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Embanked: Climate Vulnerability and the Paradoxes of Flood Protection in Dhaka

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Introduction

Across the globe, river deltas are among the most rapidly urbanizing regions. The combination of fertile soils and access to waterways for trade and transportation has made deltas especially attractive as sites of urbanization for centuries. From the Nile, to the Mekong, to the Niger, to the Ganges/Bramaputra, river deltas host some of the most rapidly urbanizing regions on the planet. (National Research Council, 2013) In this paper, I focus on one delta city, Dhaka, which faces several acute challenges that are common to many other delta cities. Specifically, the paper investigates the relationship between flood protection infrastructure, land tenure, and adaptation to environmental vulnerability in Bangladesh's rapidly growing capital city. Faced with the enormous challenge of providing space for an expanding population in the context of the low-lying and highly flood-prone Ganges/Brahmaputra delta, public and private actors in Dhaka have deployed a range of strategies for opening up new territory for development. The exploratory research described in the following pages is aimed at developing a clearer understanding the implications of land tenure security on flood vulnerability under two distinct forms of flood hazard mitigation present in Dhaka today. As more cities seek to cope with rising sea levels and increasingly severe storm events, the interaction between flood infrastructure, land tenure security, and household level adaptation to flooding will only become more critical (Parry, Canziani, Palutikof, van der Linden, & Hanson, 2007).

Background

Today, Dhaka is among the ten largest cities in the world with a population of more than 14 million residents. The city's population increased dramatically following Bangladesh's independence in 1971 and has continued to grow rapidly since. Between 1974 and 1981 population growth rates were estimated at nearly 10% per year. More recently growth rates have stabilized at a still-explosive 5% (Jahan, 2011). The city is surrounded on all sides by tributaries and distributaries of the great rivers of the Bengal Delta. While these rivers are responsible for the strategic location and the fertile soils of the region, they also carry with them the threat of destructive flooding for the city, all of which lies at relatively low elevation (R. Hafiz, 2011). Dramatic resource and capacity constraints have significantly limited the ability of the municipal and national government to meet the infrastructure expansion demands

required to adequately provide housing and basic services for Dhaka's population (A. M. Chowdhury & Hasan, 2011).

While inadequate infrastructure and municipal service impact all Dhaka residents, these problems most acutely effect the estimated more than 3 million inhabitants of the city's informal settlements (Rahman, 2011). Researchers estimate that as many as 40% of Dhaka's population lives in the city's some 5,000 informal settlements (Alam & Rabbani, 2007; Centre for Urban Studies, MEASURE Evaluation, & National Institute of Popular Research and Training, 2006). As is common in many other rapidly urbanizing regions, these settlements tend to be characterized by weak tenure security, high population density, poor municipal services, and poor housing stock (Centre for Urban Studies et al., 2006). In addition to the demographic and economic forces that drive rural to urban migration in other rapidly urbanizing regions, environmental refugees displaced from villages the countryside contribute substantially to the urban growth of Dhaka. Many people displaced by riverbank erosion, sea-level rise, and cyclones migrate to urban informal settlements in search of alternative livelihoods (Amir, n.d.; M. Roy, Hulme, & Jahan, 2013). A recent study reported that among residents of Dhaka's slum communities, the largest percentage (23%) come from Barisal District, an area in the southern portion of the country that is heavily impacted by cyclones and climate change related flooding (Centre for Urban Studies et al., 2006).

While environmental forces drive many rural Bangladeshi's to move Dhaka and other cities, the capital city is similarly vulnerable to environmental hazards. The majority of the city is less than three meters above sea level. As such, the city's urban form and development patterns have long been shaped by topography and flood infrastructure. During the pre-colonial period, Dhaka was a major trading center. In these early eras, frequent flooding of lowland areas channeled its growth to the naturally high grounds close the Buriganga River (A. M. Chowdhury & Hasan, 2011). The city's first substantial flood control embankment was build under the British Colonial regime in the 1860's. The Buckand Bund, as the mile-long hardened river front area became known, signaled the city's orientation towards its waterways, a development pattern that earned it the nickname "The Venice of the Orient" (Habib & De Meulder, 2011). However, this first embankment also marked the beginning of an adversarial relationship between Dhaka and its wetland surroundings has grown ever more pronounced to the present day.

While the first embankments on the Buriganga were built during the mid 19th century, it was not until the aftermath of major flooding in 1987 and 1988 that the infrastructure was substantially extended to encircle major portions of the city. Following disastrous flooding which inundated over two-thirds of Dhaka and vast stretches of the nation, the Government of Bangladesh, with support from JICA, the World Bank, and the Asian Development Bank, undertook Flood Action Plans 8A and 8B to protect the more rural flood-prone eastern portion of the city and the more urbanized western portion respectively

(Japan International Cooperation Agency, 1991; Louis Berger International, 1991). Together these efforts were referred to as the Greater Dhaka Integrated Flood Protection Project (GDIFPP). While Phase I of the project, intended to protect the more urbanized western part of the city, was developed in the early 1990's, Phase II was never completed due to resource constraints (Boyce, 1990; M. R. Chowdhury, 2003; Halcrow Group Limited, 2006). (See Figure 1) The GDIFPP has largely been successful in creating a more hospitable development landscape by limiting frequent river flooding. While approximately 75% of the western part of the city flooded during the 1988 floods, after construction of the first phase of the GDIFPP, the same area only saw 25% flood inundation during the 1998 floods (Alam & Rabbani, 2007).

