

# FLOATING ARCHITECTURE:

A Solution for the Char People of Bangladesh

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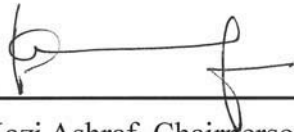
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# Floating Architecture: A Solution for the Char People of Bangladesh

Celeste Aiko Matsukawa  
December 2011

We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in partial fulfillment for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.



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*"Whatever you do, work at it with all your heart, as working for the Lord."*

-Colossians 3:23

Kazi Ashraf: Thank you to my Chairperson Kazi Ashraf, whose weekly guidance and expertise helped to shape my thesis, without which none of it would have been possible.

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Mom and Dad: Thank you to my Mom and Dad for their love, support, and encouragement. I love you both.

# ABSTRACT

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The 21<sup>st</sup> century has been and will be shaped by decisions made in centuries prior. It is our responsibility today to design for tomorrow, recognizing this century's environmental changes. With the assistance of futurist studies, architects are now equipped with the knowledge to build for a successful future. Sea level rise is one of the expected consequences of today's drastic environmental changes. Thus, floating architecture will play an important role in our future.

Bangladesh is one of the countries already experiencing the effects of sea level rise. It is one of the world's most densely populated countries, and the further inundation of its land will only bring more devastation. Within this already poverty-stricken land, a subculture known as the Char people are among the poorest. This group of people resides on the Char lands, dangerous yet highly fertile land that often suffers the most during natural disasters.

The goal of this project is to design a system of living on Char lands to cope with inconsistent water levels by applying ideals held by the Char people. The design will consist of an economic plan, three alternative site plans, and a schematic architectural prototype of a floating home. This system of living will be designed in hopes of being implemented in settings needing such applications including the Netherlands and Japan. The work includes initial research conducted in the fields of Bangladesh regarding the Char people, sea level rise concerns, and case studies of both modern and historic examples of aquatic architecture. The end product will be a system designed for "Char Abhinava," located in the Upper Meghna River.

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# PREFACE

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The inspiration for my doctoral thesis stems from a trip I took to Peru in the summer of 2009. Under the direction of Professor Luis Longhi, I was introduced to the floating, manmade islands of the Uros community. Both the rise and decline of this once brilliant civilization inspired me to focus on designing a floating community for a future in need of such options.

The Uros community rely heavily upon the totora reed. This reed serves as a base for their islands, canoes, and homes. Eager to visit this floating landscape, I boarded a boat crossing the great Lake Titicaca. Upon arriving, I learned of the Uros people's escape from Incan tyranny and their decision to live afloat rather than under the oppression of a foreign regime.

My anticipation was met with disappointment as I observed the counterfeit culture on display that these "genuine" Uros people were pedaling. The Uros community is a dying culture as most of its youth have moved on to greener pastures, finding work on the mainland to be more lucrative. Sadly, the Uros culture, tradition, and history will likely be forgotten. It is from this experience that I found the inspiration to design for a future filled with water.

My passion to reviving the Uros community, then led me to the Char people of Bangladesh, who although similar to the Uros people, experience the effects of not only sea level rise, but are also under a constant threat of flash flooding. Therefore I decided that my efforts would be better directed towards helping this subculture of Bangladesh.

The once enduring spirit of the Uros people which enabled them to rebuild their culture on the banks of Lake Titicaca, adjusting their lifestyle to new circumstances, is truly inspiring. The Uros people went forth, adjusted, survived. Theirs is a tale of a community who refused to be absorbed into the Incan empire. It is one that is relevant to today's inevitable environmental crisis. With the ever present threat of sea level rise, we have no other option but to look at past examples such as the Uros community for our continued survival.

# 1 WATER AND HUMAN SETTLEMENT

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## *Relationship between Water and Humans*

Water is the most abundant molecular structure on the planet. Humans have always had a contradicting relationship with this element, which sustains but also has the power to destroy us. It is our reliance on water that paves the way for radical ideas such as floating architecture. As futuristic ideas converge with the need for such innovation, humankind must turn to water for its continued survival.

Throughout history, man has sought to harness the power of water, for the one who controls this element controls life itself. This objective is based on human dependence on the element for survival. We are composed of about 60% - 70% water, and life ends when we are deprived of it.<sup>1</sup> This reliance also trickles down the food chain, first nourishing our agriculture, which in turn supplies animals with a food base.<sup>2</sup>

The planet itself is 71% water,<sup>3</sup> thus proving to be a viable solution for our needed expansion because it provides three hundred times more habitable space than land.<sup>4</sup> It is through this global network that all nations are connected and in it that we will find our solution to sea level rise.

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1. "The Water In you." USGS. Last Modified June 20, 2011. Accessed September 7, 2011. <http://ga.water.usgs.gov/edu/propertyyou.html>
  2. Wissing, Krista. 2009. "Water Symbolism." Suite 101: Alternative Spirituality. Accessed July 1, 2009 [http://alternativespirituality.suite101.com/article.cfm/water\\_symbolism](http://alternativespirituality.suite101.com/article.cfm/water_symbolism)
  3. M. Grant Gross. 2011. "Earth: The Water Planet." *Water Encyclopedia*. Accessed September 7, 2011. <http://www.waterencyclopedia.com/Da-En/Earth-The-Water-Planet.html>
  4. Sharma, R. C. 1985. *The Oceans: realities and prospects*. New Delhi, India: Rajesh Publications. Pg. iv.



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## Geo-hydrologic Landscapes

Because water is required for survival, settlement patterns have been arranged around it. In order for a community to thrive, there must be a source of fresh water to meet daily human needs and to support agriculture and livestock.

Not all settlement locations around the world have the luxury of calm, pristine conditions. The need for water has forced people to settle in extremely unstable geologic and hydrologic conditions. Settlements in inundated floodplains face a constant threat of flooding and heavy rainfall coupled with high monsoon winds; these are just some of the conditions associated with Bangladesh. However, these water-dwelling communities have forged through these uncertainties to build lives, societies, and cultures.

## Symbolism of Water

Humans recognize the importance of water as the primary building block of life, and it has been given different symbolic meanings in cultures all around the world. It is universally viewed as being both life-giving and life-taking. Water is also often seen as having the ability to purify. Christians use water in a purification ritual known as baptism, which serves to cleanse one's sins and is a public declaration of one's acceptance into Christianity. Hindus use water to cleanse their spiritual selves before entering temples. This purification ritual is an everyday occurrence for Hindus, and therefore, temples are strategically located near water sources. Hindus also believe that the Ganges River is the "water of life" and refer to it as "the river that flows beyond its earthly bounds to *moksa*, the realm of Nirvana."<sup>5</sup> Shinto Shrines in Japan also incorporate water in their religious practices with the act of *misogi*,<sup>6</sup> the cleansing of one's mouth and hands before entering holy ground.<sup>7</sup>

As much as water provides, it also has the power to destroy. There are tales of water spirits that convey the double nature of water; sirens of Greek mythology were imagined as both "shy nymphs and dangerous luring creatures."<sup>8</sup> The life-taking aspect of water is reflected in many cultures' view of it as a vehicle that transcends this world. Greek mythology speaks

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5. Pure Inside Out. 2010. "Water Myths, Mysteries, and Symbolism." Accessed September 11, 2011.

<http://www.pureinsideout.com/water-myths-mysteries-and-symbolism.html>

6. Clark, Scott. 1994. *Japan, a view from the bath*. Honolulu: University of Hawaii Press. Pg. 5

7. Matsukawa, Celeste. Japan trip 2006.

8. Wissing, Krista. 2009.

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of Charon, the ferry man who ushers souls across the Styx River into the kingdom of death. Similarly, deceased Egyptian pharaohs were believed to travel west across the Nile River to the after world.<sup>9</sup> For thousands of years, destructive monsoons, flooding, and tsunamis have been attributed to the supernatural because while human beings have tried to control nature, they have never fully harnessed her unyielding temperament.

## Cultural Significance of Water

From symbolic value then arises culture. Along with its religious symbolism, water has also played an important role in many societies' cultural routines. Japan and Bangladesh have unique associations with water.

