

Climate risk responses and the urban poor in the global South: the case of Dhaka's flood risk in the low-income settlements

Anika Nasra Haque

Department of Geography, University of Cambridge, Downing Place, Cambridge, CB2 3EN, United Kingdom

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ABSTRACT

The impacts of climatic hazards pose disproportionate risks on the poorer groups who are often the *least able* to adapt. The low-income urban settlements¹ present the extreme cases where the vulnerability to climate risks increases manifold due to pre-existing socio-economic vulnerabilities (e.g. developed through lack of basic services). Despite wide acknowledgement of Dhaka's growing vulnerability to climate change, there is hardly any recent documentation on the existing micro-level adaptation practices, particularly on the most vulnerable low-income communities who are the hardest hit and often lacks the pre-conditions for successful adaptation. Due to the lack of data the understanding of the ongoing phenomenon in Dhaka is not clear and this study attempts to fill the gap by identifying the ways in which Dhaka's low-income population respond to their flood risk. The study adopts mixed-methods (questionnaire survey, focus group discussions, transect walks) to collect required data covering different scales, i.e. household and community. The results show despite being challenged by numerous pre-existing conditions, the vulnerable communities show great resilience to climatic risks based on their limited resources, local knowledge and skills. The study also reveals that the urban poor does not respond to the physical risk itself, rather they respond to what that risk means to their livelihood. Based on the analysis of the existing adaptation responses, the study identifies ways in which the macro-level efforts can be integrated with the micro-level responses to achieve meaningful longer-term resilience.

1. Introduction

¹Climatic hazard converts to (varied) vulnerability determined by the local context, and, it further differs with household and communal circumstances [1–3]. This emphasizes the need for understanding contextually embedded micro-level adaptation. The IPCC Fifth assessment report ([4], p.6) has stated with high confidence that, “Climate-related hazards exacerbate other stressors, often with negative outcomes for livelihoods, especially for people living in poverty”. Hence it is imperative to identify the ways in which the urban poor respond² to their climatic vulnerabilities as they are not only exposed to high climatic risks, but also they have the least capacity to adapt [5,6]. Failure to reduce vulnerability, and also failure to engage with the needs of the vulnerable sections of the society, have put the effectiveness of the conventional top-down adaptation approaches in question [7,8]. Considering the increased impacts of climate-related risks, especially for the urban poor, the need to address adaptation processes at the

micro-level has become urgent. More effective and targeted adaptation policy can be facilitated by an improved understanding of the adaptation processes of the vulnerable urban poor [9].

Vulnerability of the urban areas to climatic hazards is a complex phenomenon resulting from a combination of interrelated physical, socio-cultural, economic and institutional conditions [3,10], hence their consequences cannot be effectively mitigated without active involvement of governments [11]. Therefore, both the capacity of government, and, its willingness to address the vulnerable groups, are deemed necessary for successful adaptation [12]. Since household and communal adaptation by the urban poor mostly addresses the immediate risks and develops as a spontaneous response to the stressors [13], their effectiveness over the longer term is questionable. Therefore, coupling these micro-level practices to the longer term and macro-level adaptation strategies is crucial to achieve greater resilience [14]. From this emerges the need to identify the autonomous adaptation practices at the micro level, and to analyse how top-down adaptation strategies can

E-mail addresses: anikanasra@gmail.com, anh31@cam.ac.uk.

¹ Here the term *low-income urban settlement* is used to include informal settlements, but it is not restricted to this, as urban poor may reside in other areas outside informal settlements and also informal settlements not necessarily house ‘only’ the urban poor.”

² In this paper, the terms ‘urban poor’ and ‘low-income urban population/settlers’ are used inter-changeably.

more effectively contribute to these, to enable the urban poor to (better) adapt to climatic risks. The paper argues for the need of acknowledgment of the relationship between risk perception, livelihoods and adaptive responses at the micro-level and integrate this with the macro-level planned adaptation.

Dhaka, the capital of Bangladesh, has been identified as one of the most vulnerable cities to climate change globally [15]. It is particularly vulnerable for its high density of population, unplanned urbanization, disadvantageous geographic location and poor human development index [16]. Note that, this study specifically focuses on one climate-related risk, that is flooding, to explore the climate risk responses by the urban poor. Flooding is a common scenario in Dhaka and occurs almost every year with varied type and intensity, but always leading to economic, environmental and livelihood damage. The city floods not only by overflowing the surrounding rivers but also through water-logging due to inadequate and inefficient drainage infrastructure as well as unplanned development [17]. Although flooding has a long history in the city, it is projected to be further exacerbated by climate change, because of erratic and heavy rainfall, and river flow changes caused by sea level change [3].

Dhaka is one of the fastest growing mega cities in the world [18]. The city's population is more than 18 million and one-third of this population are housed in the low-income settlements [18,19] that are particularly exposed to natural hazards due to various reasons, e.g. risky locations (due to unavailability of affordable land near livelihood opportunities). Government does not acknowledge most of these settlements and they do not even exist in official documents. Most of these settlements have limited (or no) public services (e.g. water supply, sanitation, education, health facility, drainage). Most of the low-income population live on daily wages without any permanent source of income. They mostly live on a rental basis without any legal tenure. Their housing is largely temporary in nature with flimsy structure which makes them even more sensitive to climatic stresses. There is hardly any effective early warning system in the city as well as no emergency response mechanism in practice. As a result, these population who are most at risk are deficient of the preconditions for successful adaptation, and accordingly face the greatest challenges to adapt.

Despite the growing vulnerability to climatic risks, there is hardly any recent study (post 2012) on Dhaka in relevance to the climate risk (i.e. flood risk) responses by the urban poor. Most of the recent studies address the macro-level flood risk assessment and management without addressing the micro-level processes and practices. For example, Dasgupta et al. [20]'s study on Dhaka's infrastructural flood adaptation; Khan et al.'s [21] study on Dhaka's flood projection and its consequences and Thiele-Eich et al.'s [22] exploration on the flooding trend in the city in relation to mortality. Although these are essential areas of enquiry, what remains unaddressed in recent studies is a closer insight into the micro-level autonomous adaptation processes. The city is urbanizing at a very fast pace³ with increased evidence of flooding in recent years (i.e. occurrence of urban flooding almost every alternate year post 2012). Due to the lack of data the understanding of the ongoing phenomenon

(to cope with the increasing climatic risks) in the city is not clear. It has been stated by UNFCCC ([23], p.5) that the developing countries must take into account the "existing coping strategies at the grassroots level and build upon that to identify priority activities". Nevertheless, in Bangladesh's Climate Change Policies⁴ there are insufficient recognition of the challenges faced by the urban poor and the adaptation practices already undertaken by them. Although the latest policy on climate change (Bangladesh Climate Change Strategy and Action Plan [25]) acknowledges some challenges faced by the urban poor, it has emphasized the need for further research. This indicates that there is a lack of research-based knowledge to delineate the policy for the targeted group. This paper addresses this gap by identifying the responses and strategies adopted by the low-income urban households and communities in Dhaka in order to identify the ways in which it can be integrated with the macro-level efforts to achieve meaningful resilience.

The paper first explores the theoretical frameworks for adaptation to climatic risks in relevance to the urban poor, followed by the research settings (including the case study and methodology used for data collection). The subsequent sections use the quantitative and qualitative data to critically explore and analyse the flood risk responses of the urban poor at the household and communal level and provide *indicative* guidance for potential solutions.

2. Understanding adaptation to climatic risk and its implications for urban poor

The IPCC Fifth assessment report ([26], p.118) has defined adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities". Peoples' responses to climatic stress are diversified. Human beings are essentially resistant to change, so they try to maintain the status-quo by re-directing resources or finding short-term pragmatic adaptation strategies. As mentioned by Satterthwaite et al. ([6], p.51), "Adaptation is all about the quality of local knowledge and local capacity and willingness to act". Over the course of human history, people have been adapting to climatic risks individually or communally as a natural response. However, the changing nature of climatic events (for instance, the changing frequency and intensity of flooding, unpredictable timing) has given this a more complex facet [27].⁵

Adaptation can be at individual or household level or at a higher-level involving community, government or other macro-level actors. It can be in anticipation of an event or hazard, or in response to individual event/s or types of events [28]. Adaptation relates to both pre-disaster, during and post-disaster actions. According to Satterthwaite et al. [6],

⁴ The major policy guidance for climate adaptation for the country are the National Adaptation Programme of Action (NAPA) [24] and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) [25]. Both policies largely derive from a top-down impact-based approach with a strong bias towards technology, infrastructure and state-managed natural resources development. This clearly indicates the dominant influence of state agencies. The urban poor have always been neglected in the national policies of Bangladesh and these two policies are no different. Both policy documents have failed to address (and acknowledge) the local knowledge and adaptation at the micro-level.