While the western embankments and flood walls which constituted Phase I of the GDIFPP have, to date, protected this area of the city from substantial river flooding, the project has not been without problems. The project's initial construction was carried out in great haste following the floods of 1988 and its alignment, design, and construction were marred with substantial setbacks. Because the embankments blocked off natural drainage canals and the installation of drainage equipment lagged behind the construction of the embankments by several years, the project created considerable waterlogging problems for low-lying areas on the inside (J. U. Chowdhury & Khondaker, 1997; Rasid & Mallik, 1996). The lack of public consultation regarding the routing of the embankment and inadequate compensation for displaced people led impacted residents to sabotage the embankment in several areas during its early years, substantially weakening the structures (Louis Berger International, 1991). While later projects sought to remediate the structural deficiencies and drainage problems caused by the embankment, as we will discuss later, waterlogging remains a problem in many areas near the embankments.

Dhaka's embankments have shaped both the supply and demand for informal housing in the city. The embankments have made an increasingly large area available for market rate development by reducing flood risk. These areas have seen property prices and development pressures increase dramatically (Ahamed & Hasan, 2010; Burby, 2006; Halcrow Group Limited, 2006). This increase in development activity has simultaneously increased economic opportunity for laborers in a number of fields including the building trades, transportation, and domestic work and displaced many thousands of people from formerly marginal settlement areas that, once rendered "flood free" by the embankments, became targets of speculative infill development. In eastern Dhaka, where embankments have not yet been constructed, low-income residents are threatened by a tide of privately funded landfill residential development. Thus, on both Dhaka's embanked western side and on the un-embanked eastern side, flood vulnerability, infrastructure, and land tenure are intertwined.

Relevant Literature and Theoretical Orientation

Since Gilbert White published "Human Adjustment to Floods" in 1945, there has emerged widespread acceptance of the idea that increases in protective infrastructure and predictive capacity often counter-intuitively increase the vulnerability of communities to flood hazards by creating a false sense of security and control (White, 1945). This maladaptive process came to be known as the "levee effect" and it emphasized the ways in which infrastructure investments shaped individual level decision making to augment hazard exposure (White, 1973).

In recent decades, another strand of theory rooted in human and political ecology has come to view disasters as largely created by underlying social processes and inequalities (Hewitt, 1983; Pelling, 2003; Benjamin Wisner, 2004). The political ecology approaches tend to emphasize how capitalism-driven social exclusion and *marginalization* can push the most vulnerable people to the most hazardous areas (Collins, 2010; Pelling, 1999). Such an approach would suggest that populations outside of protective infrastructure would be composed disproportionately of economically and socially disadvantaged groups, as "the least powerful groups and classes in a given society inhabit the most hazardous environments" (Collins, 2010). More recently Collins has suggested that, in the context of First World and urban settings, it is critical to consider the role of institutions in enabling powerful groups to inhabit areas of high hazard risk. He has labeled this mechanism *facilitation*, a process whereby "powerful groups are provided security to exploit environmental opportunities associated with hazardous places for private gain, with deleterious social and ecological consequences"(Collins, 2010). The dual concepts of marginalization and facilitation, share with the levee effect a focus on how government policy and infrastructure can shape hazard exposure.

Researchers from a range of disciplines including, international development, human ecology, and political ecology have explored the many ways in which the poor and residents of informal settlements suffer disproportionately from vulnerability to natural hazards, both for locational reasons and because they often lack the economic and social capacity to cope with major disturbances (Hewitt, 1983; Pelling, 2003; Benjamin Wisner, 2004). Secure property rights regimes have long been held as a critical component of social and economic development (Demsetz, 1967; DeSoto, 2003). There is a widely accepted connection between the strength of property rights claims and the tendency and ability of people to adapt to or mitigate hazard vulnerability (Dodman & Satterthwaite, 2008; Reale & Handmer, 2011; M. Roy et al., 2013).

The relationship between tenure and vulnerability is multi-directional (Mitchell, 2010; Reale & Handmer, 2011). That is, tenure insecurity can increase hazard vulnerability and hazard vulnerability can threaten tenure security. Major environmental disruptions, whether natural or human-induced, can increase tenure insecurity through a number of mechanisms. Post-disaster tenure insecurity can come in the form of temporary or permanent displacement through state-driven resettlement or private or public

land grabbing. Mitchell notes the potential mutually reinforcing qualities of tenure insecurity and disaster vulnerability, stating that those with insecure tenure are particularly "vulnerable to land grabbing or resettlement without compensation." (Mitchell, 2010) Disasters can also weaken tenure claims when critical documentary evidence of tenure status is lost to forces such as flood, fire, theft. Administrative challenges in the post-disaster environment can also create increased tenure insecurity when agencies are under-resourced, compensation is inadequate, or planning rules meant to reduce long-term vulnerability displace people.

While disruption can threaten tenure security, it is also true that households with insecure tenure are often subject to increased vulnerability to disaster, making a population more susceptible to devastating consequences of an environmental or human-induced shock. One of the chief mechanisms identified in the link between tenure insecurity and vulnerability is the tendency among households with weak tenure security to not mitigate their environmental vulnerability by investing in adaptations to their homes or settlements. When faced the threat of eviction, residents of informal settlements simply may not see the value in spending precious resources to reduce the vulnerability of their homes to hazards (Haque, Dodman, & Hossain, 2014).