The Japanese have always held an appreciation for water. Bathing is an integral part of Japanese culture and has been so for hundreds of years. Bathing practices provide the foundation for social gatherings, private reflection, as well as medical facilities. In the private home, bathing is done after dinner. The bath, or *ofuro*, is separate from the toilet. Young children will bathe together with a parent, for up to thirty minutes. There is also a specific procedure set for bathing. One first washes himself outside of the tub with soap and water, rinses off, and then soaks in the tub filled with hot water. This practice is modeled after the routine followed at public baths in older times when the hot water was used by everyone and therefore one had to be clean before entering. The hot water provides a means of relaxation, contemplation, and refreshment, and thereby restores the *kokoro*, the heart or spirit.<sup>10</sup>

Historical accounts reveal the traditional Japanese view of water as a means of purification. "When a person dies, they prepare a single coffin...when the funeral is over, all members of the family go into the water to cleanse themselves in a bath of purification."<sup>11</sup> This belief originated as early as 297 A.D. during the Kofun period.<sup>12</sup> Early settlements were often situated near natural hot springs, which were used for relaxation.<sup>13</sup> During the Kofun period, a cultural revolution took place in Japan and with the "importation of Buddhism, philosophy, culture and learning from China," the Japanese established the *kojiki*, a record of ancient things, and the *nihon shoki*, a chronicle of Japan. Both were intended to "legitimize the ruling powers

9. Pure Inside Out. 2010

10. Clark 1994, 5

11. Ibid., p.5

12. Ibid., p.19

13. Ibid., p.20

# 1 WATER AND HUMAN SETTLEMENT

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by recounting the divine origins and emergence of Japan."<sup>14</sup> Embedded in these records are several myths stressing the importance of bathing as a purity ritual.<sup>15</sup>

In Bangladesh, water represents fertility, cleanliness, renewal, and destruction. Bathing is customary in both the birth and death of a Bangladeshi citizen. When a woman is pregnant, she takes an early bath and shortly after, fills a small pot with paddy and "places it in a secluded place to germinate."<sup>16</sup> At death, Muslims are given their last bath. The body is rubbed with *atr*, a scent containing no alcohol and then wrapped in a white sheet and lowered into the grave.<sup>17</sup> Marriage ceremonies also have specific bathing rituals. Once the marriage negotiations are settled, both the bride and groom, engage in a special tamarind bath called *gaye halood*. Then, seven young girls are directed to bring in water and *mehndi* leaves from neighbors that they traded for betel nuts. The *kula* then has to be decorated with elaborate colors and paddy and grass placed all over it. Meanwhile, already married women are busy preparing the *halood bata* (crushed turmeric) for both the bride and groom. The bath water has to also be touched by silver and gold. This tradition has been followed for many generations and is customary of all Bangladeshis, spanning all social classes.<sup>18</sup>

Folk beliefs are also strongly tied to explanations of seasonal effects. Storms are believed to be a one-eyed demon known as *Kana Deo* who smashes everything in his path.<sup>19</sup> When drought or excessive rainfall occur, it is believed that God has sent a curse down from Heaven. One proverb states, "If we distribute the betel nut to every house, the bright sun will appear;" this is believed to lessen the effects of the unpredictable weather.<sup>20</sup> A ceremony called *bisshit* is performed on the first day of the sowing season. It is performed by an "only daughter of a mother [who] carries a *bahir kula* (a winnowing fan) on which are placed a skull of a cow and the nest of a crow."<sup>21</sup> Every home in the village is visited by the daughter and every woman pours water over the *bahir kula*.<sup>22</sup> Children then join together in a song translated as, "You, the cultivator and fisherman, give us rainfall so that we can go home. If it does not rain, we will not be accommodated in our houses, but rather in the aram field where knee-deep water is available, but if water cannot be had in the aram field, why don't you shower rain so that we can have it like the roaring sound of tamarind seeds?"<sup>23</sup> Every district located in Bangladesh

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14. Ibid., p.21

15. Ibid., p.21

16. Afsaruddin, Mohammad. 1990. *Society and culture in Bangladesh*. Dhaka: Book House. Pg. 123.

17. Afsaruddin 1990, 114

18. Ibid., p.109

19. Ibid., p.122

20. Ibid., p.122

21. Ibid., p.119

22. Ibid., p.120

23. Ibid., p.120

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has a unique set of folk songs and dances that welcome harvesting and monsoon seasons.<sup>24</sup> A famous *bhatiali* song is sung to welcome the monsoon season when the rivers and low-lying lands are filled with water.<sup>25</sup>

## Water Dwelling Communities

Similar to Bangladesh, there are other examples of water-dwelling communities around the world who also rely on floating and inundated lands for their survival.

### Uros



Image 1: Uros Boat made of totora reed

The Uros community of Peru is a prime example of a historic water dwelling lifestyle. A few kilometers off Puno, in Lake Titicaca, there is a community of man made, floating islands. The Uros people first retreated to the sea in resistance to Incan rule. Reed boats tied together formed the first islands. They later expanded their territory by creating more islands made of floating totora reeds. The construction of an island involved tying blocks of reeds together until the roots eventually

intertwined and grew together. Totora reeds were then piled on top of the root blocks, creating a layer measuring fifteen feet deep. The islands were then anchored to the bottom of the sea by a eucalyptus tree trunk embedded in the island and the floor of the lake. As true stewards of their home, the Uros people take special care to make repairs on their floating homes every three months. A new layer is added as the island continues to sink and the bottom rots out. This tradition is still carefully performed today.<sup>26</sup>



Image 2: Totora reed

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24. Ibid., p.145

25. Ibid., p.142

26. Matsukawa, Celeste. Personal Experience to Peru 2009.

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A big concern for the Uros people is the threat of fire. Cooking took place on small stoves set up away from the home. As a precaution, the homes were thought to be dispensable, and in the case of a fire, one could simply push their home into the lake.

Traditionally, the Uros people relied on the totora reed for everything. It was used to construct not only their islands, but homes and boats as well. It was also used as a source of food and medicine. They survive mainly on fishing and while agriculture doesn't play a large role in their community, they are able to grow a few potatoes in the rotting totora reeds.<sup>27</sup>



Image 3: Uros floating land.

Currently, there are about forty-two islands still in existence. Most of these islands are still inhabited, but are used mainly for tourist purposes. The Uros people have incorporated new technology into their homes, including solar panels. They are now constructed from wood and then use the totora reed as a sheathing material. A synthetic rope also now replaces the traditional totora reed rope. Upon arrival, tourists are bombarded with items not native to the Uros community available for purchase. The feel of the island is that of a tourist trap; there is nothing really native to the traditional culture besides the island itself. Overall, there is a clear loss of culture in the modern day Uros community.<sup>28</sup>

## Moken

The Moken people of Myanmar are known as the water gypsies of Asia. Unlike their land-dwelling stilt house neighbors, "the Moken are born, live, and die on their boats, and the umbilical cords of their children plunge into the sea, goes an epic of the Moken."<sup>29</sup> A truly aquatic culture, these people have adapted their bodies to fit their lifestyle at sea. Children

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27. Ibid.

28. Ibid.

29. Ivanoff, Jacques. "Sea Gypsies of Myanmar" National Geographic. April 2005. Accessed April 2, 2011.

<http://ngm.nationalgeographic.com/2005/04/sea-gypsies/ivanoff-text/2>

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Image 4: Moken People

Chinese and Malay land dwellers. These goods include seashells, sea cucumbers, sea snails, and oysters.<sup>31</sup>

An ancient myth tells the tale of the Moken people being punished by an island queen called Sibian. The story goes that Sibian's Malay husband Gaman cheated on her with her sister and as punishment the Moken people were banished to the sea. Queen Sibian deemed the kabang representational of the human body, "with the front of the boat a mouth constantly seeking nourishment and the back an anus for defecation."<sup>32</sup> Therefore, different parts of the boat correspond to names of body parts. "For example, la-kae is stomach, ta-bin is cheek, tu-koh is neck, ba-hoy is shoulder, and ta-bing is ribs."<sup>33</sup>



Image 5: Moken Boats

30. Leung, Rebecca. "Gypsies Saw Signs In the Waves." 60 Minutes. June 8, 2007. Accessed April 2, 2011. <http://www.cbsnews.com/stories/2005/03/18/60minutes/main681558.shtml>

31. Ivanoff 2005, 2

32. Ibid., p.2

33. "Boats – Kabang." The Moken Legacy Projects. 2010. Accessed April 7, 2011. <http://www.moken-projects.com/site/boat-building/>

The *kabangs* are constructed from a hallowed out tree trunk and feature “plank gunwales.” The roof structure is constructed of “pandanus leaves sewn together. The bifurcation at the bow and stern of the kabang serves as a ladder to climb in and out of the water.”<sup>34</sup> There are “only a few species of trees” suitable for constructing these floating homes.<sup>35</sup> The two most sought after trees are the *rakam* tree also known as *Salacca Wallichiana* and the *mai pan*, a local species found on the Surin Island coast. These two species of wood have the density required for floatation while other species “give the wrong weight” according to Salama, a Moken community member of the Surin Islands.<sup>36</sup> Once a log is selected, it is roughly carved into a “boat-like” shape.<sup>37</sup> This rough shape is then submerged in water and soon after heated up; a process designed to enlarge the boat. Next, the boat is “grilled over a fire of *tanai* wood” which blackens the lower part of the boat, and protects it from damage by barnacles once it is in use. The last step is attaching the sails which are constructed from *toei naam* leaves, also known as pandanus leaves.<sup>38</sup>