⁵ A distinction can be drawn in adaptation: between 'coping' and 'adaptation', though there are blurred boundaries between these two concepts in terms of practical utility and empirical identification producing a potential lack of analytical clarity. Coping capacity can be defined as the ability to respond to an occurrence of hazard and to avoid its potential impacts, whereas adaptive capacity is the ability to gradually transform structure, functioning or organization to survive under hazards threatening to existence. Coping and adaptation unfold simultaneously and continuously in shaping the human-environmental relations, they continuously interact in practical situations, and hence are difficult to separate. For this reason, this study employs the term 'adaptation' rather than differentiating between 'adaptation' and 'coping'.

³ Dhaka is projected to grow at a fast rate of 4.4% reaching a population of 22 million by 2025 [18].

ideally a pre-disaster approach should reduce the hazard scale, for instance, through provision of better drainage that reduces the probability of flooding from heavy rainfall. It should also focus on reducing the exposure of people to such events, for example, improving housing quality or relocating the people at risk of flooding. During disaster, there should be a rapid response, for example, responding to the immediate impacts on peoples' livelihoods. Regarding post-disaster responses, this should (at first) focus on recovery [6]. This involves a learning process as well that should feed into pre-disaster adaptation through observation of post-disaster effects, resulting in better planning for future events.

Satterthwaite et al. [11] highlights the importance of household and communal adaptation by the urban poor, as the city authorities are reluctant to work with this population (particularly those living in the informal settlements). Adger et al. [29] argues that although the urban poor in developing countries may be considered as victims, they have displayed considerable resilience faced with climatic risks, and have coped with climatic challenges despite their vulnerabilities. Adger et al. [29] accordingly expresses the need for a research agenda that builds on existing coping strategies at the micro-level. The urban poor are often left with very limited options so as to reduce their exposure to climatic hazards. And their capacity to adapt are largely shaped by the development context [30,31] which influences the household income and also the quality and extent of service and infrastructure provision. Both are preconditions for successful adaptation. Such insights have led scholars to conclude that there is a strong overlap between development and adaptation [32–34]. Urban poor spend their whole lives adapting to changing circumstances and immediate survival needs are always prioritized over adapting to possible future (climatic) risks [6]. According to Forsyth et al. [35], however, to 'what' risk adaptation is occurring is a crucial question, as adaptation may not always be in response to the climatic risk, but rather, to what that risk means for (their) livelihoods. De Haan et al. [36] discusses a rational approach undertaken at the household level in response to vulnerability considering existing opportunities and constraints, and based on motivation and objectives. Hence, such responses are often dependent on the pre-existing socio-economical vulnerability such as income. The urban low-income households thus adapt to external stress by seeking to maintain their livelihood.

Communal adaptation is more evident in communities with strong social capital and communal bonding. Social capital is based on the connections among individuals within a community, and the informal values or norms shared among them, which enables trust to be built and allows them to cooperate to pursue shared objectives [37,38]. This collective action facilitates pooling of not only communal efforts but also resources and knowledge [39]. It has been identified as a vital aspect of urban adaptation, specifically in the context of low-income communities [40,41]. It addresses the specific nature of climatic vulnerability at local levels, counter impacts on the vulnerable population and respond to these through communal action. This collective action facilitates pooling of not only communal efforts but also resources and knowledge [39]. This communal effort to address shared objectives collectively has been identified as a vital aspect of urban adaptation, specifically in the context of low-income settlements [40,42]. This can be seen as a source of 'capacity' for a community [26]. Central to this idea is the social structure - the bond or relationship - created among the members of the community which defines their social interaction facilitating co-operation for mutual benefit. Adaptive capacity is being continually reshaped through social capital. Attempting to map adaptive capacity through social capital, Pelling et al. [40] draws upon four areas. Social capital helps to generate material interventions for reducing vulnerability to climatic risks, such as, constructing river embankments to reduce flood risk. It can be used to encourage material interventions to increase the capacity to adapt, for example through the education of children. Social capital can be used for institutional modifications in reference to climatic risk, for instance, drawing on social capital to improve access to resources. It can also be used to generate institutional

modifications for responding to stress, for instance, by taking part in votes aimed at the change based on collective decisions. Hence, it relates not only to the embedded relationships and trustworthiness among the members of a community or group (at the micro-level), but it also has a macro-level counterpart which extends towards organizational integrity and facilitating access to resources outside a community. Thus, a community having strong bonding benefits from these links both internally and externally. UN-Habitat [43] and Mansuri and Rao [44] stress that besides the individual and household strategies for livelihood management, collective social action is a prime characteristic of low-income settlements where the communities become the *agents of development*.

Nevertheless, the idea of such autonomous adaptation at the household and communal level has been argued for its efficacy and posing risk by reducing planned adaptation [45]. At the same time, the extensive focus (of the macro-level practices for planned adaptation to climatic risks) on physical risks without acknowledging the context-specific adaptive responses (generated based on the context-specific livelihood risks and risk perception) puts its efficacy into danger by overlooking the social vulnerability to climatic risks [35]. Low-income population, particularly, adapt in diverse ways considering their existing constraints, which are often overlooked, uncoordinated, and unsupported by macro-level organizations (i.e. government, donors) [11]. Acknowledging the importance of integrating such autonomous adaptation processes with the planned adaptation to achieve meaningful resilience, the IPCC [46,47] therefore has requested for more evidence on the autonomous adaptation practices.

3. Research setting

The floods in Dhaka can be broadly categorized into two types: river (fluvial) flooding and urban (pluvial) flooding. River flooding is generated by several flood mechanisms primarily controlled by the flows of the Ganges, Brahmaputra and Meghna rivers, whereas urban flooding is caused by heavy rainfall compounded with inadequate drainage (which includes malfunctioning and nonexistent drainage and sewerage systems and a decrease of wetlands due to rapid unplanned development). Apparently, the western part of Dhaka is protected from flooding by embankments and drainage infrastructure. But Dhaka East, which is predominantly a low-lying area (with Balu river to the East and Tongi canal to the North, see Fig. 1), is completely unprotected. Furthermore, the natural drainage is hampered by illegally filling up the wetlands (to accommodate the growing urban population) and also there is inadequate drainage infrastructure (i.e. only 38% of the city is covered by storm sewer drainage system, which excludes Dhaka East [48]). This results in frequent inundation. Furthermore, most of Dhaka East is outside the municipal jurisdiction (see Fig. 1), hence lacks the municipal services. A significant portion of the city's low-income settlements are located in this part of the city. Being located outside the municipal jurisdiction these settlements cannot access the municipal services. Moreover it hampers their access to NGOs as many of the NGOs can only use their 'urban' funds within the municipal areas to adhere to the definition of 'urban' (which only includes the municipal area) set by the (most) international donors. Hence being largely deprived from the governmental and non-governmental supports, the vulnerability of the low-income populations in Dhaka East are further increased. Considering this context, Dhaka East is selected as the case study for this research.

The research adopted a mixed-methods approach involving different data collection methods primarily governed by the need to collect data from different scales (household, community) and also for triangulation. Hence, a questionnaire survey, focus group discussions (FGDs) and transect walks were undertaken. Note that, based on the available secondary data on the demographics of the study area, here the term 'low-

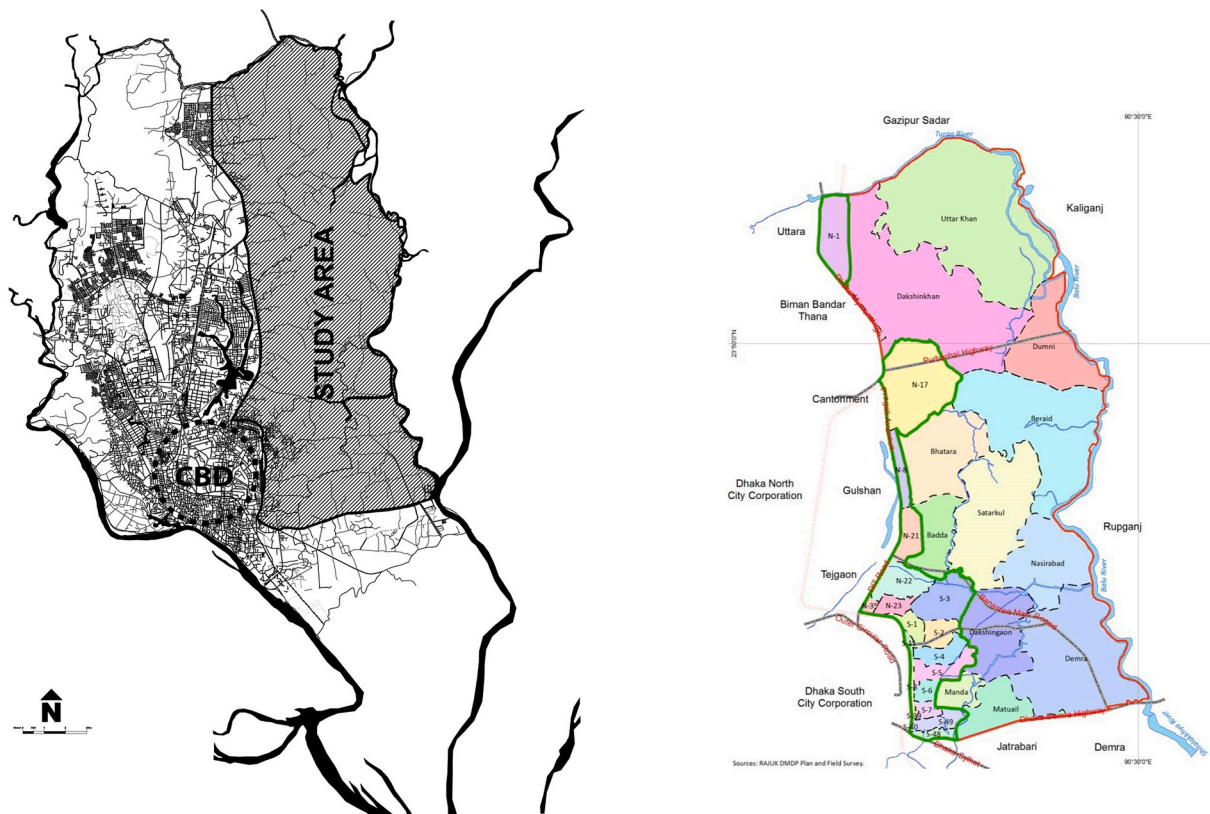


Fig. 1. (L) Location of the study area, Source: Bangladesh Centre for Advanced Studies, (R) Blow up of Study area (Green demarcated areas are areas within Municipality), Source: Adapted from DAP, 2010 [49]. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