As Mitchell observes, "poor tenure security and a lack of recognition of access rights reduce the resilience of people to natural disasters; the poor are the most vulnerable in this situation (Mitchell, 2010). This account and others like it place tenure security near the center of the complex of social, legal, and economic factors that shape the adaptive capacity of individuals, households, and communities. Disaster researcher Ben Wisner notes that, "disasters produce more marginal people - people who have survived but are unable to recover their livelihoods, who are destitute and forced to live in even more vulnerable situations"(Ben Wisner & Luce, 1993).

Methods

During the summer of 2014, I undertook a program of exploratory research to seek a better understanding of the ways in which Dhaka's embankments have shaped the city. Through documentary research and interviews with 15 government, NGO, and academic experts, I explored the institutional forces and policy-making processes related to the city's existing and planned embankments. Expert interview data is supplemented by a review of secondary literature and planning documents. Of particular interest were the planning documents associated with FAP 8A and 8B, which lay out the rationale and design considerations behind the eastern and western embankments respectively (Japan International Cooperation Agency, 1991; Louis Berger International, 1991). The 2006 update and extension of the FAP 8A study includes the latest justification and design for the eastern embankment, providing particularly useful insights into the current considerations underway in the planning of that, as of yet unexecuted project (Halcrow Group Limited, 2006).

Field observation and semi-structured interviews with 40 residents of settlement areas immediately inside and outside of the city's western embankment were meant to explore questions of residents' location choices, social networks, perceptions of flood risk, and means of adaptation to flooding. Interviews and field observation sights also included some of the areas likely to be affected by the proposed expansion of the embankments to encompass eastern Dhaka in order to explore how the patterns of urban development in this area may be similar to or different from that in the embanked western portion of the city.

In order to develop a more holistic understanding of how Dhaka's embankments have shaped urban growth, the team investigated research sites in many different areas of the city's periphery from Sardarghat and Kamragichar in the southern portion of the city, to Gabtoli in the west, to Uttara in the north, to Beraid in the still largely agricultural eastern periphery. In most cases, the research and interview sites were constrained to the area immediately (within 100m) on either side of the actual or proposed embankment routes. In areas where there were substantial areas of settled land that lay between the major rivers and the embankments, the research team conducted interviews in these more distant areas to better understand to what extent the presence of the embankments has shaped their development.

Limitations

While this study suggests some potentially fruitful avenues for future research, there are several limitations that constrain the scope of the conclusions that might be drawn at this time. As is the case in many rapidly developing cities, there are severe limitations on the availability and reliability of data on property ownership, flood vulnerability, and general demographics in Dhaka. In addition to the limitations imposed by the dearth of existing data, the data gathering processes employed for this study also impose further limitations. Due to the exploratory nature of this research, the team conducted a small number of interviews at a large number of sites around Dhaka's periphery. Though the sampling of interview subjects was random in that there was no systematic selection criteria for interview subjects other than their presence in the settlements of interest at the time of the site visit, sampling was non-random insofar as subjects were drawn from a biased sample of those people who were present and willing to talk with visiting researchers. Of particular concern for future studies was a notable bias towards male interview subjects. Only 3 of the 40 interview subjects were women. Several other women who were approached for interviews by the research team declined to participate. It is likely that this reluctance among women to participate in interviews is rooted in tradition of *purdah*, whereby women are discouraged from contact with unfamiliar men (Rasid & Mallik, 1996). The small, non-random sample of interview subjects as well as the evolution in the interview guide over the course of the research limit the conclusiveness and generalizability of the findings.

Other substantial limitations imposed on the research relate to the status of the primary author as a non-native Bangla speaker. The assistance of knowledgeable local translators was invaluable in allowing the research team to conduct interviews with residents of Dhaka's peripheral neighborhoods, where virtually no one spoke English. However, since the lived-experience and perceptions of residents are at the core of the research, it is inevitable that some of the nuance and richness of responses was lost in translation.

Findings

While the focus of interviews and site observations was not explicitly focused on land tenure related issues, it became clear through the process of observing conditions of the urbanizing edges of the city that there is a significant nexus between land tenure, infrastructure development, and adaptation to flood hazards at Dhaka's edges. In all of the peripheral areas studied, the city's ineffective planning and land use control regimes along with inadequate infrastructure and service provision, high levels of natural flood vulnerability, and extremely rapid urban growth create conditions where economically and socially-disadvantaged populations are rendered disproportionately vulnerable to flood hazards. While there are some shared characteristics that present themselves across the urban region, the specific dynamics creating this uneven vulnerability manifest in distinctly different ways in the highly urbanized embanked western portion of the city and the as yet un-embanked eastern portion of the city.

Urbanization and the Western Embankment: Not an edge, but a spine

When construction was completed in the early 1990's, Phase I of the GDIFPP encircled an area 136 square kilometers in size defined by the converging Tongi Khal, Turag River, and Buriganga River on the north, west, and south and by the elevated road bed of DIT Road to the east (See Figure 1). At the time of the embankment's design and construction, this area was home to 87% of the city's population (Louis Berger International, 1991). In weighing the costs and benefits to be expected from the Phase I project to build the embankments, project planners expected that the embankments would radically reshape settlement patterns by encouraging rapid in-migration into the areas rendered "flood free" by the new infrastructure. The FAP 8B planning study predicted that:

"The existence of flood free zone will encourage in-migration further straining infrastructure and government services."(Louis Berger International, 1991)