The Moken are a peaceful people, who would rather retreat than live with the harassment of military officials and the government’s wishes to exploit them as tourist attractions. In the past, they have been exploited and discriminated against by the Japanese, British, Thai, and Burmese. Due to the strong military presence in Myanmar, they are now not allowed to move freely between locations, which makes it difficult for young men to find wives or traders who will supply them with rice, their main source of food, and fuel for their boats. The Moken require very little, never wanting to acquire material possessions as material wealth weighs a person down.<sup>39</sup> No translation for the term “want” exists in their language as one doesn’t *want* an item, they either *take* or *give*; there is no *want*. Their concept of time also differs greatly from those of westerners; there is no word for “when” in their language. They also don’t have any words for greetings such as “hello” and “goodbye.” When one departs or leaves, he just does so without much fuss or verbal indication. Ethnologist Jacques Ivanoff describes his departure after living a year with them as such. He just left. There were no good byes.<sup>40</sup>

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34. The Moken Legacy Projects 2010

35. Sukin, Kamol. “Thailand’s Sea Nomads.” UNESCO July 2000. Accessed April 7, 2011  
[http://www.unesco.org/csi/act/thailand/moken\\_e.htm](http://www.unesco.org/csi/act/thailand/moken_e.htm)

36. Sukin 2000

37. Ibid.

38. Ibid.

39. Ivanoff 2005, 2

40. Leung 2007

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There are currently only about a 1,000 Mokens who still lead this lifestyle. When compared to the previous 2,500, it is evident that this unique community is in danger of losing its culture.<sup>41</sup> In the early 70s, many of the Moken communities were displaced due to political issues occurring in Myanmar that restricted their “traditional sea-route along the coastline of both Myanmar and Thailand.”<sup>42</sup> They were thus forced to migrate to new places that didn’t accept their traditional nomadic lifestyle. Many of the Moken tribes migrated to the Surin Islands located near Thailand, and in 1981, this area was “declared a national marine park and restrictions were placed on their fishing and foraging activities.”<sup>43</sup> The development of tourism also arose, bringing with it the threat and introduction of western modernity. Items such as instant noodles, condensed milk, and other snacks became a delicacy for the Moken.

A 1997 UNESCO project entitled the *Andaman Pilot Project* hopes to preserve the Moken culture by merging their traditional knowledge with the region’s sustainable development. An extensive study of their cultural practices, migration, and traditional knowledge was conducted and supplemented with additional local marine studies ensuring a complete understanding of the local ecology.<sup>44</sup> Today, the only surviving traditional Moken society resides in Meruyi, an area located right outside the borders of Burma and Thailand.<sup>45</sup> As one of the last true aquatic cultures, their sustainable lifestyle is one from which the world can learn a great deal. It deserves to be studied further and may serve as a precedent for future populations as sea levels continue to rise.

### Chinampa

The residents living in the Valley of Mexico developed floating gardens known as *chinampa* as early as 1400BC as a means of increasing agriculture production. This development served as a solution to population increases. These raised-bed gardens were developed along the swampy edges of lakes, constructed on each side of a canal through a layering process. A thick layer of reeds was laid upon freshwater mud and the mud was then “dipped up” and poured on to a layer of dry rushes. This was then laid out to dry and formed “a rich ‘muck’ soil.” Over time, this bed of soil “gradually [sank] down into its muddy foundation,” and had to be repaired every couple of years, requiring additional layers of the muddy

41. Ivanoff 2005, 2

42. Sukin 2000

43. Ibid.

44. Ibid.

45. The Moken Legacy Projects 2010



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concoction.<sup>46</sup>

These gardens were arranged on a grid dictated by the local government. This grid encompassed a system of feeders, main canals, and dikes that supported the agriculture. The height of Chinampa development was recorded in 1520, having an area of 25,000 acres, located in the Xochimilco-Chalco area, which also provided food for the Aztec city of Tenochtitlan. This same process was



Image 6: Chinampas

also applied to construct new land for neighborhoods. A process similar to a landfill, composed of “garbage, trash, and building debris,” was used to create these artificial landmasses. Nineteen islands were built up around Tenochtitlan, an area where the water proved unsuitable for crops. These floating gardens continued to flourish up until the 19<sup>th</sup> century when the lake bed was drained and cleared for what is today’s modern Mexico City.<sup>47</sup>

This development allowed for agricultural practices to continue year-round as well as

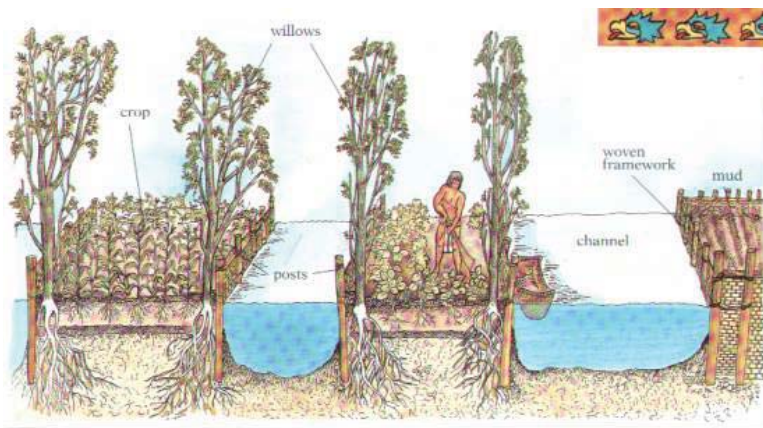


Image 7: Chinampas diagram

allowed farmers to grow a variety of other crops, expanding the local diet. Through this process, the gardens also recycled waste products by creating a rich biodiversity that attracted waterfowl, aquatic animals, and fish, further contributing to the rich Mexican Valley diet.<sup>48</sup> These floating gardens were able to sustain a

46. Crouch, Dora P., and June Gwendolyn. Johnson. *Traditions in Architecture: Africa, America, Asia, and Oceania*. New York: Oxford University, 2000. 82

47. Crouch and Johnson 2000, 85

48. *Ibid.*, p.82

population of several million people. They produced thirteen times more “produce than dry-land farming in the same area, [and] a family could survive on less than half the food it grew while working only 200 man-days per year.” This efficient system allowed the remaining days of the year to be spent on the “support of aristocrats, artisans, soldiers, and bureaucrats of the metropolis.”<sup>49</sup>

### Hanji

Kashmir, a floating community located along the India/Pakistan border, in the river valleys of the Himalayas at an altitude of 5,300 feet, boasts a mix of Hindu and Muslim cultures. Unlike most other water dwelling communities, the Kashmiri actually retain floating homes and have designed their infrastructure around these floating concepts. Waterways serve as the main mode of transportation, and water levels and entries are regulated with a series of locked gates. “When the water in a canal reaches the necessary level, the boats glide into the twisting, turning waterways, a never-ending panorama of flowers, shady cypress and chinar trees, shops, and people along the banks.”<sup>50</sup>

A caste system is prevalent here, and groups are divided into three tiers, with the *Doonga Ha’enz* at the top and the *Bahat Ha’enz* at the bottom. The *Doonga Ha’enz* own houseboats, which are used to transport people and grain across the rivers while the *Bahat Ha’enz* have *bahat*, a barge type of boat used to transport cargo such as timber, bricks, grain, or fuel.

The *doonga* is constructed from wood with approximate dimensions of 50 feet by 6 feet. It has a sloping roof structure and the inside walls are covered with matting. The boat also features a tiny kitchen which uses a dried-clay surface for cooking,<sup>51</sup> located in the aft section of the boat. There is also a clear hierarchy between the passengers the *Doonga Ha’enz* transport and themselves. The passengers sit in the forefront of the boat, a more desirable space to occupy than the back area that the *Hanji* inhabit. The second type of boat is the *bahat*, used for both transportation and housing by the *Bahat Ha’enz*. The living spaces take up most of the room on this boat with a two-room cabin. A third type of floating structure is the gardens that house the *Hanji*’s vegetables. These rafts are constructed from lake weeds.<sup>52</sup> The gardener

49. Ibid., p.86

50. Ibid., p.141

51. Ibid., p.141

52. Ibid., p.141

then makes indentations in the weeds and fills them with soil collected from the bottom of the lake. Once the base is formed, the gardener can insert seeds. These rafts are then towed at the back of the boat and the vegetables grown are sold.<sup>53</sup>

Life for the boat people of Kashmir is a constant struggle to meet basic needs. They can barely support themselves and live at near-poverty levels. Food costs the most money and accounts for 60% of their expenses. Due to such economic woes, the family unit relies heavily on the combined income of the entire extended family. This may include the father, sons, grandsons, brothers, and their wives and children.<sup>54</sup> Families tend to live together on one houseboat, creating issues of privacy and overcrowding which then leads to sanitation issues. There aren't many lavatories, and thus, the Hanjis rely on the river for hygienic purposes.