income group' has been specified as the households having a monthly income of 9000 BDT (USD 106)⁶ or less. Economic status has been further categorized into three groups according to income level: 'upper' low-income (monthly household income: BDT 5000 (USD 59) – 9000), 'middle' low-income (monthly household income: BDT 3000 (USD 35)-5000), and 'lower' low-income (monthly household income: less than BDT 3000). The categorization is based on the relevant demographic reports on the study area [49,50].

For the ease of collecting data, the study area was divided into four quadrants.⁷ The quadrants were categorized according to the distance from predefined references, i.e. primary road, the central business district (CBD) and the river. Each quadrant was again divided into sub-units, i.e. settlements near water body, housing typology, income, within/outside the municipal area. A pilot survey was conducted to finalize the locations and the settlements to cover within each quadrant.

The questionnaire survey was adopted primarily to collect household responses. 520 households were surveyed covering 99 settlements. Stratified Random Sampling was applied to ensure the representation of the specific groups (refer to the sub-units) in the sample. The (selected) number of settlements in each quadrant varied due to the variation in the population density in each quadrant. A list of 20 adaptation measures was included in the questionnaire based on the pilot survey and author's longitudinal study in the study area⁸ [51,52].

44 FGDs⁹ were conducted with the communities to identify communal perspectives on vulnerability and responses to flooding. The FGDs helped to identify more adaptation responses which are mostly

non-structural and could not be identified during the pilot survey, and hence were not included in the questionnaire. Settlements for the FGDs were decided primarily based on purposive sampling covering different locations (as mentioned earlier). An advantage of snowball sampling was taken to include certain groups, i.e. female-headed households; households with old member, children, disabled; households particularly vulnerable to flooding or having unique experiences from previous floods which were identified while conducting the pilot survey and the questionnaire survey. There were 7–10 participants for each FGD.

Transect walks¹⁰ were conducted to spot the adaptation practices that were not identified through the other two methods. It was important as in many instances there were measures people adopt out of a natural response to flooding without being aware of those to be adaptation measures, which therefore were missed out from the survey or the FGDs. The transect walks also helped to triangulate the data collected through the other methods.

4. Adaptation practices in the study area

It is widely acknowledged that despite the lack of assistance from macro-level organizations, the urban poor keep adapting to climatic risks based on their own capacity and existing knowledge [5,6,14,35]. However, in many instances their everyday struggle for survival might not allow much scope for dealing with possible future climatic risks:

"Shall we adapt to flood or struggle to stay alive by only fulfilling the basic needs? We can't even ensure meals three times a day for our family ... adapting to flood is an insignificant issue to worry about" (female, from a settlement near waterbody, outside municipal area).

⁶ 1 USD = 84.5 BDT (Bangladeshi taka) has been used.

⁷ See supplementary material 1 for further details.

⁸ See supplementary material 2.

⁹ See supplementary material 3.

¹⁰ See supplementary material 4.

Despite this, a total 37 flood adaptation measures were identified from the field (see Table 4). Amongst the 20 adaptation measures included in the questionnaire (refer to section 3), 12 were household-level adaptation and 8 were community-level adaptation. Another 17 measures were identified through the FGDs. Table 1 represents the demographics of the surveyed population¹¹ in relevance with the most recent (2005) slum census data on Dhaka city [50] which shows the surveyed sample is broadly representative of the city with some deviations.¹²

4.1. Household adaptation¹³

The survey data shows the most frequently applied flood-adaptation practices at the Household level are (also refer to Table 2): *raising the level of the household furniture* during periods of water logging or flood (99.8%)¹⁴; *raising the plinth level* (96.5%); *putting bricks on the pathway* in front of the house to facilitate mobility (95%); and *using polythene sheets on the roof and walls* to prevent rain-water seepage inside the house (84%). *Raising the plinth level* has now become a form of vernacular architecture and people adopt this even without being aware of it as a flood adaptation measure. There are some more practices widely adopted by the households, for example: constructing *matcha*¹⁵ and placing bedding and other valuable objects on *matcha* to protect those from the flood-water inside the house. Another example is *construction of shelves near the ceiling* for storing household valuables during the period of water logging (to avoid damage). Very few households were found to *store food* as they simply cannot afford to do so (even after getting a flood warning) due to their poor financial condition:

“... we hardly can afford three meals-a-day ... storing food is beyond our capacity” (male, FGD participant, settlement near waterbody, outside municipal area).

Therefore such measure is only adopted by the ‘upper’ low-income group [see Table 2]. 41% of the surveyed households were growing vegetables either on roof or in the surrounding areas. The households

Table 1
Demographic data.

Variable	Indicator	Survey data (in the study area)	Census data (Dhaka city)
Housing ^a	Temporary	40%	46%
	Semi-permanent	50%	52.3%
Income	below BDT 3000	16.3%	22%
	BDT 3000-5000	37.7%	62.1%
	Above BDT 5000	46% (between BDT 5000–9000)	14.6%
Occupation	Daily wages	43%	46%
Education	Illiterate	50.2%	–

^a Here temporary structure refers to structures constructed with wood, bamboo, corrugated tin etc. Semi-permanent structures differ from temporary structure in terms of plinth material which uses more permanent construction materials, e.g. concrete, brick.

¹¹ For further information on the demographics, see supplementary material 5.

¹² Note that, the data can vary across sources depending on various factors, for example, definition of variables and indicators.

¹³ See supplementary material 6 for the images for household adaptation practices.

¹⁴ Percentages of households adopting certain adaptation measure in reference to Table 2.

¹⁵ ‘Matcha’ is a local term used for temporary elevated platform constructed by bamboo or wood.

Table 2
Household adaptation practices as identified based on the questionnaire survey.

Adaptation practice	Frequency of responses	Adaptation practices in relation to income level		
		‘Lower’ low-income	‘Middle’ low-income	‘Upper’ low-income
Putting bricks on the pathway in front of the house to facilitate mobility	94.8%	15.4%	37.3%	47.3%
Vegetation on the roof	21.3%	0.9%	44.1%	55.0%
Storing food	4.6%			100.0%
Using polythene sheet on the roof and wall to prevent rain-water seepage inside the house	84.0%	19.2%	43.7%	37.1%
Raising the plinth level	96.5%	16.5%	37.5%	46.0%
Elevating the level of the household furniture during water logging or flooding	99.8%	16.4%	37.8%	45.9%
Modification of (housing) roofing material	34.6%		26.7%	64.4%
Modification of (housing) walling material	22.5%		24.8%	71.8%
Construction of shelves near the ceiling	67.7%		34.1%	58.8%
Vegetation in the surrounding	41.0%	8.5%	28.6%	62.9%
Constructing matcha	63.1%		43.0%	52.7%
Others (i.e. use of Styrofoam for vegetation)	1.5%		50.0%	50.0%

living by the riverside (where there are more open spaces) grow vegetables in the surrounding areas, whereas roof vegetation is mostly practiced in the settlements near the CBD where there is limited space due to the high density of housing development. Such measure not only ensures food security during disaster but also provides them with income source by selling the vegetables in times of crisis. *Modification of housing material* is not much in practice because of tenure insecurity (as mentioned during FGDs). Note that, 88% of the surveyed population do not have any legal tenure (this includes 6% who have illegally built their houses on vacant lands). Most of these settlements are either developed by the influential local people (locally known as *mastaans*) in public vacant land or by the landowners on privately owned land. Therefore, the majority live under threat of eviction, though the degree of threat may vary depending on the type of settlement. It was revealed during the FGDs that they hesitate to invest in making their housing more resilient in fear of forced eviction (i.e. if they are force-evicted all their investment will be lost) (also refer to section 5). This resonates with Payne et al. [53] reporting evidence from Peru where 75% of the households with legal tenure invest in improving their housing, whereas a much lower percentage of households (39%) invest for the same purpose when they lack legal tenure.

