early departure of the monsoon may create drought conditions in Bangladesh, and adversely affect crop output. Drought acts as a catalyst of land degradation through reducing soil moisture and water retention capacity, and thereby increasing soil erosion, decline in soil organic contents and overexploitation of sparse vegetation.

Climate change effects on socio-economic vulnerability: Vulnerability to climate change is related not only to biophysical factors, but also to social, cultural, and economic ones. Socio-economic aspects that affect climate change vulnerability in Bangladesh include the country's dependence on agriculture (most notably rice cultivation) and other resource-dependent sectors, its economic growth and poverty, health, gender, population growth, population density and migration (Islam and Shafie 2017).

Climate change and migration: An increasing trend of migration is observed in Bangladesh and a rapidly growing urban population are the result of climate stresses and shocks. Many Bengalis have been pushed to migrate in CHT due to extreme weather events, rising sea levels, soil salinity and flooding. Due to loss or damage to land, members of many coastal communities, whose livelihoods depend on farming or fisheries, are choosing to move to urban cities or the low populated hill areas of CHT. Every year half a million people moved to the cities mainly from coastal and rural areas. Millions of people will become 'climate migrants' due to sea level rise unless existing coastal polders are strengthened and new ones built. Migration will increase pressures on land and resources in other parts of Bangladesh, which will exacerbate existing problems. Meanwhile, a number of climate refugees from coastal areas are migrated to the hill lands of Chattogram, Cox's Bazar and CHT.

Climate change impacts on food security: Food security is the primary concern in the CHT since most of the rural poor depend on agriculture for their livelihood. Changes in the intensity of rainfall events could significantly affect crop yields. The exact magnitudes are likely to vary but the possible impacts of climate change on all dimensions of food security is expected in Bangladesh (Shahabuddin et al. 2015). In fact, temporal and special changes in temperature coupled to water stress might have key implications for agriculture, in particular for falling crop yields. Effect on agriculture will vary according to locality, but models project a 15-30 % decline in the productivity of most cereals and rice across the region. Climate change impacts could imply significant changes in crop yields, production, storage, and distribution. Low-income rural populations that rely on traditional agricultural systems or on marginal lands are particularly vulnerable.

Degradation of natural resources: CHT faces serious problems of agricultural land degradation (Shoaib et al. 1998, Gafur 2001, Rasul 2006). About 80% of the CHT region is steeply sloped. Combined with heavy seasonal rainfall (2,032 - 3,810 mm per year) and poor soil structure, the topography poses a serious impediment to annual cultivation in most of the region (96%) that is otherwise suitable for tree farming, agroforestry, horticulture and the cultivation of other perennial crops (FFEI 1966, SRDI 1986).

Landslides in hill region are becoming deadlier: Local and indigenous knowledge-based adaptations to climate change have been pursued in Bangladesh, such as Ahmed (2001), Islam and Atkins (2007), Mahmood et al. (2010), Alam (2011), and Anik and Khan (2012). The tribal people living in the remote and rural hill areas experience few or no landslide disasters. Preserving and promoting the indigenous knowledge can help reduce disaster risk. But, local aid workers say indigenous communities are losing some of these traditions as they have to shift toward urban areas. Internal migration has gained momentum in the past decade. Both indigenous communities and Bengali settlers have clear-cut the surrounding hills that accelerates the landslides in the hill districts.

Expected changes and technologies to address Climate Change in CHT

Climate changes will influence both food security and water availability in CHT. The expected effects of climate change in CHT may be as follows:

- Increased temperatures may lead to an increase in diseases, pests, insect attacks on human, crops, livestock etc.,
- Changing seasons (with the length of the crop growing periods decreasing between 2000 and 2030), and erratic rainfall will lead to lower crop productivity or harvest failures,
- higher temperatures will lead to higher rates of evaporation, which may increase by 10-20% already by 2030 that leading to higher irrigation requirements,
- Glacial melt in the Himalayas, combined with increased monsoon rainfall will lead to higher quantities of river discharge. An increase in glacial melt, which already contributes to up to half of the current river flow in the basin, will increase runoff especially during early spring, when irrigation water demand is still low. Increase summer discharges of the three rivers will be 6-18% by 2050 and up to 50% by the 2070s. This increases risks of flooding and requirements for drainage capacity,
- Floods lead to harvest failures, destruction of infrastructure that is vital for agricultural production,
- River and soil erosion and landslides lead to loss of life, agricultural land and production,
- More droughts in some areas will reduce crop/livestock productivity and increase irrigation demand, and
- Cyclones and storm surges may destroy vital infrastructure and lead to harvest failures.

The following indigenous knowledge and technologies of the hill people may be useful to address the climate change impacts in the hill regions of Bangladesh.

Conservation of indigenous knowledge: Ethnic community of CHT has traditional knowledge, practices and technologies which is unique to their culture and society. The knowledge and practices are environmentally and socially appropriate and sustainable (Ahmed 2001, Sarkar et al. 2015) and being transmitted from generation to generation orally (Khan et al. 2007, Mohiuddin et al. 2012). Traditional knowledge supports

livelihood, influences life style, land use planning, resource conservation, culture and unique to a given culture or society. Mohiuddin (2009) documented 26 traditional knowledge practices by the tribal communities where identified 289 ethno-medicinal and food plants growing in wild habitat in Bandarban. The community has vast experiences in utilization and conservation of biological and ecological diversities and ecosystems (Khisa et al. 2006).

Indigenous knowledge and the food security: There are a number of research and academic studies those documented some traditional knowledge, innovations and practices from the CHT and other parts of the country. The hill people in the CHT developed and practices different farming practices by their own effort. In most cases it is location and sometimes community specific. A good number of research and academic studies have documented some traditional knowledge and innovation practices from the CHT and other parts of the country (Alam 1996, 1997, 1998, 2002, Alam and Khisa 2000, Alam and Mohiuddin 2001, Kibria et al. 2015, Mohiuddin 2009, Mohiuddin and Alam 2011). The role of indigenous people and traditional knowledge on natural resource management in CHT has been well focused by a number of studies (Khisa 1997a, 1997b, 1998, Millat-e-Mustafa 1998, ADB 2001, Mainuddin et al. 2007). There is no systematic effort by the government to document and integrate this knowledge in any sector plan or biodiversity conservation planning. Recently an effort has been taken on the rehabilitation of Village Common Forests through Chittagong Hill Tracts Development Facility (CHTDF) program (Chowdhury 2019).

Crop diversification: More than 35 different types of crops are cultivated in CHT annually. Mohiuddin (2009) documented 23 rice varieties and 55 crop species as jhum agro-biodiversity and these species are used as cereals, spices, vegetables, culinary herbs and oil producing plants. Agriculture crops including fruits and trees provide both subsistence uses and cash incomes for local ethnic groups (Quais et al. 2017). But the main cultivated crops are limited to seven including rice paddy, turmeric, ginger and banana. Cotton and sesame were once valuable cash crops but have gradually declined in recent years due to a decline in productivity.

Local climate condition as an indicator for crop selection: Climate of an area is an important parameter for selecting crops for a particular area (Mohiuddin 2009). The Murang community of Empu Para, Bandarban district has select crops considering the climatic-conditions such as thanda (coldness) and gorom (warmness) of a locality depending on altitudinal variation. The farmers at a higher altitude in Chimbuk hill range (about 875 meter) grow citrus fruits like orange (*Citrus reticulata*), malta (*Citrus sinensis*), jambura (*Citrus grandis*), and Satkora (*Citrus macroptera*) etc. in addition to jhum farming. They do not go for pineapples though the farmers near Bandarban and Ruma grow pineapples. Empu Para is situated at higher elevation than Bandarban and Ruma. The climate is comparatively cooler in Empu Para and this condition is locally called as thanda and considered as suitable sites for citrus cultivation and not suitable for ginger cultivation. Foggy weather during flowering time is considered to be suitable for good citrus fruit setting. On the other hand, Sharon Para is comparatively hotter (gorom) than Empupara, and, considered suitable for ginger cultivation. Climate is considered comparatively warmer (gorom) in Ruma and Bandarban than Empu Para, and farmers grow here pineapples, mango, banana, lichi, boroi and papaya. Use of this knowledge will helps in species selection for farming practices of a particular sites based on local climate. Anik and Salam (2017) identify drivers of production and technical efficiency in okra and eggplant production in CHT.