Bathing is a ritual held in high regard as both Hindus and Muslims associate cleanliness with godliness. Bathing takes place in the rivers during warm months, and mosques provide bathing facilities during the winter months. The majority of the people here are Muslim, but they are still ruled by a strict Hindu caste system that restricts any intermarriage between the different economic groups of the Hanji. Tourism contributes to a large portion of their income, but during the off season, they turn to loans for survival.

### Ma'dan

The Ma'dan are a unique people who reside in the marsh lands at the convergence of the Tigris and Euphrates of Al Quranah in southern Iraq.<sup>55</sup> There are currently 100,000 people occupying these lands, extending over 4,000 square kilometers. The Ma'dan people have a lifestyle similar to the floating Uros community of Peru who take advantage of their surroundings, using reeds to construct their architecture and boats. They too live on land close to sea level ranging in height from 1 meter below sea level to 4 meters above, with most of their land flooded up to a depth of 4 meters.<sup>56</sup> Their climate is described as having cool dry winters but with hot humid summers and features low rainfall but sudden storms. The marshlands are ideal for growing the *gasab* reed as it contains "sedimentary soils and sluggish waters [which]

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53. Ibid., p.142

54. Ibid., p.143

55. Oliver, Paul. Encyclopedia of Vernacular Architecture of the World. Cambridge: Cambridge University Press, 1997. 1591.

56. Oliver 1997, 1591

## 1 WATER AND HUMAN SETTLEMENT

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encourage [the growth of] extensive reed beds."<sup>57</sup> The Ma'dan herd indigenous cattle and water buffalo which provide them with milk and dung for fuel. They import fish, fowl, mutton, dates and other fruits, and palm timber.

Unlike the Uros, their architecture is constructed *purely* from the gasab reed and is not used for tourist purposes. They are an Arabic community composed of Shi'ah Muslims, an offshoot of the Bemdouin nomads who lead a fairly sustainable lifestyle, resulting from a lack of electricity, running water, and few material possessions. Water is collected from the marsh lands and defecation occurs on site, but despite the lack of sanitation facilities, the Ma'dan people are described as relatively healthy people.<sup>58</sup>

The Ma'dan live on both natural and artificial islands in the marshlands known as Tuhul. The artificial islands are constructed from the gasab, a bamboo-like reed that grows in the marsh lands and can grow up to 25 feet tall.<sup>59</sup> They are built up to 1 meter above water level and are large enough to house several buildings. Villages are composed of a number of islands linked together by floating waterways.<sup>60</sup> The structures begin with a 20-foot-high gasab fence. Reeds and rushes are then packed into this fence, which serve as the foundation

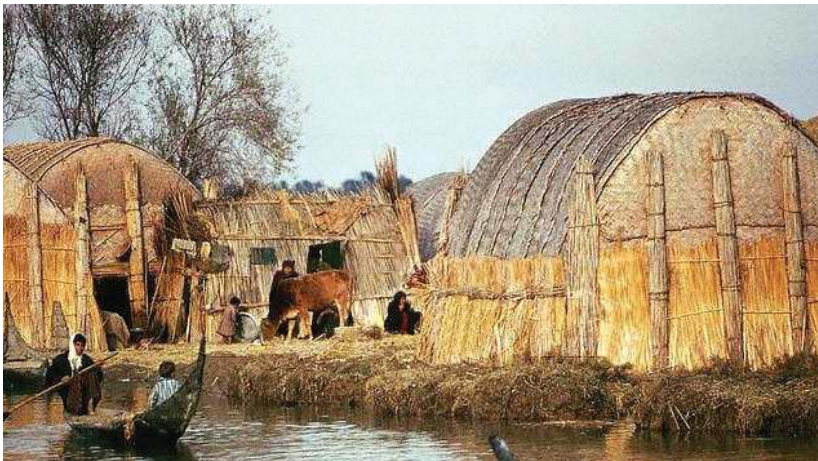


Image 8: Ma'dan Floating homes

for houses. When the floor begins to sink or water levels rise, a new layer of reeds is added ensuring stability above the water level.<sup>61</sup> This type of housing is called a *kibasha*. Another type of dwelling is known as a *dibin*, a more permanent site whose foundation contains an extra layer of mud. However, "if a

57. Ibid., p.1591

58. "Ma'dan" Countries and Their Cultures. Accessed April 11, 2011.

<http://www.everyculture.com/wc/Germany-to-Jamaica/Ma-dan-Marsh-Arabs.htm#ixzz1ljkEg3qb>

59. "Ma'dan" Countries and Their Cultures.

60. Oliver 1997, 1591

61. "Ma'dan" Countries and Their Cultures.

# 1 WATER AND HUMAN SETTLEMENT

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family leaves a dibin unoccupied for more than a year, they lose their right to it and anyone may take possession of it.”<sup>62</sup>

Homes are constructed from the gasab reed as well. Paul Oliver describes these homes as “the most remarkable example of simple efficient and durable technique.”<sup>63</sup> Larger structures contain a curved roof that is supported by reed arches while secondary structures contain “vertical walls and a flat, low-pitched roof,” and smaller structures are described as “no more than a pitched tent like structure.”<sup>64</sup> These structures consist largely of reeds bundled and bound together.<sup>65</sup>



Image 9: Inside a Ma'dan Home

The arched buildings are constructed by first setting pairs of long thick reed bundles into holes cut “0.75m deep into the reed base, aligning each 2m apart [and] in two parallel rows, with their upper parts leaning up to 3 meters outwards.”<sup>66</sup> Next, the reeds are bent inwards so that their tops overlap 1-2 meters. “The resulting horse-shoe shaped arches are finally tied together longitudinally with thin bundles acting as purlins to form the basic shape.”<sup>67</sup> Woven reed matting provides cladding for the roof, which includes a “shallow tier of open matting” to allow for ventilation. This same opening is closed during cold weather. Entrances are formed by a large opening placed at either the front or back of the structure. An *upstand* is incorporated into the entrance, which prevents animals from entering the structure. The flooring and side sheathing is also covered with woven mats.<sup>68</sup>

Smaller buildings are built similarly to the large structures, with rectangular bays constructed from bundles of reeds set into the reed bed. These bays are then joined together

62. Ibid.

63. Oliver 1997, 292

64. Ibid., p.1591

65. Ibid., p.1591

66. Ibid., p.1591

67. Ibid., p.1591

68. Ibid., p.1591

## 1 WATER AND HUMAN SETTLEMENT

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with wall plates, “bridging pieces and ties and with further posts to support a ridge. Rafters and sometimes purlins, of bundled reeds, complete the structure which is then clad with reed panels and matting in the usual way.”<sup>69</sup>

All structures last roughly seven to ten years, and rotting parts of the home need to be replaced constantly. It is usually the lower parts of the home that suffer from rotting, and can easily be cut out, lowering the entire structure. When homes are deemed unlivable, they are either demolished or abandoned to be consumed by rising water levels.<sup>70</sup>

We need water to survive, and it plays a large role in our rituals and daily routines. All of the aforementioned cultures exemplify the widespread and diverse methods of living with and on water. The unavailability of the element would paralyze life and culture, and ultimately disrupt our whole existence. Distinct from other water-based communities, the Char people of Bangladesh are the epitome of a water-centered culture, whose existence is characterized by their integration rather than evasion of their fluid environment.

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69. Ibid., p.1591

70. Ibid., p.1591

# 2 CHARS

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## Deltas

Deltas play a pivotal role in the survival of many societies since 25% of the world's population resides on deltaic coastlines.<sup>71</sup> These deltas provide a rich agricultural environment that serve to sustain their populations. Deltas are newly created land, resulting from the deposit of river sediment at the meeting of the river's mouth and a large standing body of water. When the flowing water of the river combines with the standing water source, the area expands in width thus slowing the velocity of the flowing water. This decrease in velocity results in the dumping of sediment collected in the river water's flow, which forms the deltaic lobe.