Planners expected that this rush of in-migration would drive property values inside the protected zone to increase substantially faster than those immediately outside (Louis Berger International, 1991). While field investigations and interviews clearly support the hypothesis that the embankments have encouraged development in the vicinity, it appears that the provision of flood protection has not been the driving force behind urbanization in the area. Urban land use and residential infill development have unquestionably increased substantially in the area *immediately inside* western Dhaka's embankments. However,

urbanization has also exploded in the area *immediate outside* the embankment and on the infrastructure corridor itself. (See Figure 2)

Though the initial plans called for the retention of a substantial 50 meter right-of-way along both sides of the embankment, as early as 1991, before the embankments was even finalized, planners observed that people had begun to “build residences on the embankment” (Louis Berger International, 1991). Twenty years later, commercial and industrial establishments of various scales and types line both sides of the embankment for much of its length. These establishments, along with a continuously spreading swath of mixed residential development on newly filled land can make it difficult to even visually identify where the embankment begins and ends in many areas. Given that it is approximately evenly distributed on both sides of the embankment, it seems that the dense development that has formed along the embankments has been driven more by the embankment’s status as a rare relatively unobstructed roadway than by concerns floods safety. Across Dhaka, the lack of adequate road infrastructure has created crippling traffic problems (Rahman, 2011). Though the government did not followed through on the initial plan to build a major highway immediately inside the embankment as called for in the planning documents, the road built atop the crown of the embankment has become a de facto thoroughfare, driving commercial and residential development along its length. Interview responses support the claim made by other researchers that commuting time and proximity to employment are, in many cases, more powerful drivers of location choice than flood safety (Rashid, Hunt, & Haider, 2007). Rather than forming a stark wall dividing settlements inside and outside, the embankment has acted as a linear trunk upon which land filling and urban development have spread on both sides. The embankment acts, not as an edge, but as a spine of urbanization.

Interviews with residents immediately on either side of Dhaka’s western embankment suggest that land tenure interacts with flood vulnerability in complex ways in the area. According to recent surveys, Dhaka’s slums are predominantly small clusters of residences located on private lands. More than 50% of slum clusters are composed of fewer than 200 households (Centre for Urban Studies et al., 2006). Informal settlers on public land in Dhaka have faced heightened threats of eviction and resettlement for decades. In 1975 alone, approximately 200,000 squatters were removed from central Dhaka settlements and either directed to return to their village of origin or removed to distant resettlement sites. Again between 1990 and 1992 an estimated 162,000 people were evicted from Dhaka informal settlements (Wendt, 1997). Aggressive clearance of slums from public lands has pushed low-income residents into a fragmented network of informal settlements on privately owned land. As land prices in Dhaka have dramatically increased in recent decades, informal settlements are often pushed from one privately owned plot to another as more and more flood-prone land is filled and developed. In the process, low-income residents are subjected to ever-greater levels of flood risk. A 2005 survey estimated that 60%

of slum clusters were subject to partial or complete flooding in normal monsoon years (Centre for Urban Studies et al., 2006).

Given the vulnerability of informal settlements on private land to displacement by development pressure, the right-of-way for the western embankment presented a broad swath of relatively stable, publicly owned land, ripe for settlement. However, many residents living along the right-of-way faced a range of tenure challenges. All but a handful of residents interviewed rented their modest rooms from other owners who themselves did not have legal tenure security for the land or dwellings that they rented. Many residents reported regular threats of eviction from government agencies (BWDB and DCC, in particular). Some residents reported threats of eviction or extortion by the parties who owned the land before it was acquired for construction of the embankment. Among residents immediately on either side of the embankment, there was no discernable difference in the perceived tenure security from one side to the other.

While it is perhaps not entirely surprising that unauthorized settlers report threats to their tenure security on both sides of the embankment, it was more unexpected to find that residents do not perceive of the flood risk to be substantially lower inside the embankment than outside. When asked whether vulnerability to flooding was worse inside the embankments or outside, the combined number of residents who reported that the danger was the same on both sides or that it was better outside the embankments was larger than the number who said flood risk was better inside (See Table 1). While the limited sample size limits the strength of conclusions that could be drawn from such a survey, it nonetheless suggests that the perceived benefits of the embankment are, at least, not as widespread as might be expected.

At the time of the interviews, most residents reported that the last time there had been significant river flooding in their area was either 1998 or 2004. Given the relatively long interval since the last flooding event, it is possible that the minimization of perceived flood risk outside the embankments expressed by residents on both sides is the result of the *availability heuristic*, a bias whereby events that have occurred more recently (and are thus more cognitively “available”) are seen as more probable (Kahneman, Slovic, & Tversky, 1982). Alternately, the respondents’ perception that flood risk inside the embankment was not substantially better than outside might have been driven by the persistence of waterlogging problems inside (Louis Berger International, 1991; Rasid & Mallik, 1996). Though the installation of sluice gates and pumps has reportedly alleviated some of these internal drainage problems (Rasid & Mallik, 1996), residents interviewed continue to report waterlogging problems inside the embankments.