Thus the most practiced measures (e.g. raising the level of furniture, using freely available bricks/broken slabs/stones to facilitate mobility) are largely those that hardly require any investment. The most practiced modification of housing involves using readily available materials which do not cost much or are available for free, e.g. second-hand corrugated tin, polythene sheet, wood, bamboo, jute sticks etc.

An interesting and innovative practice was identified through the survey where households (1.5%) were making styrofoam tubs on the water body to grow vegetables (i.e. catering to food security). This was identified in a settlement which was partially on a waterbody and there was no available land for vegetation. Some more innovative practices

came out into light during the FGDs and transect walks. One such practice is mixing ash, bran and straw to increase the strength of the mud and using this reinforced mud to construct the plinth and the walls of the house to increase the strength to withstand longstanding water-logging. Households were domesticating animals which could potentially help them during the times of food scarcity and also could serve as an income source at times of financial hardship during disasters. They were also teaching their children to swim (mostly after experiencing recent big flooding events) as this is often required during the big flood events.

Interestingly, the FGDs also revealed that the surveyed groups often adopt fatalist behaviour when they feel that individually investing on adaptation will not make any difference and they are unable to (significantly) reduce their flood vulnerability with their limited income/capacity. Hence they prefer not to do anything and face the situation when it arises. This behavior was well expressed by one of the FGD participants (male participant from a settlement near the canal, outside the municipal area),

“It does not matter whatever action we take individually, we have to face the consequences of flood, may be the intensity will be slightly lower, but we have to anyways face it, so it is better not doing anything and face it when it ariseswe pray to Allah (God) that no flooding happens.”

The households reporting this behavior mostly belonged to the ‘lower’ low-income group who mentioned about responding only when the situation demands, rather than taking precautions. Hence they are mostly relying on during-disaster measures, rather than pre-disaster planning. During the FGDs several communities (29 out of 44) reflected on the unpredictability of the current weather and the lack of early warning system in the study area, that do not allow them (and also they cannot afford) to be prepared for floods all the time. Therefore, they are left with no other option but face the situation when it arises.

“... we cannot be ready all the time for a disaster before it occurs, we have no choice for that as we have so many issues to deal with in our everyday life ” (female participant from a settlement within the municipal area, near CBD).

Some households move out of their house during the big flood events and take shelters at friends’ or relatives’ places within the city (where possible) and in most cases send their families to their home village. They return to their house once the flood water recedes. This can be seen as another ‘during-disaster’ response though they consider it to be the last option and are not willing to leave their house until it is a big threat for their family and livelihood. Some even mentioned about living on the roof (when flood water intrudes inside the house) before deciding to leave their houses. It was also revealed that women tend to avoid going to the flood shelters but prefer to move to their home villages or to a relative’s house. The primary reason behind this, as identified by the women during the FGDs, is the socio-cultural values which discourage them to share the same room at the flood shelters with unknown males. There are households who switched their occupation on suffering from a flood event (post-disaster response). For example, one household-head mentioned being a small trader and selling vegetables in the local neighbourhoods whose business suffered severely during the 2008 flood: during the flood he had nothing to sell and he had to use his assets to survive the flood. And he could not restart his business after the flood as there were no capital left. This pushed him to switch occupation and now he is a rickshaw-puller. Referring to the general discussion on Dhaka’s urban poor in section 1, the majority (57%) of the surveyed population lives on daily wages (e.g. construction worker, domestic help, rickshaw puller, taxi driver, boatmen). These occupations might

require travelling to different locations within the city which can be restricted during flood events. Another 14.2% runs small businesses (e.g. vegetable vendor and shop owner) which are mostly local (within the neighborhood).¹⁶ Although it was found that all the surveyed households’ livelihoods were threatened by flood to varied levels influenced by various determinants (e.g. asset, location of housing, gender, access to organizations), certain occupations were found to be more threatened (than the others) which includes small enterprises/business (e.g. due to lack of supply of selling items or price hikes); day labourer (e.g. halting of construction works).

Some communities with active community-based organizations (CBO)¹⁷ mentioned using the savings of the CBOs (voluntarily donated by the community members and other influential locals) to supply them with emergency food and drinking water during flood. During transect walks, households were found constructing barriers on the doorsteps to prevent flood water entering the house (pre-disaster adaptation) and if water gets inside they bail it out using bowls and buckets (during-disaster activity). Some houses were using plastic sheets on the floor to prevent water seepage when the water level reaches the plinth level. Following repeated destruction by the river floods, especially in the riverside settlements, the households built ancillary facilities (e.g. cooking areas, stable for animals, storage) with locally available materials without spending much anticipating potential damage during the future floods. One such example is using jute sticks and bamboo frames for wall and plastering this with dried cowdung to increase the strength of the wall. Dried coconut leaves or second-hand corrugated tins are used as roofing for this type of structure. Dried cowdung is also used on the surface of the elevated lands for settlements to make it more stable so that it does not erode easily during prolonged water logging.

4.2. Communal adaptation¹⁸

Communal efforts were very evident in the study area primarily addressing the locally-experienced flood vulnerability. These types of adaptations are mostly found in the settlements where there is a closely knit and active community. Such communal adaptations, as referred by Ayers et al. [1], address the specific nature of climatic vulnerability at local levels, counter the impacts on the vulnerable population and respond to these through communal actions. During the FGDs, all the surveyed communities repeatedly stressed on the efficacy and importance of collective action for flood adaptation.

“... individually we cannot do much as we have so many limitations particularly in terms of financial capacity, but collectively we can certainly act better” (male CBO member from a riverside settlement, outside the municipal area).

The most common form of such adaptations, as encountered in the study area, was *formation of community groups/CBOs*¹⁹: (89% surveyed households had voluntarily formed formal/informal community groups to serve their common interests, see Table 3). Existing social capital (see section 2)- with increased trust, co-ordination and communication within the communities-made it possible for individuals within the communities to come together and form such voluntary organizations, and use their networks and bonds to address the communal needs [54]. However, only 12% CBOs were found to be formally registered with the

¹⁶ For more information on occupation types of the surveyed households see supplementary info 5.

¹⁷ A Community-Based Organization is a grass-root organization which is non-profit and mostly develops voluntarily, and is representative of a community, working at the local level with an objective to serve the communal needs.

¹⁸ See supplementary material 7 for the images for communal adaptation practices.

¹⁹ Further adding to the footnote 18, in this paper CBOs refer to community groups irrespective of their formal recognition (registration).

Table 3
Adaptation practices at communal level identified based on the questionnaire survey.

Adaptation practice	Frequency of responses	Adaptation practices in relation to income level		
		'Lower' low-income	'Middle' low-income	'Upper' low-income
Elevating land level of immediate surroundings of the house	31.3%	5.5%	16.0%	78.5%
Cleaning up the adjacent drains	29.0%	13.9%	42.4%	43.7%
Use of community kitchen	35.6%	16.2%	43.2%	40.5%
Formation of community groups/CBOs to serve common interests	89.0%		38.0%	44.5%
Communally fixing or repairing basic services and infrastructures	57.7%		41.7%	41.7%
Constructing elevated pathway with bamboo during water logging	25.8%		39.6%	43.3%
Constructing small retaining walls at the edge of water-body to avoid soil erosion	28.1%	6.2%	37.0%	56.8%
Use of sandbags to protect the edge of water body from soil erosion	46.7%		38.7%	45.3%

Government. Registration with the government gives a CBO more formal grounds to be acknowledged by both the government and NGOs, which helps them to access outside resources (funds), and to collaborate with NGOs for service provision. Further investigating on this during the FGDs, the political difficulties of the registration process were revealed. For registering CBOs it often requires bribing government officials at different levels and yet they might not get registered as the government restricts the number of registrations. And to adhere to this limitation communities with households lacking formal tenure are hardly considered for registration. Moreover, if there are no politically influential people affiliated with the CBO, registration is very unlikely to proceed.

Another form of community-based adaptation is *communally fixing or repairing basic services and infrastructures*, e.g. tubewell, toilet, road. Some of the communities were found to communally *clean-up adjacent drains* (i.e. removing solid wastes from the drains causing blockages). But this is less practiced (29%) as the majority of the surveyed settlements do not have surface drains (also as mentioned earlier, the study area does not have any storm sewerage system). Some of the riverside settlements were found *elevating the land level of the immediate surroundings* of their houses to protect the settlements from river floods and this is mostly practiced by the small settlements (including 5–6 households). Communities also *constructed elevated pathways with bamboo* during waterlogged periods to facilitate mobility. It is a common scenario that the banks of the water body or river erode during flooding, sometimes the land erosion engulfs settlements as well. Settlements located by the river and waterbodies were found to *construct small retaining walls* (often bamboo structures) at the edge of the water-body to avoid such land erosion (refer to Ref. [40] in section 2). *Sandbags* are also used for the same purpose. *Community kitchens* are used by 36% of the surveyed households for cooking communally during floods, i.e. the participating households contribute food items and cook for the community during flooding (during-disaster activity).