There are three types of deltas: river dominated, tide dominated, and wave dominated. River dominated deltas have "an ample flow of freshwater and sediment from the upland and a placid seaward receiving basin." Tide dominated deltas are cases when "freshwater discharge is overpowered by tidal current," and wave dominated deltas contain "typically smooth shorelines, and [occur] when longshore currents carry sediment away."<sup>72</sup> Three characteristics common to all deltas are:

1. The presence of a large catchment, or drainage basin (the area where all run-off water drains to the river) – The top 30 river deltas all have catchment basins in excess of 1,000,000 sq km.
2. They all are at the mouth of large river systems that carry large quantities of clastic sediments (soils or portions of rocks that have been moved by water from where they formed).
3. They are not near geologically active coastlines. In order to have a large

71. Giosan, Liviu, and Janok P. Bhattacharya. 2005. *River deltas: concepts, models, and examples*. Tulsa, Okla: SEPM (Society for Sedimentary Geology).Pg. 3

72. Applied Coastal Oceanography. Accessed March 10, 2010. <http://web.bryant.edu/~dlm1/sc366/deltas/deltas.htm>

catchment basin, a very complex tributary system is necessary. These long, complex systems take a long time to develop, so they are very rarely situated on tectonically active coasts. <sup>73</sup>

The Delta of Bangladesh is formed by the silt deposits of the Ganges River and is therefore known as the Ganges Delta. <sup>74</sup> The 200-mile-wide delta sits along the Bay of Bengal. <sup>75</sup> Contributing rivers are the Ganges, Brahmaputra, and Meghna with a combined flow rate of 200,000 cubic meters per second. It is estimated that a billion tons of sediment pass through the three rivers and of that, two-thirds are emptied into the Bay of Bengal. <sup>76</sup> Copious amounts of rainfall coupled with snow melt in the Himalayas comprise the water flowing through the rivers. The Ganges Delta plain originated 12,000 years ago as a result of rising sea levels

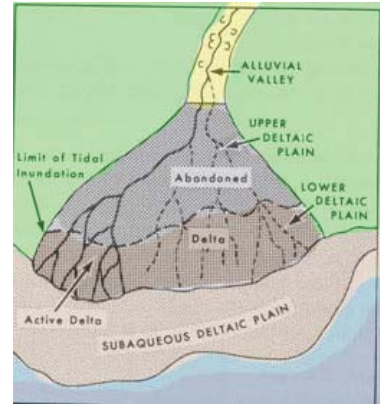


Image 10: Different shapes of the three types of rivers.

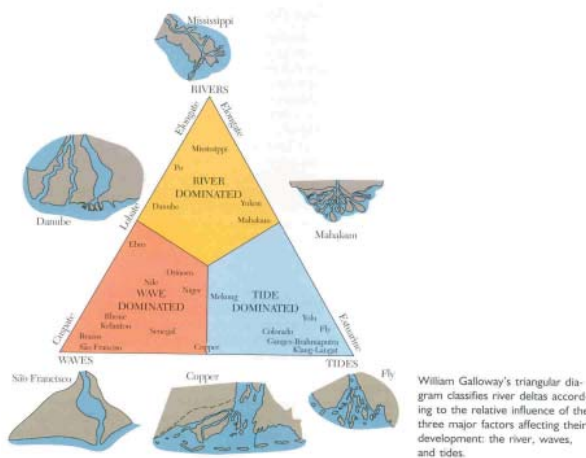


Image 11: Delta types

flooding the land we know as Bangladesh. Around the time of its formation, sea levels were 60 meters below today's levels, but they began rising swiftly due to sheets of northern ice melting. "The immense quantity of sediments delivered by the Ganges and Brahmaputra rivers balanced with sea level rise, and the delta built vertically for several thousands of years." <sup>77</sup> About 6,000 years ago, sea level rise slowed down, and the river sediments began to build

73. "What is a River Delta." America's Wetland. Accessed March 10, 2010. [http://www.americaswetlandresources.com/background\\_facts/detailedstory/RiverDelta.html](http://www.americaswetlandresources.com/background_facts/detailedstory/RiverDelta.html)

74. Islam, M. Rafiqul. 2004. *Where land meets the sea: a profile of the coastal zone of Bangladesh*. Dhaka, Bangladesh: Published for Program Development Office for Integrated Coastal Zone Management Plan (PDO-ICZMP), Water Resources Planning Organization (WARPO), [by] University Press. Pg. 13

75. Giosan, Liviu, Bhattacharya, Janok 2005, 3

76. Islam 2004, 13

77. Ibid., p.14



the coastal plains as we see them today.” First to arise were the western regions surrounding Kolkata. The plains continued moving eastward followed by the Meghna estuary which arose 2,000 to 3,000 years ago.<sup>78</sup>

The Bay of Bengal covers roughly 510,000 square kilometers of coast. A U-shaped basin is evident upon studying the bottom topography. This basin “opens in the south to the Indian Ocean, and funnels in the north towards the coast of Bangladesh.”<sup>79</sup> What is described as a “thick abyssal plain” contains a subtle southern slope set “at a one degree angle, [and] occupies almost the entire Bay.”<sup>80</sup> The Bangladesh coast is surrounded by a continental shelf beginning “at the 150m datum line.”



Image 12: Bay of Bengal

<sup>81</sup> This shelf measures roughly 300 kilometers wide with a steady slope of 1:800. This delta, a combination of the “Ganges, Brahmaputra, and

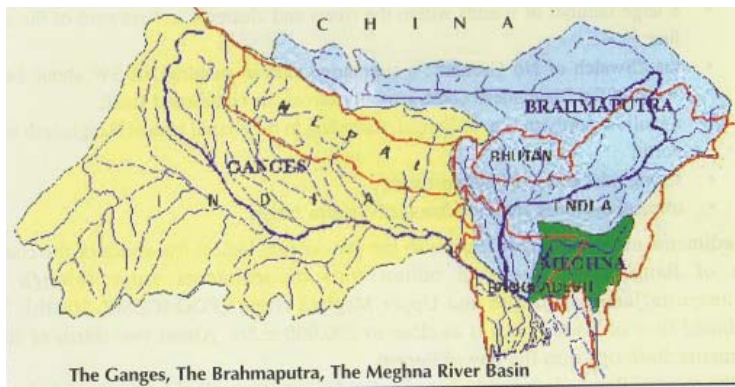


Image 13: Ganges-Brahmaputra-Meghna River Basin

Meghna rivers extends for about 150km from the coast out to 80m depth.”<sup>82</sup> This area is less than 12,000 years old and is composed mainly of Holocene sediment. An area of roughly 18,000 square kilometers of the total area averages less than 12 meters deep and is an “extension of the coastal plain that has been built by the rivers.”<sup>83</sup> Most

of the sediment deposited here is brought down via the Meghna Estuary. “This broad, shallow

78. Ibid., p.15  
 79. Ibid., p.15  
 80. Ibid., p.15  
 81. Ibid., p.15  
 82. Ibid., p.15  
 83. Ibid., p.15

area is important, because it protects the coast from high wave energy, and it also represents the base for future land development as sediments are brought to the coast.”<sup>84</sup> A submarine canyon known as the *Swatch of No Ground (SNG)*, is located around “25 km south of the western coastline” and serves to circulate open water as well as other aquatic processes. It is through the SNG that the Bengal Fan is created as large amounts of sediments pass through the

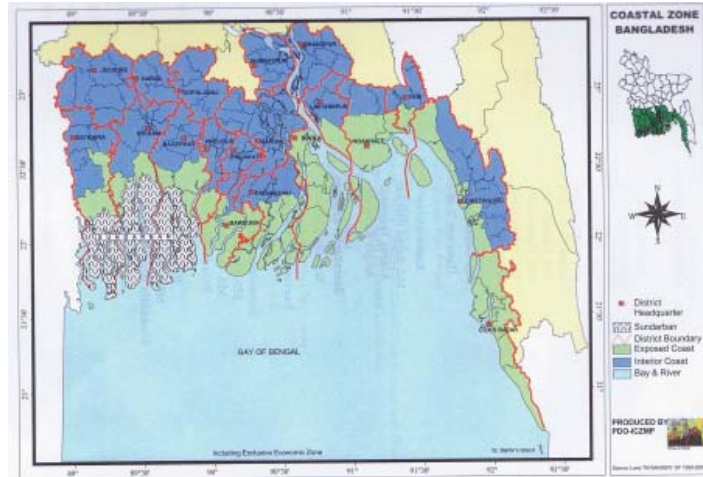


Image 14: An aerial view of the Ganges Delta

SNG forming the largest deep-sea fan. The waters of this area are high in nutrients due to an upwelling effect, where deep ocean water is displaced closer to the surface, allowing for diverse marine life with an abundance of planktonic species. Additional nutrients are also added as the river waters discharge into the bay. The large amount of freshwater emptied into the bay lowers salinity levels in its northern parts. Areas up to 300 meters in depth are affected by this flux in salinity saturation, and salinity levels change each season. These levels range from 30% to 35%, but can decrease to as low as 26% during monsoon seasons.<sup>85</sup>