Existing literature widely supports the presence of a *levee effect*, whereby residents within a flood protection embankment are likely to reduce the degree to which they adapt their buildings and behaviors to mitigate flood risk (Colten, Kates, & Laska, 2008; White, 1973). The planning study for the western

embankment refers repeatedly to the danger of just such an effect, where residents inside the embankments might “develop a false sense of security” leading to “disastrous impacts” in the event of a breach of the infrastructure (Louis Berger International, 1991). While field investigations support the idea that, since the construction of the embankments, infill development within the inside zone has led to the rapid filling and development of many low lying areas, it is difficult to discern a significant difference between the patterns of development and adaptation inside the embankment from those of the unprotected area to the outside. It appears that tenure security has a far greater impact on residents’ likelihood of adopting adaptations to their houses than their status on one side or the other of the embankment. Residents of dwellings immediately on either side of the embankment repeatedly told me that they did not substantially invest in adapting their structures to reduce flooding because of the threat of eviction.

While residents with weak tenure security generally did not invest in costly adaptations to their structures, they did engage in a wide range of what Haque *et al* label “impact minimizing” adaptations (Haque et al., 2014). Though various forms of elevated construction are common throughout the flood prone rural regions of Bangladesh, it was rare for residents of informal settlements immediately on either sides of the embankments to invest in elevating their homes above anticipated flood depths. While elevation and other costly adaptations were rare, nearly all residents employed some form of simple impact minimization. Common adaptations included: building simple wooden shelves to elevate valued possessions; building small brick curbs across doorways to keep rain out during minor events; and elevating belongings on beds or purpose build raised platforms known as *macha*. When such simple measures were overwhelmed during more extreme flooding events, residents reported evacuating to higher ground (often railroad or flood embankments), taking shelter in schools or with relatives, and living on the roof of their home for a period. In areas with longer-standing settlement patterns that have evolved to cope with flood events, residents reported living aboard boats for a period of weeks until flood water subsided. Each of the above mentioned adaptation strategies except for living on boats was reported with approximately even frequency both inside the embankments and outside.

In cases where land tenure appears to be more secure and owners or developers have invested in developing more substantial multi-family buildings, there does not appear to be a significant difference in the adaptive strategies employed outside the embankments as compared to those employed inside. In both cases, the most common building strategies include a combination of building on a raised earthen plinth and reserving the ground floor for car parking and commercial uses. Even in this more formalized sector of the housing market, it appears that these adaptations are less a function of building and land use regulation than of market demand and perceived risk. Officials from RAJUK, the municipal body responsible for building and land use regulation, stated during interviews that the “Private Housing Project Land Development Rules” adopted in 2004 imposed a minimum flood elevation for buildings

built by private developers. However, these regulations, like other regulations meant to guide the development of the city, are not widely enforced (Jahan, 2011). Even if the building standards were to be more strenuously implemented, they do not make any distinction in terms of flood elevation or other measures for buildings that lies inside and outside the flood protection system. Thus, building regulations in Dhaka, along with popular perception and market response, tend to treat flood risk on either side of the western embankments as essentially the same.

In the context of Dhaka's largely unregulated, extremely rapid urbanization process, interview responses and development patterns suggest that the relatively infrequent occurrence of river flooding has been largely superseded by other more immediate concerns in shaping decisions about where and how people choose to build and live. While urbanization has accelerated, in the twenty years that have elapsed since the embankments' construction, flood adaptation and urbanization patterns have largely developed along similar trajectories inside and outside of the infrastructure. Generally speaking, residents do not see the land inside the embankments as substantially more flood-safe than the land outside. The level of adaptation to flood risk on both sides of the embankments appears to be much more heavily influenced by the length and security of tenure than by the location of a given residence with respect to the embankments.

Urbanization and Flood Risk Mitigation in Eastern Dhaka: Inversion of Protection

During the initial planning of the GDIFPP, the area to the east of the zone embanked during Phase I, the area defined by DIT Road on the west and the Balu River on the east, was composed primarily of highly flood prone agricultural land (See Figure 1). According to the planning study for FAP 8A, some 50% of the eastern zone slated for embanking in Phase II was prone to regular flooding during the yearly monsoon (Japan International Cooperation Agency, 1991). The initial 1991 plans called for the completion of both phases of the embanking of Dhaka over the course of 10-15 years. Though the second phase of the GDIFPP has been repeatedly studied and recommended, it has not been carried out.

While the government has neither carried out its plans for the eastern embankment nor developed a detailed land use plan for the eastern part of the city, the booming private housing development industry has moved quickly to fill and develop ever-larger sections of the region (Halcrow Group Limited, 2006). Fueled by strong housing demand from Dhaka's booming population and speculative capital flows from remittances from Bangladeshis abroad (Seraj, 2011), developers employ fleets of sand barges and legions of dredgers to pump river sand onto former paddy lands and canals to raise them above predicted flood levels for residential development. While the post-embankment urbanization of the western portion of Dhaka has been dominated by relatively small-scale infill development with a few larger state-sponsored housing estates, the development of eastern Dhaka has been dominated by these large-scale landfilling operations conducted by private developers (Seraj, 2011). (See Figure 3)

Interviews with residents of eastern Dhaka reveal patterns of land tenure security and flood adaptation that are significantly different than those seen in the western portion of the city. Residents of this part of the city, particularly those closer to the Balu River edge where the eastern embankment is planned were more likely to be long-term residents. Many described generations of family occupation and mixed agricultural and fisheries employment. Though this long-term occupation would suggest more stable and secure tenure, many residents spoke of threats to their ability to stay on the land. Echoing the process that Feldman and Geisler call “peri-urban land predation,” several residents alluded to threats of social or physical violence employed to force residents off of their land to make way for private landfilling and development (Feldman & Geisler, 2012). Much as Feldman and Geisler describe, residents spoke of alliances formed between influential local residents, bureaucrats, and developers using a variety of means to force residents to leave their land with little or no compensation. Describing the dual threat from a powerful real estate developer and from corrupt government officials, one resident who lives along the Balu River told me, “We are dead! Bashundarah can catch us or the government can catch us.”