More such successful communal adaptation practices were identified during FGDs. For example, a formal CBO (within Municipal area)

constructed a drainage system to solve the longstanding waterlogging issue in their community. They utilized the funds accumulated through the voluntary donations from local political leaders, the community and a local mosque to construct the drainage system that allowed to drain the excess water from their neighborhood to the adjacent canal. Referring to UN-Habitat [43] and Mansuri and Rao [44] from section 2, this is an example when communities become the *agents of development*. During the FGDs, the surveyed communities unanimously admitted about the difficulties to adapt to the river floods individually or even communally. They considered it to be the responsibility of the government who could potentially save them by making large-scale interventions. Also, they reflected on their limitation to significantly reduce their vulnerability and exposure without organizational intervention. As Ensor eds [55], suggests adaptation cannot occur in an institutional vacuum: support from relevant institutions is needed in order to enhance the adaptive capacity of the local communities, and to reduce the exposure and sensitivity. Aptly noted by a CBO member (male) from a riverside settlement (outside the municipal area):

“... how far can we go? ... we neither have the money nor capacity to put embankments to protect our settlement from flooding ... nor do we have the capacity to install a drainage system in our locality ... it is only Sarker (government) who can save us”.

There is no pre-disaster governmental support in the study area. Governmental support is only available during disaster, e.g. relief, and the municipal reliefs are only offered to the settlements within the municipal areas. Hence the study area ends up with minimal relief support from the central government and NGOs. Furthermore during national flood events, central government prioritizes relief activities based on the impact across the country, hence in most cases, coastal areas are prioritized over the other areas. Although post-disaster activities are relatively uncommon, some NGOs render assistance to the affected communities after disasters, e.g. by providing construction material for rebuilding houses and small grants for income-generating activities. But such activities are also somewhat controlled and restricted, as the common practice for the government is not to approve a project that falls outside the governmental activities or contradicts its policies. For instance, it only approves projects in the low-income settlements that are recognized by the government. Hence there is not only lack of governmental support in the study area but also NGO supports are somewhat restricted by governmental interventions.

5. Categories of adaptation practices

According to Smit et al.'s [56] framework, adaptation practices to climatic risks can be described by analyzing three basic components: adaptation to what, who/what adapts, and how does adaptation occur. The scope of this paper narrows down these considerations with specific focus on adaptation to 'flood risks' (i.e. adaptation to what) by urban poor (i.e. who or what adapts). Smit et al. [56] elaborates on the third component, i.e. how does adaptation occur, by emphasizing on the basis of the intent of purposefulness, function and outcome (e.g. prevent, tolerate, protect from loss and damage). Further expanding on the discussion in section 2 (refer to Ref. [6]) on the adaptation typologies based on temporal scope and combining this with Smit et al.'s [56] framework to describe adaptation, all of the identified adaptation practices in the case study area can be broadly grouped into five principal categories (as follows):

5.1. Temporary adaptation

The majority of the responses by the low-income households are temporary solutions addressing the immediate risks, hence, those are rather impact-minimizing than preventive. These activities encompass *minor modifications to housing*. 51% of the adaptation practices are found

to be temporary in nature (refer to Table 4). Poor financial capability is certainly one of the fundamental reasons behind this [refer to Table 2] and it also somewhat reflects the vulnerability deriving from the lack of tenureship, which does not encourage them to invest much in making the housing and built environment more adaptable to flooding (see section 4). This resonates with other literatures indicating the ad hoc adaptation practices by the low-income urban residents due to tenure insecurity [57–59].

5.2. Risk reduction

Risk reduction strategies include preventive activities, mitigation activities and activities for building adaptive capacity [60]. Referring to Satterthwaite et al. [6] (see section 2) this type of activities are mostly pre-disaster activities reducing the hazard scale and exposure. In practice only 27% of the identified measures are focusing on risk reduction (Table 4), for the same reasons as mentioned above (e.g. lack of financial capability). However, these approaches were mostly found in the well-knit and organized communities or the communities with efficient CBOs. These include activities like *putting bamboo embankments* by the edge of river/water body, *elevating the land* of the settlements, *improving drainage system* etc.

5.3. Insurance

Here insurance refers to any kind of security system (monetary or non-monetary) that assists people during the event of disaster. These include: *saving activities* which can be household-based or through services offered by government and NGOs (e.g. money saving schemes); *having assets* that can be sold when needed or which can help with survival during disaster (e.g. growing vegetables on the roof or in the surrounding area, having domestic animals); *switching to jobs* which are not climate sensitive; *moving to a safer location*. Approximately 11% of the identified measures are broadly insurance related (see Table 4) and mostly adopted by the ‘middle’ to ‘upper’ low-income groups [see Tables 2 and 3]. It was identified during FGDs that sometimes insurance can be accessed through organizations as well; for example, CBOs may have emergency funds. As most of the settlements have very limited or no access to organizations (i.e. government and NGOs) (see section 3), only few households are able to adopt measures related to insurance. Note that, some of the NGOs require households to hold a legal tenure in order to be assisted. The primary reason behind this, as explained by a senior NGO official, is that many of their long-term financial services (e.g. microcredit, loan) require to track the beneficiary households which is difficult for households without a legal tenure. This further justifies low uptake of insurance related practices in the study area.

5.4. Fatalist behavior

As mentioned earlier, an interesting identification from the study area is the practice of fatalist behaviour, which is basically a ‘non-strategy’ for survival, involving only praying to god and doing nothing. This is based on the notion that taking any measure or not doing anything will have the same negative consequence (also see Ref. [60]). Although among the identified practices, only 2.7% belongs to this category (as there is only one strategy under this category/behaviour, and that is *praying to god*), the FGDs revealed that it is largely practiced by those belonging to the ‘lower’ low-income group who have no or very limited capacity to adapt.

5.5. Recovery

Recovery strategies refer to post-disaster activities undertaken to recover as fast as possible from the flood impacts. It is closely linked with insurance and mostly practiced within the households. For instance, savings can help to recover from loss and damage. Organizational access

Table 4

Categorization of the adaptation practices in the surveyed settlements.

No	Response	Scale	Type of response	
1	Putting bricks on the pathway in front of the house to facilitate mobility	Household	During-disaster	Temporary
2	Vegetation on the roof	Household	Pre-disaster	Insurance
3	Storing food	Household	Pre-disaster	Insurance
4	Using polythene sheet on the roof and wall to prevent rain-water seepage inside the house	Household	Pre-disaster	Temporary
5	Raising the plinth level	Household	Pre-disaster	Risk reduction
6	Elevating the level of the household furniture during water logging or flood	Household	During-disaster	Temporary
7	Modification of housing roofing material	Household	Pre-disaster	Temporary
8	Modification of housing walling material	Household	Pre-disaster	Temporary
9	Construction of shelves near the ceiling	Household	Pre-disaster	Temporary
10	Vegetation in the surrounding	Household	Pre-disaster	Insurance
11	Constructing matcha	Household	During-disaster	Temporary
12	Use of Styrofoam for vegetation	Household	Pre-disaster	Temporary
13	Domestication of animals	Household	During/post disaster	Insurance
14	Increasing strength of mud used as construction material by mixing ashes (chai), bran (bhushi), straw	Household	Pre-disaster	Risk reduction
15	Elevated door slab to prevent logged water entering inside the house	Household	Pre-disaster	Risk reduction
16	Using savings for recovery after disaster	Household	Post-disaster	Recovery/insurance
17	Removing the water intruded inside the house by using bucket or bowl	Household	During-disaster	Temporary
18	Moving out of the house for safe shelter	Household	During-disaster	Temporary
19	Switching job	Household	Post-disaster	Recovery
20	Praying	Household	Pre/ During-disaster	Fatalist
21	Teaching swimming to the children	Household	Pre-disaster	Risk reduction
22	Using bricks to level the depressed soggy floor	Household	During-disaster	Temporary
23	Using chatai (bamboo sheet), paper boards to protect water seeping from roof	Household	During-disaster	Temporary
24	Using brick, wood, stone lining the plinth	Household	Pre-disaster	Temporary
25	Using broken concrete slabs to define pathway	Household	Pre-disaster	Temporary
26	Using readily available material for ancillary services	Household	Pre-disaster	Temporary
27	Use of plastic sheets on flooring to avoid water seepage through floor	Household	Pre-disaster	Temporary
28	Elevating land of the immediate surroundings of the house	Communal	Pre-disaster	Risk reduction
29	Cleaning up the adjacent drains	Communal	Pre-disaster	Risk reduction
30	Use of community kitchen	Communal	During-disaster	Temporary
31		Communal	During-disaster	Temporary

(continued on next page)

Table 4 (continued)

No	Response	Scale	Type of response	
32	Formation of informal community groups to serve the common interests Communally fixing or repairing basic services and infrastructures	Communal	Post-disaster	Risk reduction
33	Constructing elevated pathway with bamboo during water logging	Communal	During -disaster	Temporary
34	Constructing small retaining walls at the edge of waterbody to avoid land erosion	Communal	Pre-disaster	Risk reduction
35	Use of sand bags to protect the edge of water body from land erosion	Communal	Pre-disaster	Risk reduction
36	Using emergency funds of CBO	Communal	During -disaster	Insurance
37	Using dried cowdung on the surface of the elevated land for settlements to make it more stable	Communal	Pre-disaster	Risk reduction

can help with recovery by providing monetary support, humanitarian assistance and assistance for recovering infrastructural damages (for example, repairing and/or constructing new infrastructure). The surveyed communities mentioned that it sometimes takes them several years to recover from a disaster (and that, too, depends on outside assistance). Among the identified practices less than 6% are recovery related. This clearly demonstrates the poor recovery mechanism of the low-income populations in the study area.