The coast can be grouped into three main geomorphic regions, the eastern, western, and central regions. The eastern region is composed of flat beaches made of clay and sand and reaches from “the big Feni River to Badar Mokam, the southernmost tip of the mainland.” The Karnaphuli, Matamuhuri, Sangu, and Naf rivers empty freshwater throughout the plains. The western region contains a “patch of natural mangrove forest known as the Sundarban.”<sup>86</sup> The central region stands between the eastern and western regions. Located in the central region is the active Meghna Estuary and “most of the combined flow of the Ganges-Brahmaputra-Meghna system discharge[s] through this low-lying area.”<sup>87</sup>

84. Ibid., p.15

85. Ibid., p.15

86. Ibid., p.13

87. Ibid., p.13

The Delta can be broken down into three main zones. The Brahmaputra Alluvium, the Ganges Alluvium, and the Tessta Silt. The Brahmaputra Alluvium consists of the “districts of Dhaka, Mymensingh, Tangail, and Comilla of Bangladesh.”<sup>88</sup> The Ganges Alluvium is the “districts of Kushtia, Jessore, Khulna, Rajshahi, Pabna, and Dhaka of Bangladesh and [a] major portion of West Bengal of India.”<sup>89</sup> The last districts of the Tessta Silt are “Dinajpur, Rangpur districts, East Bogra, and Sirajganj of Bangladesh and some parts of West Bengal of India.”<sup>90</sup>

### Island Chars and Attached Char Formations

A char is a “tract of land surrounded by the waters of an ocean, sea, lake, or stream; it usually means, any accretion in a river course or estuary.”<sup>91</sup> These chars are sought after because of their highly rich soil, steeped in silt brought down from the Himalayas by river flow.<sup>92</sup> A total of 60 islands, 65 known char lands, and 112 newly discovered char lands exist in Bangladesh.<sup>93</sup> These islands only last for around twenty years at the most before they are wiped out by flooding or erosion.<sup>94</sup>

There are two different types of chars: island chars and attached chars. Island chars are surrounded by water year round while attached chars are connected to the mainland during periods of normal water flow. Chars develop in two distinct settings, braided and meandering rivers, and differ depending on their location in the river, either upstream or downstream. Upstream chars often times contain coarser bed materials when compared to chars that developed downstream.

Braided rivers are rivers that contain a valley slope of less than 4%. Water flows through a number of different branches, or braids “within the bank lines of a single (multi-thread) broad channel.” Temporary islands arise from large “sediment deposits [that] separate these braids.”<sup>95</sup> The bed of this type of river is fashioned from “large sediment deposits” made

88. “Ganges Delta: World’s Best Land for Cultivating Quality Jute & Allied Fibers.” Import Export Trade Leads - Global Trade Business Opportunity Services - The Mellinger Co. Accessed March 10, 2010. [http://www.tradezone.com/tradesites/ganges\\_delta.html](http://www.tradezone.com/tradesites/ganges_delta.html).

89. Ganges Delta: World’s Best Land for Cultivating Quality Jute and Allied Fibers.

90. Ibid.

91. Islam, Prof. Sirajul. “BANGLAPEDIA: Char.” Banglapedia :: National Encyclopedia of Banglaesh. 2006. accessed November 05, 2011. [http://www.banglapedia.org/httpdocs/HT/C\\_0135.HTM](http://www.banglapedia.org/httpdocs/HT/C_0135.HTM).

92. Banglapedia 2006

93. Islam 2004, 17

94. Harrabin, Roger. “BBC NEWS | Science/Nature | Climate Fears for Bangladesh’s Future.” BBC News - Home. Accessed February 29, 2010. <http://news.bbc.co.uk/2/hi/5344002.stm>.

95. Crosato, Alessandra. 2008. *Analysis and modelling of river meandering = Analyse en modellerende*

of gravel and sand, while the banks also contain coarse-grained sediment and sometimes a cohesive top layer. "Once this is eroded or undermined by the river flow, banks and riverbeds behave in a similar way. As a consequence, the topography of a braided river can change rapidly, the channel may widen and one braid may be abandoned and replaced by a new one in the time space of a single flood event." <sup>96</sup>

Meandering rivers are located in low-land alluvial plains and are distinguished as containing dense vegetation and cohesive soils. These rivers contain a single, more "permanent, twisting channel without large longitudinal width variations." <sup>97</sup> Sediment deposits in the inner sides of bends form beaches. At the opposite ends, pools form due to the increase of velocity and resulting erosion. "The outer bank progressively retreats due to erosion and the inner bank accretes, due to sedimentation."<sup>98</sup> Overall, the rate of accretion and erosion are more or less the same, thus the river channel width may experience short-term fluctuations, but no long-term changes. "As a result of the interaction between bank retreat and advance, river bends progressively increase in amplitude and migrate." <sup>99</sup>

A braided river island char develops when water is directed around two sides of the land sediment. This effect tends to widen the river as the water erodes both sides of land. <sup>100</sup> As the river is continuously widened, the island chars also produce a widening effect as well. As a result of this process, there is a net loss of floodplain land and an increase in sand. This process also further encourages bar formation which in turn produces more island chars as these bars merge together. Along wider and parts without curves, it is common to find more island chars with nodes formed in the shorter and narrower parts of the river. <sup>101</sup>

In a meandering river, there are two types of reaches: bends and crossings. With bends, point bars are formed by secondary currents. These secondary currents "erode the outer bank of a meandering bend and deposit the sediments in the inner bend." <sup>102</sup> The topography of chars formed in a meandering river is therefore "elevated at the upstream part of the inner

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*rivieren*. [Delft]: Delft University Press. Pg. 9

96. Crosato 2008, 9

97. Ibid., p.10

98. Ibid., p.10

99. Ibid., p.10

100. Environment and GIS Support Project for Water Sector Planning. 2000. *Riverine chars in Bangladesh: environmental dynamics and management issues*. Dhaka: University Press." Pg. 29

101. EGIS 2000, 29

102. Ibid., p.30

bend and gradually slopes down in the downstream and from the bank towards the river.”<sup>103</sup>  
 Attached chars tend to develop off of an island char “by abandonment of an anabranch near the floodplain.”<sup>104</sup>

The Ganges and Padma rivers are both wandering types and therefore the char formations in both undergo similar processes. Additional chars are also created when “large sweeping meandering bends produce point bars as well as in areas of active chute channels during both dry and wet seasons.”<sup>105</sup> When chute channels then disappear, island chars become attached chars “if the channel reach becomes meandering or the anabranch near the floodplain is abandoned.”<sup>106</sup>

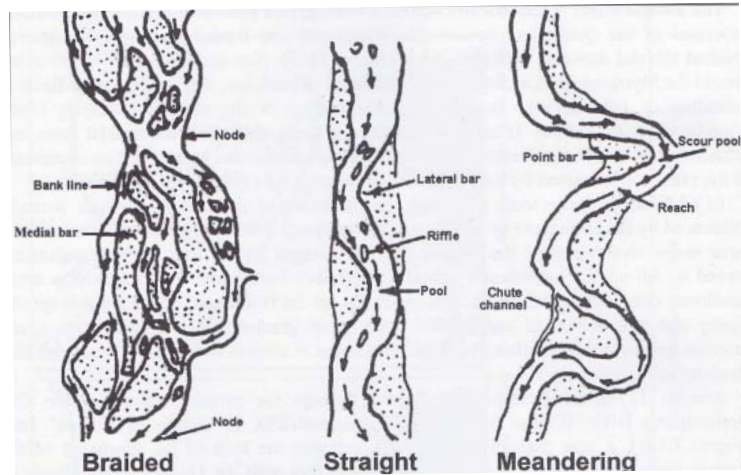


Image 15: Different River Types.