Crop selection by farmers based on altitude and wind velocity: Altitude and wind velocity of an area are also considered as important criteria for crops selection of an area. The hill people of Empu Para and Rwangchari have their traditional knowledge for crop selection based on the altitude and wind velocity of the locality.

The farmers of the Empupara do not cultivate til (*Sesamum indicum*) in jhum at high altitudes, because when the til fruit ripe, the pods split up and disperse for high wind velocity. Cashew nut (*Anacardium occidentalis*) is an important cash crop of the Bawm community of the Rowangchari but farmers of Sharon Para do not cultivate cashew nut. Farmers of Sharon Para reported that high wind velocity during flowering season in the areas causes less fruit setting than Rwangchari. This practice provides site-specific crop selection information and thus ensures higher productivity.

Conservation of forest resources: The climate change may affect geographical distribution, species composition and productivity of forests. Natural forests in CHT must be protected for sustained supply of water following their traditional wisdom. It will also create resilience against climate change and emphasis should be given over conservation rather than plantations. Forests absorb CO_2 from the atmosphere and preserve it into biomass, soils and tree products.

Adaptation and Mitigation measures to the Climate Change effects: The government has developed several strategies and mechanisms to respond to address these risks. The core policy, strategy, and action thrusts have been outlined in the Outline Perspective Plan, National Adaptation Program of Action (NAPA), Bangladesh Climate Change Strategy and Action Plan (adopted in July 2008 and amended in 2009). Adaptation to the impacts is the main focus of these plans. The basic approach is to address economic development and climate change issues in an integrated way so that the resilience of the people is increased and climate change impacts managed through effective adaptive activities.

A few studies, e.g. Ahmed (2001), Ahmed et al. (2018), Islam and Atkins (2007), Mahmood et al. (2010), Alam (2011), and Anik and Khan (2012) succeeded on indigenous knowledge-based adaptations to climate change in Bangladesh. Rahman and Alam (2016) identified a total of 29 climate change local adaptation strategies practiced by three indigenous communities in CHT for crop management (37%), water management (11.1%), soil management (18.5%), production management (14.8%), energy management (7.4%) and income management (11.1%). Farmers have proved highly adaptable in the past to short- and long-term variations in climate and their environment. Also key to the ability of the farmers to adapt

to climate variability and change is the access to relevant knowledge and information (Challinor et al. 2007).

Conclusion

Bangladesh is a small developing country with huge population. Bangladesh is often cited as climate vulnerable and the security of people, community and the nations is decreasing due to climate change. Expectation is that the consequences of climate change will increase livelihood insecurity, food insecurity, poverty, malnutrition, unemployment, lack of safe drinking water and water borne diseases in Bangladesh. Climate change equally affect all the people but indigenous people in CHT, Bangladesh are going to be more vulnerable because of their more closeness to the natural environment and they are the first one to experience, identify and adapt to any climate related change. Climate change has diverse effects on indigenous communities' livelihoods, mainly on their farming systems, agriculture, water, forest, fisheries and the livestock of the CHT. Number of studies suggests that applications of indigenous knowledge in CHT are able to halt the vulnerability of the hill people. Some of the indigenous early warning system may be incorporated into locally managed warning systems to increase the empowerment and resilience of poor and vulnerable people of CHT. Indigenous knowledge used for agriculture, water and forest resources will allow them to cope with better climate change hazards. Indigenous techniques working well in comparison to externally induce techniques, so that crop selection, cultivation with the local wisdom may reduce the poverty and food insecurity in CHT.

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