Reflecting on this a FGD participant (female) from a settlement near CBD (outside municipal area) mentioned,

“ repeated disasters one after another ... big or small ... damages our assets and livelihood hence we are becoming poorer day by day ... on the other hand, everyday costs are going higher we cannot find a way to improve our condition, we cannot even sustain the current condition as we are financially becoming weaker and there is no one to help us.”

6. Discussion and recommendations

The discussion on adaptation practices in the study area, particularly at the household-level, clearly shows the importance of livelihood behind the adoption of strategies to reduce their vulnerability to flooding. It depicts how the adaptation decisions are determined by the socioeconomic factors defining livelihood status, for example, economic condition, access to resources and services, lack of motivation for adaptation beyond survival and also due to lack of tenure. Hence, they are not responding to the *physical* risk itself, rather they are responding to the *identity* risk, i.e. what that risk means for their lives and livelihoods.

The study reveals that how the flood risk is perceived by each household largely influences the adaptation measures. The adaptive action/s varies from household to household depending on what the flood risk means for their livelihood. It also depends on how they decide to utilize their available resources considering the (potential) impact of the flooding event on their livelihoods. Every household, even within the same community with similar physical exposure to flood, adopted different adaptation strategies, as determined by the household's motivation and objectives. For example, even within the same community some households are growing vegetables on their roofs and some are not. Some households may consider securing food during flood as 'important' while others might prefer some other strategies to be 'more important', for instance, keeping valuables up on a shelf.

The socioeconomic (e.g. income) and political conditions (e.g.

tenure) produce *added* dimensions of risk (defining the *identity* risk) which further influence their risk perception, and thereby their motivations and objectives. Referring to Forsyth et al. [35] (see section 2), although the study predominantly focuses on the low-income group which somewhat defines the low-level of adaptive capacity, the adaptation practices were found to vary even within this population based on the level of income (*lower*, *middle* and *upper* low income). For example, the 'lower' low-income group adopts fatalist behavior which was not evident in the 'upper' low-income group, whereas insurance related measures were mostly adopted by the 'middle' to 'upper' low-income group.

The analysis of adaptation practices in the study area shows that despite a large adaptation deficit and numerous barriers for adaptation, the households and communities show remarkable resilience²⁰ to flooding (also refer to Ref. [29] in section 2). The word 'remarkable' is used here to mark the effort of the households and communities in the face of the existing adaptation deficit, uncertainty and limited or no organizational support, and surviving and continuing to live even after being hit by frequent flooding.

It was also identified during the FGDs that the households and communities in the study area are very much aware of their flood vulnerability as well as their strengths and capacities. They have a fair idea about the options that could potentially reduce their vulnerability to floods. But they are largely unable to implement those because of the existing barriers like poor income, lack of tenure, lack of organizational access. They keep surviving even without any formal advice or support, only on the basis of household and communal efforts. In many instances they have shown extraordinary efforts in trying to fill the gap created through the lack of organizational assistance by forming community-based organizations, which represents the co-operation among the households to work communally to withstand flooding. Although a certain level of malfunction is often existent, e.g. loss of income, damage of household asset and more on, they continue to survive by diverting regular activities, by switching jobs or with the aid of CBO for example.

As discussed earlier, the ways in which flooding affects particular areas or particular population is influenced by several factors, such as quality of infrastructure, exposure to flooding, local organizational capacities, communal and household capacities etc. And these factors vary from context to context. Hence one measure successfully adopted in one place can be maladaptation for another place. In the case of Dhaka, no localized need or vulnerability is considered for adaptation planning. The existing governmental approach is largely top-down in nature (e.g. large infrastructural measures) considering the city as a whole rather than focusing on specific areas or populations under specific threat. But there should not be *one shirt fits all* strategy for adaptation. Hence, this approach needs to be altered by planning adaptation locally and integrating it with the wider (city-level) planning in a holistic manner. The IPCC's Fifth Assessment Report acknowledges the importance of city government-community partnerships to achieve this [47], which can certainly be implemented through the CBOs. Also, localizing NAPA (in the form of LAPA: Local Adaptation Programme for Action) can be useful not only for the variation of risk and vulnerability across different contexts but also for the influence of local governments on the

²⁰ The author adopts the normative concept of resilience, where resilience is situated along a spectrum with 'resilience' at one extreme, and 'vulnerability' at the other (also see Refs. [61,62]). This implies resilience to be a 'good' state, whereas vulnerability is the opposite. Resilience is thus observed as an outcome from human action, and refers to the quality of a human system [63]. Processes directed towards increasing resilience involve enhancing adaptation processes that reduce vulnerability [67]. The normative perspective also helps to understand how the human system reacts to hazards and recognizes the social learning process in building resilience [67], and thereby accommodates directional policy guidance aiming towards reducing vulnerability and influencing stakeholders to change their behaviour where required.

adaptation processes. Furthermore, preparing targeted smaller scale LAPAs focusing on cities can be even more beneficial and effective. This process of localizing NAPA needs to ensure inclusion of the urban poor. This will help to enrich NAPA with the provision of local knowledge and experience. Although LAPA formation is in its infancy, it certainly has prospects provided the necessary linkages can be established to the respective NAPA.

Furthermore, risk and adaptation need to be considered holistically rather than in isolation. In the case of Bangladesh, it is common practice for the local and national governments to mitigate physical exposure to flooding and to deal with the emergency situations (as it arise) derived from flooding. This approach cannot fill the gaps developed through climatic changes, and the growing vulnerability of the urban poor to it. There is a failure in addressing risk and adaptation more holistically by combining building adaptive capacity, prevention, mitigation and recovery. This calls for revising the current practice.

The study has identified a large number of adaptation strategies among which some are unique to particular contexts and built on the local skills, knowledge and resources. Considering the limited resources available, it is advantageous for the government to acknowledge and support such local strategies and scaling up the effective ones. The process of identification of such strategies involves an assessment of certain basic attributes, e.g. the objectives of the strategy (risk reduction, prevention, recovery); the nature of the strategy (physical, social, economic, institutional); its timing (before, during or post disaster); the level of support required; transferrable capability (whether it is transferrable to other areas with similar contexts); its long, medium and short term effectiveness. This will certainly make the local government activities much easier through maintaining locally adopted measures and assisting those to scale up, rather than identifying (new) strategies for each context.

Most importantly an attempt should be made to combine institutional efforts and local responses to achieve more sustainable adaptation, e.g. maintaining and upscaling good practices, eliminating maladaptation and offering alternate or complimentary measures. Achieving resilience is not a single intervention, it is rather a set of continuing processes of evaluation, revision and implementation of adaptation approaches and strategies. This transformation, improvisation and adoption of new strategies, as a population learns, require organizational support which in turn can help to build adaptive management.

Communal adaptation practices in the study area clearly represent their potential to withstand climatic risks. Responding to the context-specific nature of flood vulnerability, CBOs can address risks locally taking in account the local knowledge and skills. Hence locally generated CBOs are crucial for adaptation to be context-specific. Also their potential lies in adopting a participatory approach involving, incorporating and bridging local stakeholders at different levels to build locally appropriate solutions. However local governments need to ensure that CBO interventions are consistent and complementary with the wider flood adaptation strategies at different scales. Government should provide financial and technical support to facilitate their (CBO) activities and further explore their potential, which is currently absent in the study area. Government's assistance should not only acknowledge CBOs, but also help communities to form them. Studies have highlighted the importance of such grassroot organizations for providing a medium to access outside resources and also the role of local community leaders to operationalize such organizations in promoting the development at the micro level [68,69]. CBOs are not only localized organizations serving specific communities but are also needed to integrate bottom-up and top-down adaptation initiatives in a more socially-inclusive way to achieve resilience [70]. Furthermore, CBOs can not only serve the immediate needs of the community but also can undertake the development approach of adaptation through increasing the communal adaptive capacity (see Ref. [44] in section 2). They can potentially serve to attain the vertical link between the low-income communities and the

macro-level organizations which is currently absent in the study area (also refer to Refs. [71–73] for more empirical evidence on such successful applications).