Chars are composed of sand containing “the same coarseness as the bed material of the river reach,” although finer materials are deposited on the lee side of a medial or point bar and “when the char elevation reaches average flood levels, a layer of silt and clay is deposited over the sand layer, facilitating the development of vegetated land.”<sup>107</sup>

### Jamuna River Chars

The Jamuna is a braided river containing chars of all different sizes. ISPAN conducted an extensive study on the Jamuna from 1973 through the 2000s, which found chars “in the reaches opposite to the Old Brahmaputra offtake, North and East of Sirajganj and in the

103. Ibid., p.30  
 104. Ibid., p.30  
 105. Ibid., p.30  
 106. Ibid., p.30  
 107. Ibid., p.30

## 2 CHARS

southernmost reach above the confluence with the Ganges.”<sup>108</sup> The chars were determined to be “rarely stable in the medium-term and most people living on them have had to move during this period” from 1973-2000.<sup>109</sup> There have also been measures implemented to reduce bank erosion, which have resulted in a decrease in char formations as well as their destruction.<sup>110</sup>

Flooding in the Jamuna River affects both island and attached chars equally. It should be noted that younger chars are more susceptible to flooding since they have a lower elevation. This is due to the fact that the “maximum elevation of chars can be close to the maximum flood levels occurring there.”<sup>111</sup> It is predicted that flooding over the next ten years, “may increase the water level by 20 to 40 cm at the upstream of the bridge.” Drastic floods over the past 20 years included one in 1987, which left 90% of the usually dry char areas inundated. Then in 1988, all char lands were underwater. In 1990, another flood left 50% of the areas underwater.<sup>112</sup>

### Ganges River Chars

The Ganges is known to have a lower vegetated land area than the Jamuna River. There is also a greater difference between island chars and attached chars in the Ganges with a ratio of 1.6 compared to the 1.0 ratio of the Jamuna River. The chars contained in the Ganges also have a higher stability rate. The exception to this is the area where the river starts to show braiding characteristics.<sup>113</sup>

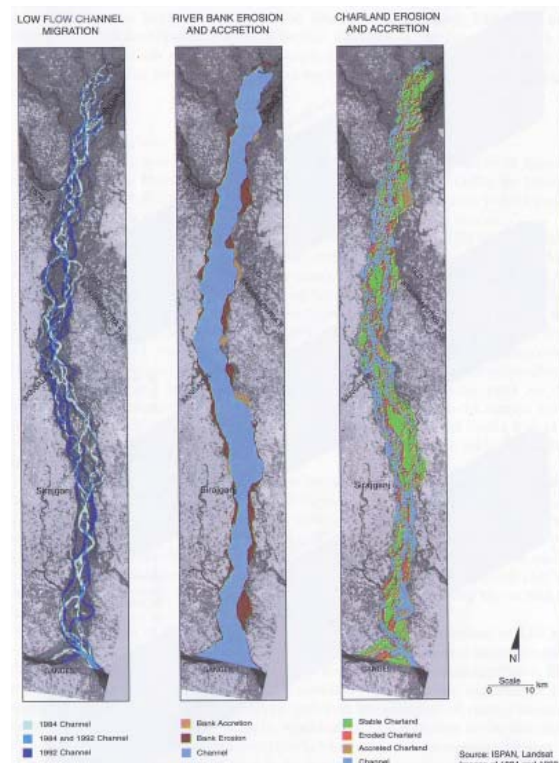


Image 16: Jamuna River mappings.

108. Ibid., p.33

109. Ibid., p.33

110. Ibid., p.34

111. Ibid., p.37

112. Ibid., p.38

113. Ibid., p.34

Flooding in the Ganges River had similar results to those that occurred in the Jamuna River in the same years. The 1987 and 1988 floods left about 90% and all chars inundated respectively. Then, between 1989 and 1992, flooding led to an average inundation of 65% of the attached chars and 83% of the island chars. It was also concluded that the middle portion of the Ganges River experienced more flooding than other parts. <sup>114</sup>

### Padma River Chars

Padma River chars contain even less vegetated land than the Jamuna and Ganges rivers with only 20%. Although limited, the amount of fertile land has been dramatically increasing at a rate of 244% since 1984. The stability of the Padma River chars is currently unknown, although scientists believe that the chars in this wandering river are likely to be more stable than the chars of the Jamuna River. <sup>115</sup>

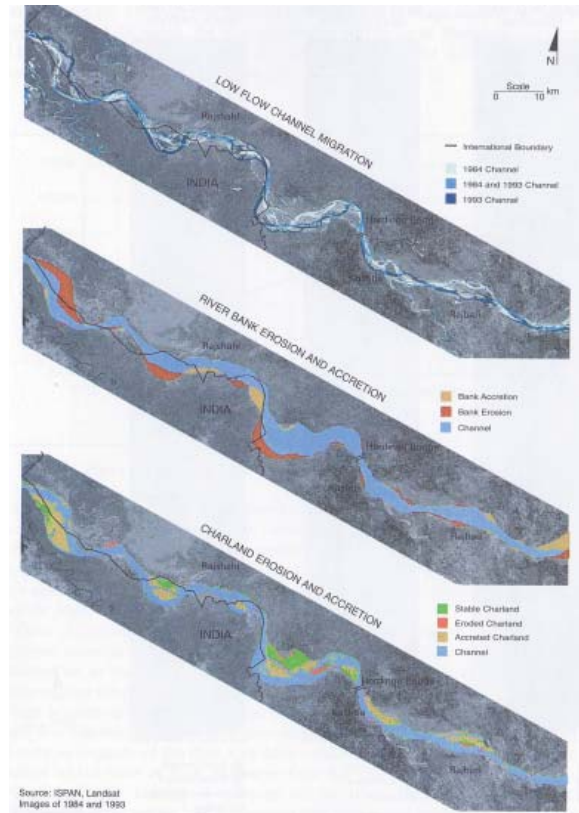


Image 17:Ganges River mappings.

The Padma flood patterns were less severe than those occurring in the Ganges and Jamuna rivers. The 1987 flood caused less damage, but then in 1988, a flood left all chars inundated. From 1989 to 1992, an average of 47% of the attached chars and 7% of island chars were flooded. Similar to those in the Ganges River, Padma island chars are more likely to be flooded than attached chars. This is due to the fact that island chars formed in wandering rivers are much younger. <sup>116</sup>

114. Ibid., p.38  
 115. Ibid., p.35  
 116. Ibid., p.38

### Upper Meghna River Chars

Upper Meghna River chars are highly stable. As the river is a multi threaded stream, containing parallel channels, it behaves as a series of separate meandering rivers instead of forming a braided river. This provides for a stable environment producing stable chars. There are predominantly island chars in this area, most lasting more than 70 years. The chars of this area account for 38% of the total area within the banks.<sup>117</sup>

The Upper Meghna River is highly susceptible to flooding. The 1987 flood led to more than 80% flooding of the chars. From 1989 through 1992, an average of 68% of all chars were inundated each year. When compared to chars of other rivers, flooding in this area was more frequent. This is because the "low sediment contents of the Meghna waters do not raise the chars by any substantial degree." Scientists predict that the flooding of this area may increase in time.<sup>118</sup>

### Lower Meghna River Chars

The Lower Meghna River consists of two separate areas: the confluence of the Padma and Upper Meghna and the Lower Meghna downstream from Chandpur. These two areas perform quite differently from one another. The confluence of the Padma and Upper Meghna area has significantly widened over the years and resulted in an increased char land area. From 1984 to 1993, the river lost about 4,500 hectares of non-vegetated land and 7,000 hectares

117. Ibid., p.35

118. Ibid., p.39

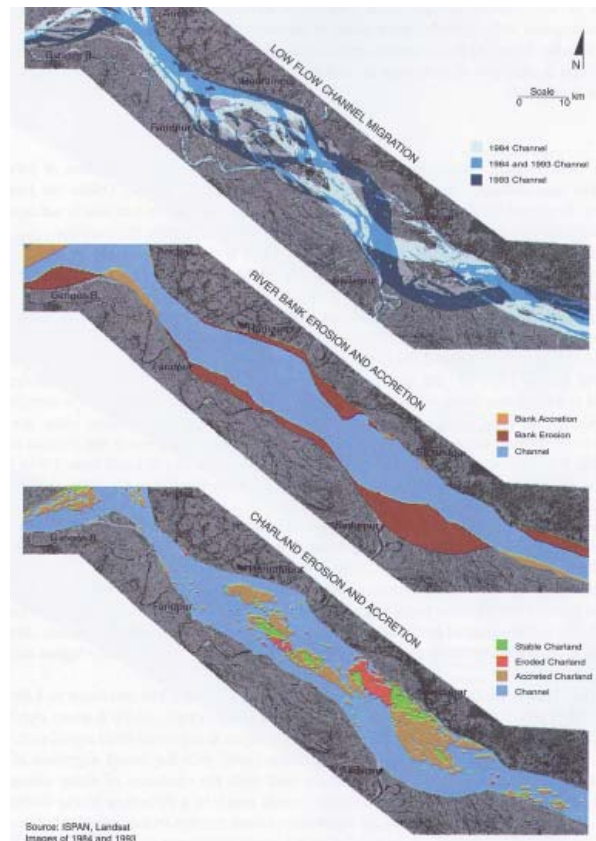


Image 18: Padma River mappings.



of vegetated land. The area downstream from the confluence also experienced a loss of land, but an increase in island char formations.<sup>119</sup> The chars experienced an increase in vegetated land from 900 hectares in 1984 to 4,600 hectares in 1993.<sup>120</sup>