Even if residents of the eastern region can resist having their property bought or taken for development, their livelihoods are often threatened by the developers’ landfilling. The land of eastern Dhaka is now marked by long straight reinforced concrete and brick walls erected by developers to demarcate land claimed for future development. However, these walls do not confine the impacts of the sand filling. Rather, either in slurry form or born on the wind, the sands shift and drift, filling in adjacent land and canals. One resident told me that for every one unit of land intentionally filled with dredged sand fifty units are ruined for farming and fishing, the traditional form of livelihood of the people of the region. Thus, even when developers do not directly take land from residents of the area, they can destroy their livelihoods and thus undermine their ability to stay on their lands.

In eastern Dhaka, private housing development has far outpaced the government’s ability to provide adequate infrastructure and services to the region. Planning efforts for the area long called for “infrastructure led development initiatives” with a particular emphasis on the need to provide flood protection and drainage infrastructure to the low-lying region (Jahan, 2011). While there has been little progress in providing public flood protection in the area, the government has invested significant resources in building roads and bridges through the area to facilitate residential development activity. Residents told me that the alignment of the roads had been determined not by pre-existing land use plans efforts but by bribes from well-connected developers. Even without flood protection, these roads have spurred significant speculative development in the area. One long-time resident whose land abuts one of the new roads recounted that, in the two years since the road was opened, land values in the area had increased ten fold.

Recent planning processes for the eastern embankment also reflect the greater emphasis on road construction as compared to flood protection. The FAP 8A study which initially called for the construction of the eastern embankment was entitled “Master Plan for Greater Dhaka Protection Project.” It contained virtually no reference to transportation as a project goal (Japan International Cooperation Agency, 1991). In stark contrast, the most recent study is entitled “Updating/Upgrading the Feasibility Study of Dhaka Integrated Flood Control Embankment cum Eastern Bypass Road Multipurpose Project.” This updated study includes transportation as a nearly coequal goal with flood protection (Halcrow Group Limited, 2006). The study’s recommendation that the project “incorporate a road on the top of the flood embankment (similar to that on the Western Embankment)” suggests that, if the project is ever completed, it will likely perform much as the western embankment does in forming not an edge to development, but a linear spine from which development and land filling will radiate without respect for flood vulnerability.

The development patterns emerging in eastern Dhaka challenge the conventional notions of what constitutes formal and informal settlement and development. Large-scale illegal land grabbing by real estate developers with the implicit blessing of political power structures of the nation and municipality support Roy’s contention that, in some cases, informality and state planning are not opposed, but are linked in ways that can victimize socially and economically vulnerable populations (A. Roy, 2009). While there has long been great concern among planners and policy makers about the encroachment of slum settlements on drainage infrastructure such as *khals* or canals, the rapid and unchecked advance of land filling in the former agricultural lowlands at the city’s edges by private developers is impacting far larger areas with far greater speed than the city has seen before (Feldman & Geisler, 2012). The rapid advance of large-scale private development in the region forced the redesign of the water retention and pumping systems slated to be built with the eastern embankment. Because the land originally designated for flood water retention had already been filled by private developers, the updated planning study for the embankment calls for reducing the size of the retention ponds and pushing them to the periphery where “it will take some time by the developers to reach” (Halcrow Group Limited, 2006). The plan further calls for the construction of a “encircling earth embankments” around the retention ponds to “demarcate” their edges so as to keep private developers from encroaching on them (Halcrow Group Limited, 2006). Thus, it appears that, though RAJUK and other municipal and national authorities are nominally empowered to regulated private land development, the balance of power between these agencies and private developers has shifted dramatically. At this point infrastructure planners have been forced into a reactive and defensive posture, revising their plans in an attempt to keep from being completely over run by the wave of private development.

Discussion

In the rapidly urbanizing agricultural lowlands of eastern Dhaka, as in the densely settled western sections of the city, land use, land tenure, and flood vulnerability are intimately intertwined. However, the mechanisms through which these forces interact differ substantially from one side of the city to the other due to differences in existing settlement patterns and the presence or absence of flood control infrastructure. In both areas it appears that transportation infrastructure, access to employment, and intense competition for land, rather than flood control are the driving force shaping the expansion of concentrated urbanization. Nonetheless, as the responsible agencies continue to contemplate the development of a system of engineered embankments, pumps, and retention ponds for the eastern half of the city, the recent history of urbanization in western Dhaka may offer some useful insights in to how such infrastructure can shape growth in ways that are both predictable and surprising.