As discussed in section 2, development and adaptation are complementary. Much adaptation at the local level are simply the pragmatic means of achieving development. The Sustainable Development Goals (SDGs) [74] support adaptive capacity in multiple targeted goals: Goal 1 (no poverty), Goal 3 (good health and wellbeing), Goal 4 (quality education), Goal 5 (gender equality), Goal 6 (clean water and sanitation), Goal 10 (reduce inequalities), Goal 11 (Sustainable cities and communities), Goal 13 (climate action). Hence, mainstreaming the SDG goals into the NAPA would be useful to achieve both goals simultaneously. This mainstreaming would indeed be a complex endeavour, but it can be initiated through some basic steps, for example, reviewing existing strategies and identifying probable areas of modification and inclusion considering the SDG plan of actions across national, regional and local scales. NAPA inclusive SDGs could be a potential way to ensure climate-resilient development. Being able to relate the SDGs to household and communal level can also pave the way for government and NGOs to leverage international effort and support to help the urban poor.

7. Conclusive remarks

Although households and communities have always adapted to climatic risks, this has rarely been acknowledged by the macro-level organizations and informed policy making processes. Indeed, the way these settlements are seen by the macro-level authorities have direct implications on how they (macro-level authorities) act or respond to their vulnerabilities. Considering the severity of the vulnerability of the urban poor in Dhaka East, and also responding to the IPCC's call for more evidence on the context specific micro-level adaptation, this study identifies range of diverse adaptation practices and also the rationality behind such practices. Lack of such understanding also reflects in the macro-level efforts by blindfolding on the vulnerability of this population to climatic risks. Nevertheless, in order to move towards greater resiliency and transform beyond mere adaptation, local governments' support for the urban poor is crucial. A flexible and inclusive approach needs to be adopted operationalizing the means by which considerations such as risk perception at micro-level (i.e. household and communal), local knowledge and capacity, context-specific vulnerability of those at risk from flooding are acknowledged to identify appropriate context-specific measures.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

- [1] J. Ayers, T. Forsyth, Community based adaptation to climate change, *Environment* 51 (4) (2009) 22–31.
- [2] S. Cutter, B. Osman-Elasha, J. Campbell, et al., Managing the risks from climate extremes at the local level, in: C. Field, et al. (Eds.), *Managing the Risks of Extreme*

- Events and Disasters to Advance Climate Change Adaptation, Cambridge University Press, Cambridge, 2012, pp. 291–338.
- [3] A.N. Haque, A 'whole systems' view of vulnerability of urban poor to climate change in the developing world, *Prog. Dev. Stud.* 20 (2) (2020) 101–118, <https://doi.org/10.1177/1464993420908094>.
- [4] IPCC, Summary for policymakers, in: C.B. Field, V.R. Barros, D.J. Dokken, K. J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R. C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014.
- [5] A.N. Haque, D. Dodman, M.M. Hossain, Individual, communal and institutional responses to climate change by low-income households in Khulna, Bangladesh, *Environ. Urbanization* 26 (1) (2014) 1–18.
- [6] D. Satterthwaite, S. Huq, H. Reid, M. Pelling, P.R. Lankao, Adapting to climate change in urban areas: the possibilities and constraints in low- and middle-income nations, in: *Human Settlements Discussion Paper Series: Climate Change and Cities*, vol. 1, International Institute for Environment and Development (IIED), London, 2007.
- [7] B.R. Regmi, C. Star, W. Leal Filho, Effectiveness of the local adaptation plan of action to support climate change adaptation in Nepal, *Mitig. Adapt. Strategies Glob. Change* 21 (2016) 461–478, <https://doi.org/10.1007/s11027-014-9610-3>.
- [8] E. Boyd, N. Grist, S. Juhola, V. Nelson, Exploring development futures in a changing climate: frontiers for development policy and practice, *Dev. Pol. Rev.* 27 (6) (2009) 659–674, <https://doi.org/10.1111/j.1467-7679.2009.00464.x>.
- [9] D. Dodman, D. Archer, M. Mayr, Addressing the Most Vulnerable First: Pro-poor Climate Action in Informal Settlements, UN-Habitat, Nairobi, 2018.
- [10] E.A. Gencer, Natural disasters, urban vulnerability, and risk management: a theoretical overview, in: *The Interplay between Urban Development, Vulnerability, and Risk Management*, Mediterranean Studies, 2013, p. 7.
- [11] D. Satterthwaite, D. Archer, S. Colenbrander, D. Dodman, J. Hardoy, D. Mitlin, S. Patel, Building resilience to climate change in informal settlements, *One Earth Review* (2020) 143–156, <https://doi.org/10.1016/j.oneear.2020.02.002>.
- [12] C. Gore, Climate change adaptation and african cities understanding the impact of government and governance on future action, in: C. Johnson, N. Toly, H. Schroeder (Eds.), *The Urban Climate Challenge: Rethinking the Role of Cities in the Global Climate Regime*, Routledge, New York, 2015. Available at: http://www.tandfbooks.com/userimages/ContentEditor/1446652363256/9781138776883_oachapter11.pdf. (Accessed 3 August 2020).
- [13] N. Mimura, R.S. Pulwarty, D.M. Duc, I. Elshinnawy, M.H. Redsteer, H.Q. Huang, J. N. Nkem, A. RSanchez Rodriguez, Adaptation planning and implementation, in: C. B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, L.L. White (Eds.), *Climate Change 2014: Impacts, A Daptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014, pp. 869–898.
- [14] D. Dodman, D. Archer, D. Satterthwaite, Responding to climate change in contexts of urban poverty and informality, *Environ. Urbanization* 21 (1) (2019) 3–12, <https://doi.org/10.1177/0956247819830004>.
- [15] Maplecroft, Maplecroft: climate change vulnerability index 2013 – most at risk cities, Available from: <http://www.preventionweb.net/english/professional/maps/v.php?id=29649>, 2013. (Accessed 24 October 2020).
- [16] Un-Habitat, Case Study: Dhaka's Extreme Vulnerability to Climate Change, United Nations Human Settlements Programme, Nairobi, Kenya, 2008. Available from: http://www.preventionweb.net/files/4292_Dhaka20extreme1.pdf. (Accessed 10 November 2020).
- [17] F. Ahmed, E. Moors, M.S.A. Khan, J. Warner, C.T. van Scheltinga, Tipping points in adaptation to urban flooding under climate change and urban growth: the case of the Dhaka megacity, *Land Use Pol.* 79 (2018) 496–506.
- [18] UN, The world's cities in 2016, in: *World Urbanization Prospects: Data Booklet (ST/ESA/SER.A/392)*, United Nations, New York, NY, USA, 2016.
- [19] G. Rabbani, A. Rahman, N. Islam, Climate change implications for Dhaka city: a need for immediate measures to reduce vulnerability, *Resilient Cities: Local Sustainability* 1 (6) (2011) 531–541. Netherlands: Springer.
- [20] S. Dasgupta, A. Zaman, S. Roy, M. Huq, J. Jahan, A. Nishat, Urban Flooding of Greater Dhaka in a Changing Climate, World Bank, Washington, 2015, p. 225.
- [21] D.M. Khan, W. Veerbeek, A.S. Chen, M.J. Hammond, F. Islam, I. Pervin, S. Djordjević, D. Butler, Back to the future: assessing the damage of 2004 Dhaka flood in the 2050 urban environment, *Journal of Flood Risk Management* 11 (2) (2018) S43–S54.
- [22] I. Thiele-Eich, K. Burkart, C. Simmer, Trends in water level and flooding in Dhaka, Bangladesh and their impact on mortality, *Int. J. Environ. Res. Publ. Health* 12 (2) (2015) 1196–1215, <https://doi.org/10.3390/ijerph120201196>.
- [23] UNFCCC, Chronological evolution of LDC work Programme and concept of NAPAs, Available from: https://unfccc.int/resource/docs/publications/ldc_brochure2009.pdf, 2010. (Accessed 14 December 2018).
- [24] GoB, *National Adaptation Programme of Action (NAPA)*. Dhaka: the Government of the People's Republic of Bangladesh, 2005. Available from: <https://unfccc.int/resource/docs/napa/ban01.pdf>. (Accessed 18 July 2020).
- [25] GoB, *Bangladesh Climate Change Strategy and Action Plan (BCCSAP)*, Ministry of Environment and Forests, Dhaka, 2009, 78 pages, Available from: <http://nda.erd.gov.bd/files/1/Publications/CC%20Policy%20Documents/BCCSAP2009.pdf>. (Accessed 18 July 2020).
- [26] IPCC, Annex II: glossary, in: K.J. Mach, S. Planton, C. von Stechow (Eds.), *In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* IPCC, Geneva, Switzerland, 2014, pp. 117–130.
- [27] A.N. Haque, S. Grafakos, Assessment of Adaptation Measures against Flooding in the City of Dhaka, Bangladesh, Institute for Housing and Urban Development Studies, Rotterdam, The Netherlands, 2010. IHS Working Papers, 25.
- [28] W.N. Adger, S. Huq, K. Brown, D. Conway, M. Hulme, Adaptation to climate change in the developing world, *Prog. Dev. Stud.* 3 (3) (2003) 179–195.
- [29] N. Adger, S. Huq, K. Brown, D. Conway, M. Hulme, Adaptation to climate change in the developing world, in: L. Schipper, I. Burton (Eds.), *The Earthscan Reader on Adaptation to Climate Change*, Earthscan, London, 2009, pp. 295–312.
- [30] A. Brown, A. Dayal, C. Rumbaitis Del Rio, From practice to theory: emerging lessons from asia for building urban climate change resilience, *Environ. Urbanization* 24 (2) (2012) 531–556.
- [31] Wilbanks, T. & Romero Lankao, P. With manzhu bao, frans berkhou, sandy cairncross, jean-Paul ceron, manmohan kapshe, robert muir-wood and ricardo zapata-marti (2007) industry, settlement and society, in Parry, Martin, Osvaldo Canziani, Jean Palutikof, Paul van der Linden and Clair Hanson (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge and New York, 357–390.
- [32] S. Huq, J. Ayers, European Parliament, Streamlining adaptation to climate change into development projects at the national and local level, in: *Financing Climate Change Policies in Developing Countries*, European Parliament, Brussels, 2008.
- [33] M. Pelling, Disaster risk and development planning: the case of integration, *Int. Dev. Plann. Rev.* 25 (4) (2003) i–ix.
- [34] E.L.F. Schipper, Climate Change Adaptation and Development: Exploring the Linkages, Tyndall Centre Working Paper, 107, Tyndall Centre for Climate Change Research, Norwich, 2007.
- [35] T. Forsyth, E. Natalie, What is autonomous adaption? Resource scarcity and smallholder agency in Thailand, *World Dev.* 43 (2013) 56–66.
- [36] L. De Haan, A. Zoomers, Exploring the frontier of livelihoods research, *Dev. Change* 36 (1) (2005) 27–47.
- [37] R.D. Putnam, *Bowling Alone: the Collapse and Revival of American Community*, Simon and Schuster, New York, NY, 2000.
- [38] E. Ostrom, T.K. Ahn (Eds.), *Foundations of Social Capital*, Edward Elgar Publishing Limited, U.K, 2003.
- [39] P. Christopher, E. Weinthal, M. Bellemare, M. Jeuland, Social capital, trust, and adaptation to climate change: evidence from rural Ethiopia, *Global Environ. Change* 36 (2016) 124–138.
- [40] M. Pelling, C. High, Understanding adaptation: what can social capital offer assessments of adaptive capacity? *Global Environ. Change* 15 (2005) 308–319.
- [41] W.N. Adger, Social capital, collective action, and adaptation to climate change, in: M. Voss (Ed.), *Der Klimawandel. VS Verlag für Sozialwissenschaften*, 2010, https://doi.org/10.1007/978-3-531-92258-4_19.
- [42] J. Ayers, D. Dodman, Climate change adaptation and development: the state of the debate, *Prog. Dev. Stud.* 10 (2) (2010) 161–168.
- [43] UN-Habitat, *Cities and Climate Change: Global Report on Human Settlements 2011*, United Nations Human Settlements Programme (UN-HABITAT), Earthscan Publications, London, UK and Sterling, VA, USA, 2011, p. 279.
- [44] G. Mansuri, V. Rao, Localizing development: does participation work?. Policy Research Report World Bank, Washington, DC, 2013.
- [45] M. Chambwera, J. Stage, *Climate Change Adaptation in Developing Countries: Issues and Perspectives for Economic Analysis*, International Institute for Environment and Development, London, 2010.
- [46] IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)*, Special Report of the Intergovernmental Panel on Climate Change (IPCC), IPCC Secretariat, Geneva, 2012.
- [47] IPCC, Summary for policymakers, in: C.B. Field, V.R. Barros, D.J. Dokken, K. J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R. C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014, pp. 1–32.
- [48] DWASA, *Updating/Preparation of the Storm Water Drainage Master Plan for Dhaka City under the Dhaka Water Supply and Sanitation Project (DWSSP)*, Interim Report I, Government of Bangladesh, 2012.
- [49] DAP, *Detail Area Plan. Dhaka Metropolitan Development Plan (DMDP) 1995-2015*, Rajdhani Unnayan Kartripakkha (RAJUK), Dhaka, Bangladesh, 2010.
- [50] CUS, *Slums of Urban Bangladesh: Mapping and Census*, Dhaka, Bangladesh and Chapel Hill, USA, 2005, 2005.
- [51] A.N. Haque, S. Grafakos, M. Huijsman, Participatory integrated assessment of flood protection measures for climate adaptation in Dhaka, *Environ. Urbaniz.* 24 (1) (2012) 197–213, <https://doi.org/10.1177/0956247811433538>.
- [52] A.N. Haque, Application of multi-criteria analysis on climate adaptation assessment in the context of least developed countries, *J. Multi-Crit. Decis. Anal.* (2016), <https://doi.org/10.1002/mda.1571>.
- [53] G. Payne, A. Durand-Lasserve, C. Rakodi, Social and economic impacts of land titling programs in urban and peri-urban areas: a short review of the literature, in: S.V. Lall, M. Freire, B. Yuen, R. Rajack, J.J. Helluin (Eds.), *Urban Land Markets: Improving Land Management for Successful Urbanization*, Springer, 2007, pp. 133–161.

- [54] J. Ensor, R. Berger, *Understanding Climate Change Adaptation: Lessons from Community-Based Approaches*, Practical Action Publishing, Rugby, UK, 2009.
- [55] J. Ensor, R. Berger, S. Huq, *Community-based Adaptation to Climate Change: Emerging Lessons*, Practical Action, UK, 2014.
- [56] B. Smit, I. Burton, R.J.T. Klein, R. Street, *The science of adaptation: a framework for assessment*, *Mitig. Adapt. Strategies Glob. Change* 4 (2000) 199–213.
- [57] M. Pelling, *The Vulnerability of Cities: Natural Disasters and Social Resilience*, Earthscan, London, 2003.
- [58] C. Moser, D. Satterthwaite, *Towards pro-poor adaptation to climate change in the urban centers of low-middle income countries*, in: *Climate Change and Cities Discussion Paper*, vol. 3, International Institute for Environment and Development, UK, 2008.
- [59] J.L. Baker (Ed.), *Climate Change, Disaster Risk, and the Urban Poor: Cities Building Resilience for a Changing World*, World Bank Publications, 2012.
- [60] (a) C. Wamsler, *Bridging the gaps: stakeholder-based strategies for risk reduction and financing for the urban poor*, *Environ. Urbanization* 19 (1) (2007) 115–142; (b) H. Schmuck, *An act of Allah: religious explanations for floods in Bangladesh as survival strategy*, *Int. J. Mass Emergencies Disasters* 18 (1) (2000) 85–95.
- [61] F. Miller, H. Osbahr, E. Boyd, F. Thomalla, S. Bharwani, G. Ziervogel, B. Walker, J. Birkmann, S. Van der Leeuw, J. Rockström, J. Hinkel, T. Downing, C. Folke, D. Nelson, *Resilience and vulnerability: complementary or conflicting concepts?* *Ecol. Soc.* 15 (3) (2010). <http://www.ecologyandsociety.org/vol15/iss3/art11/>.
- [62] M. Duffield, *Challenging environments: danger, resilience and the aid industry*, *Secur. Dialog.* 43 (5) (2012) 475–492, <https://doi.org/10.1177/0967010612457975>.
- [63] G.A. Wilson, *Constructive tensions' in resilience research: critical reflections from a human geography perspective*, *Geogr. J.* (2017). Available from: <http://onlinelibrary.wiley.com/doi/10.1111/geoj.12232/pdf>. (Accessed 7 August 2020).
- [67] C. Folke, *Resilience: the emergence of a perspective for social-ecological systems analyses*, *Global Environ. Change* 16 (3) (2006) 253–267, <https://doi.org/10.1016/j.gloenvcha.2006.04.002>.
- [68] A.M. Auerbach, *Neighbourhood associations and the urban poor: India's slum development committees*, *World Dev.* 96 (2017) 119–135.
- [69] A.M. Auerbach, *Demanding Development: the Politics of Public Goods Provision in India's Urban Slums*, Cambridge University Press, Cambridge, 2019.
- [70] T. Forsyth, *Community-based adaptation: a review of past and future challenges*, *WIREs Climate Change* 4 (5) (2013) 439–446, <https://doi.org/10.1002/wcc.231>.
- [71] J.D. Palacios, L. Miranda, *Concertación (reaching agreement) and planning for sustainable development in Ilo, Peru*, in: S. Bass, H. Reid, D. Satterthwaite, P. Steele (Eds.), *Reducing Poverty and Sustaining the Environment*, Earthscan, London, 2005, pp. 254–278.
- [72] F. Oscar, S. Dias, D. Mitlin, *Developing urban waste management in Brazil with waste picker organizations*, *Environ. Urbanization* 23 (2) (2011) 597–608.
- [73] J.C. Rayos, *Community-driven Disaster Intervention: Experiences of the Homeless Peoples Federation Philippines*, IIED/ACHR/SDI working paper 25, IIED, London, 2010, p. 54.
- [74] UNDP, *Sustainable development goals*, Available from: http://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf, 2015. (Accessed 8 September 2020).