Based on field observations and interviews, it appears that the western embankments have affected the relationship between land tenure and flood vulnerability in at least two substantial ways: 1) by opening up a ribbon of accessible but illegal public land to settlement by low-income populations and 2) by serving as a linear spine of access for intensified urban development at the periphery of the city. Previous literature suggests the development of a levee effect, wherein residents on the inside of the embankments develop a false sense of security and undertake patterns of development that ultimately place more people and property at risk. While it is clearly the case that urban development has intensified in the areas immediately inside Dhaka's western embankment, it is not at all clear from interviews or from field observations of building adaptation strategies that development patterns inside the embankments reflect a substantially different perception of risk than that seen outside the embankment. Rather, in the areas both immediately inside and immediately outside the embankments adaptation to flood hazards appears to be more closely correlated with land tenure security than with location relative to the embankments. Both inside and outside of the embankments, low-income residents tend to invest only minimal resources in reducing the vulnerability of their homes to flooding because they lack security of tenure. While residents immediately adjacent to the embankments are threatened with extortion or eviction by representative of government agencies or pre-embankment landowners, slum dwellers in areas further afield are also subject to frequent eviction and relocation because of the rapid turnover in the residential development market. The absence of any discernable levee effect may be a function of any number of factors including: the prevalence of other factors superseding flood risk as the primary determinants of where and how people build; the relatively long interval between river flooding events in recent years; and the persistence of waterlogging problems in the area inside the embankments. In this climate of imperfect infrastructure, explosive population growth, and minimal land use regulation, the western embankment has come to act as a spine of urbanization, rather than as an edge.

While the western embankment has, since its construction in the early 1990's, served as a spine of urbanization along Dhaka's western periphery and has allowed for ever more intensive development of low-lying lands, development in the eastern portions of the city has followed a different path. In spite of the fact that the planned eastern embankment has never been constructed, speculative private housing developers have moved with remarkable speed to fill vast swaths of former agricultural lands with river sand to create saleable plots for residential development. Using a broad spectrum of legal and extralegal tactics, politically-powerful real estate developers undertake campaigns of land grabbing to gain control of developable agricultural lands. Through direct forms of intimidation and violence and through indirect means such as destroying the productive capacity of adjacent paddy and fishing lands with overflowing dredged sands, developers displace communities that have long inhabited these lands. The participation of governing authorities in the landfilling of eastern Dhaka, whether through lax regulation, enabling of land grabbing, or the direction of supportive infrastructure, might be seen as a form of facilitation whereby wealthy developers and upper and middle-class homebuyers benefit from reduced flood risk. This processes simultaneously marginalizes low-income residents of the area by forcing them out of their lands and livelihoods into more environmentally and economically tenuous positions.

Conclusions and Implications

Many of the greatest challenges facing Dhaka in the coming decades will be related to the tensions created by the city's rapid population growth and its severely limited supply of flood safe developable land (M. R. Hafiz, Jahan, & Khan, 1997; R. Hafiz, 2011). The western and eastern portions of the city today display two distinct methods of coping with the city's inherent flood vulnerabilities. In the west, there is a publicly-funded system of embankments, pumps, and sluices. In the east, private developers have funded the landfilling of massive areas of former agricultural land. From the preceding analysis, it is clear that both of these methods can have considerable negative impacts, particularly with respect to vulnerable low-income populations. While embankments treat flood protection as a non-excludable public good for everyone within their encircling embrace, in the absence of adequate land use planning and control, the western Dhaka embankment has actually driven unwise flood-vulnerable development on both sides of the embankment. The flood vulnerability of the lowest-income residents is further exacerbated by the insecurity of their land tenure. Because they face the constant threat of eviction, they do not invest in adaptations that would reduce their exposure to flooding. Further, the area inside the western embankment has, in recent decades urbanized at an extreme density, placing an enormous number of people and properties at risk if and when the embankments ever should fail (Louis Berger International, 1991). While the non-embanked eastern portion of the city does not face this problem of such "residual risk" (Ludy & Kondolf, 2012) from failed infrastructure, flood protection via

sand filling in this area is an enormously capital-intensive and wholly private service, afforded only to those people who can afford to buy land or flats in the private developments underway in the area. The vast profits available to unscrupulous developers have driven mass displacement of the agricultural populations of eastern Dhaka, often with little or no compensation (Feldman & Geisler, 2012).

While it is likely that some selective use of both structural embankments and land filling will be necessary to allow for the expansion of urban Dhaka to house its growing population, this preliminary analysis makes clear that both of these strategies will require a substantial increase in the capacity of municipal authorities to ensure that the most vulnerable citizens are not disproportionately burdened by flood risk and insecurity of land tenure. Because of the disconnect between Dhaka's breakneck growth and the relative infrequency of dramatic river flooding, public policy and planning are essential to shaping patterns of growth to reduce vulnerability to flooding.

Further Research

While the scope and scale of this initial research project does not allow us to draw definitive conclusions about how Dhaka's embankments have shaped urbanization patterns in the city, the inquiry points towards several avenues for potential further research. Future explorations suggested by this research include: more extensive survey research to analyze the risk perceptions and adaptations of residents of various areas to determine the extent to which their position relative to the embankments is a determining factor; analysis of long-term spatial and demographic trends to explore how the construction of embankments has shaped land use and settlement patterns among different segments of the city's population; and interviews with individuals involved in real estate development in both eastern and western Dhaka to determine the extent to which planned or existing flood protection infrastructure shapes their decision making.

Large-scale urban embankments can have enormously negative unintended consequences including exacerbating the threats of internal waterlogging, marginalization of the poor, and widespread devastation in the event of catastrophic failure. In spite of these potential pitfalls, Dhaka, like many other cities, continues to plan for structural flood control infrastructure as climate change creates increased flood vulnerability. Structural flood control measures necessarily define clear zones of *inside* and *outside*, thereby creating *insiders* and *outsiders*. It is essential that planners and policy makers develop more complete understanding of how such infrastructure shapes the formation, composition, and adaptation of communities on both sides. This research is meant to begin to sketch the outlines of a research agenda to create such understanding.

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Tables

Table 1: Perception of Relative Flood Risk among Residents Outside and Inside of Dhaka's Western Embankment

Residents outside embankments		Residents inside embankments	
Flood risk is worse <i>outside</i> embankments	8	Flood risk is worse <i>outside</i> embankments	5
Flood risk is worse <i>inside</i> embankments	5	Flood risk is worse <i>inside</i> embankments	2
Flood risk is the same inside and outside	6	Flood risk is the same inside and outside	5
Don't know/Can't say	4	Don't know/Can't say	3

Figures

Figure 1. Dhaka flooding and drainage infrastructure (by author)

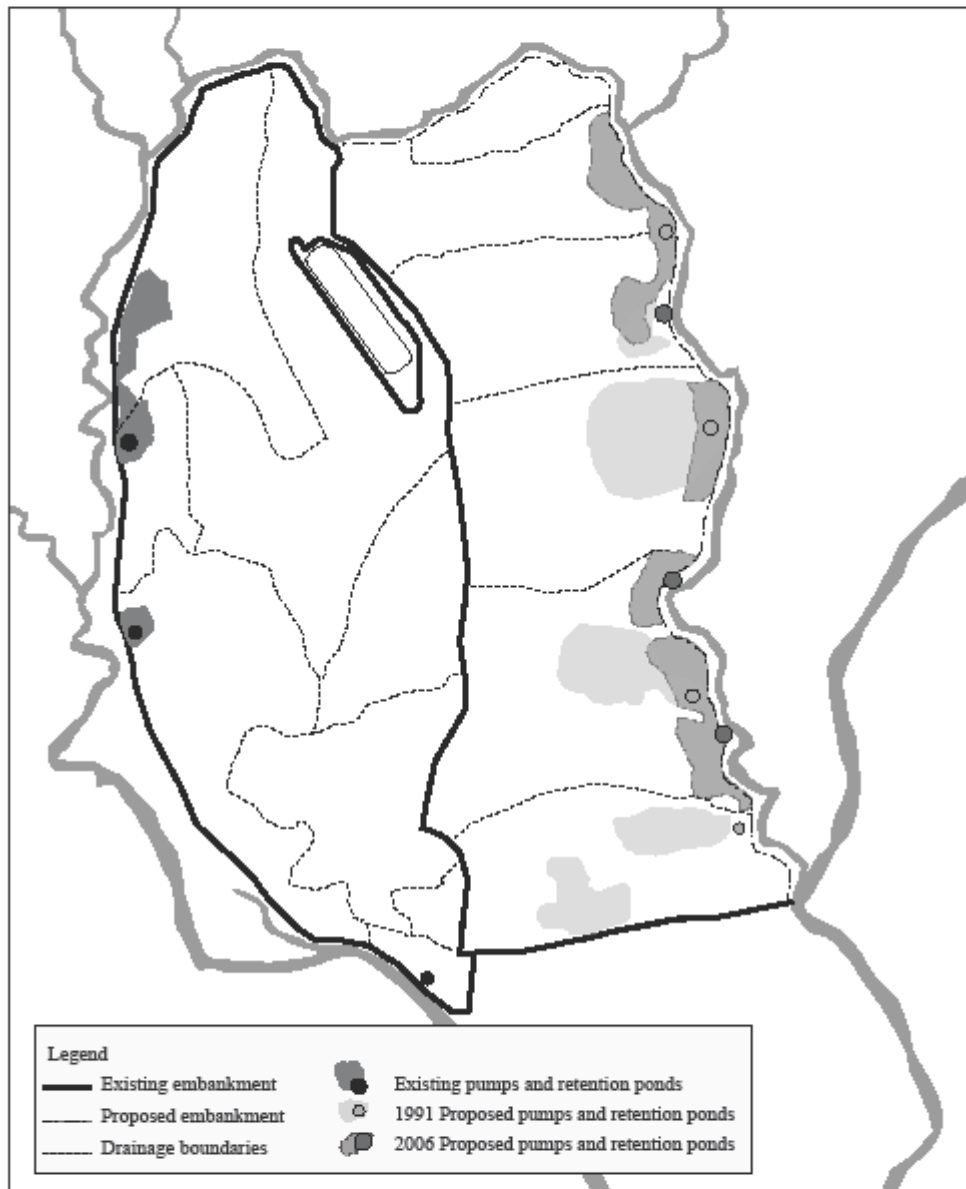


Figure 2. Urbanization on the western Dhaka embankment. Embankment indicated in broad dashed white line. (Google Earth)



Ramchandrapur 2001

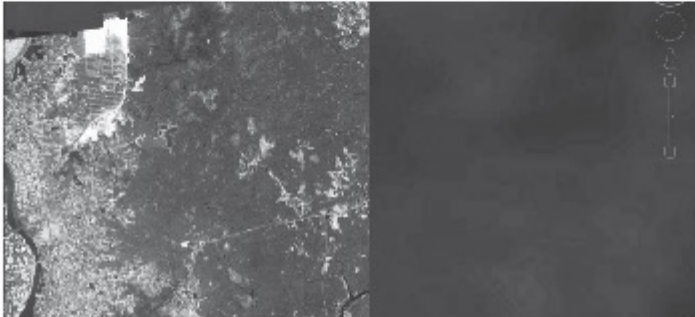


Ramchandrapur 2006



Ramchandrapur 2014

Figure 3. Urbanization via landfilling in eastern Dhaka (Google Earth)



Eastern Dhaka 2001



Eastern Dhaka 2009



Eastern Dhaka 2014