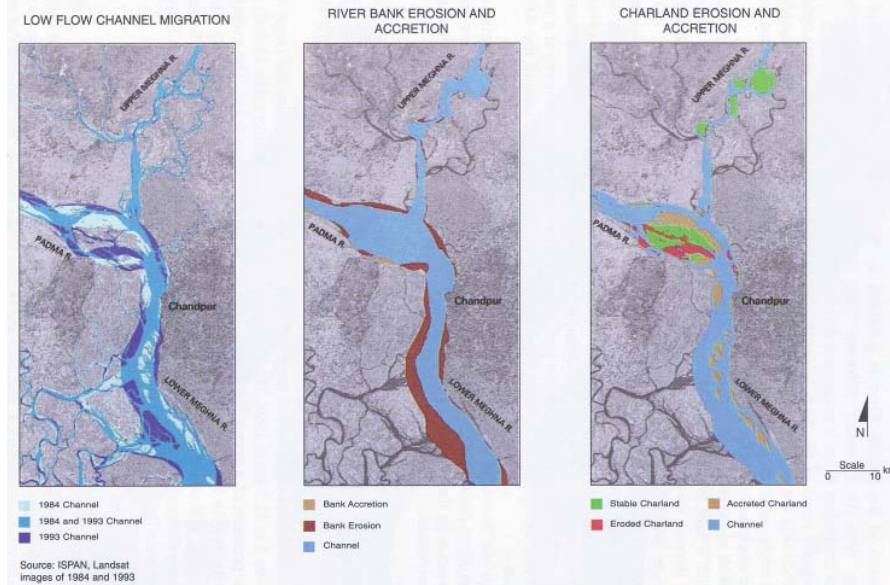


Image 19: Lower Meghna mappings

Flooding of the chars of the Lower Meghna River depends on the water levels of the Bay of Bengal. These figures vary from year to year. In 1987, flood waters inundated 52% of char lands and then 61% in 1988. An average of 50% of all chars are estimated to have been flooded between 1989 and 1992.<sup>121</sup>

### Concluding Comparisons

Of the mentioned rivers, the one with the most land area including bank area is the Jamuna River, with the Ganges, Padma, Upper Meghna, and Lower Meghna following in respective order. All of these river areas offer opportunities for agriculture, except for the northern part of the Jamuna River as the soil in this area consists mainly of coarse grained sand, and some issues may arise during the dry season of the Lower Meghna, as this area becomes saturated with high salinity levels, but ultimately without any adverse long term effects. All areas also possess a fresh supply of potable water.<sup>122</sup>

119. Ibid., p.35  
 120. Ibid., p.37  
 121. Ibid., p.39  
 122. Ibid., p.40

Increases in vegetated land occurred in all areas except for the Upper Meghna River locations. During the period from 1984 through 1993, vegetated lands increased to 36,000 hectares, collectively. The Jamuna grew by 10%, the Ganges and Lower Meghna both grew by 60%, and the Padma River expanded by more than 100%.<sup>123</sup>

A few stable chars exist in the Jamuna, Ganges, and Padma rivers, while the Upper Meghna River chars are highly stable. The Ganges and Padma rivers are wandering rivers, which show a higher level of stability than the Jamuna. Therefore, the best place for settlement from among these choice would be the Upper Meghna River chars, with the Ganges and Padma rivers coming in second.<sup>124</sup>

There are also a number of factors to consider when dealing with the future of these chars. Geological considerations include the fact that the Delta of Bangladesh is geologically active and earthquakes and tectonic plates continue to play a role in the formation of the rivers. Human development also plays a critical role in the future conditions of these char lands. A critical place to consider is the Ganges Basin where construction and development can lead to an increase in sediment supplied to the river waters. With the deforestation and land use of this area, large amounts of sediment added to the river could result in increasing water levels. This in turn may lead to flooding and could affect char dynamics. Climate change is also a concern for the future of these char lands. Sea level rise may cause more extreme flood conditions both in terms of the maximum and minimum flow of water. Bank protection efforts may also help to increase the stability of these char areas. Plans are currently being made to implement a number of structures along the right bank of the Jamuna River.<sup>125</sup>

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123. Ibid., p.40

124. Ibid., p.40

125. Ibid., p.41

## 2 CHARS

### Soils

**Table 3.5: Classified area of water, sand lands and chars and extent of flooding within river banks**

Item		Jamuna	Ganges	Padma	Upper Meghna	Lower Meghna
Total water area (ha)	1984	55,740	28,619	43,397 <sup>c</sup>	7,951 <sup>c</sup>	45,608 <sup>c</sup>
	1993	61,236 <sup>a</sup>	28,983	57,716 <sup>c</sup>	8,440 <sup>c</sup>	57,684 <sup>c</sup>
Total sand area (ha)	1984	54,009	36,226	–	–	–
	1993	70,237 <sup>a</sup>	35,663	–	–	–
Total vegetated land area: chars (ha)	1984	89,580	24,354	6,249	5,046	11,069
	1993	98,761 <sup>a</sup>	35,558	15,269	4,627	18,075
Total area within banks (ha)	1984	199,329	89,199	49,646	12,997	56,677
	1993	230,234	100,204	72,985	13,067	75,757
Ratio of attached char area to island char area	1993	1.00	1.56	1.22	All chars are island char	
Av. flooded area in 1989-92 (%)	Attached	50 <sup>b</sup>	65	47	–	–
	Island	50 <sup>b</sup>	83	72	68	49

Notes: <sup>a</sup>1992 data; <sup>b</sup>Flood extent in 1991; <sup>c</sup>Area of water and sand.

Source: ISPAN, 1995.

Image 20: Char Land flooding comparisons

**Table 4.1: Area of charland (sq. km)**

River/ River reach	Total char		Island char		Attached char	
	1984	1993	1984	1993	1984	1993
Jamuna	895.80	987.60	447.90	493.80	447.90	493.80
Ganges	243.54	355.58	95.13	138.90	148.41	216.68
Padma	62.49	152.69	28.15	68.78	34.34	83.91
Upper Meghna	50.46	46.27	50.46	46.27	–	–
Lower Meghna	110.69	180.75	110.69	180.75	–	–
Total	1,362.98	1,722.89	732.33	928.50	630.65	794.39

Image 21: Char land area comparisons

**Table 4.4: Average number of years taken for char development**

(median values within brackets)

Physical characteristic	Upper	Middle <sup>a</sup>	Lower	Total
Interval between formation and natural vegetation				
Jamuna	1.1 (1)	1.2 (1)	1.25 (1)	1.15 (1)
Ganges	3.48 (2)	1.27 (1)	1.53 (1)	1.89 (1)
Padma	1.67 (1)	1.34 (1)	2.12 (1)	1.66 (1)
Meghna	2.5 (2)	1.44 (1)	1.21 (1)	1.39 (1)
Interval between natural vegetation and cultivation (no settlement)				
Jamuna	2.97 (2)	2.59 (3)	1.92 (2)	2.29 (2)
Ganges	2.3 (1.5)	1.6 (1)	1.63 (1)	1.78 (1)
Padma	2.1 (1)	1.43 (1)	2.45 (2)	1.95 (1)
Meghna	3.46 (2)	1.9 (1)	2.58 (2)	2.3 (2)
Interval between natural vegetation and settlement (no cultivation)				
Jamuna	2.39 (1)	1.77 (1)	1.28 (1)	1.67 (1)
Ganges	3.93 (3.5)	1.86 (2)	3.48 (3)	3.02 (2)
Padma	3.93 (2)	2.59 (2)	2.81 (3)	3.22 (2)
Meghna	3.89 (4)	2.96 (2)	6 (6)	4.71 (4)
Interval between natural vegetation and settlement-cum-cultivation				
Jamuna	1.25 (1)	1.1 (1)	1.10 (1)	1.11 (1)
Ganges	1 (1)	1 (1)	1 (1)	1 (1)
Padma	1.63 (1)	1.08 (1)	1.2 (1)	1.33 (1)
Meghna	2 (2)	2.2 (1)	1 (1)	2.14 (1)
Interval between cultivation and settlement				
Jamuna	2.23 (1)	1.3 (1)	1.5 (1)	1.62 (1)
Ganges	2.88 (2.5)	1.2 (1)	2.5 (1)	2.25 (1)
Padma	3.49 (2)	1.65 (1.5)	1.87 (1)	2.52 (2)
Meghna	1.6 (2)	2.26 (2)	3.75 (4)	3.52 (2)
Interval between settlement and cultivation				
Jamuna	2.86 (1)	1.64 (1)	4.8 (1)	2.79 (1)
Ganges	9 (9)	1.35 (1)	11 (11)	2.6 (1)
Padma	0 (0)	2 (2)	11.67 (1)	9.25 (1.5)
Meghna	2.5 (3)	2.88 (2)	6 (6)	3.09 (2)

Note: <sup>a</sup>the middle reach for the Meghna River refers to the confluence between the Meghna and the Padma rivers.

Source: ISPAN, 1995.

Image 22: Char land development

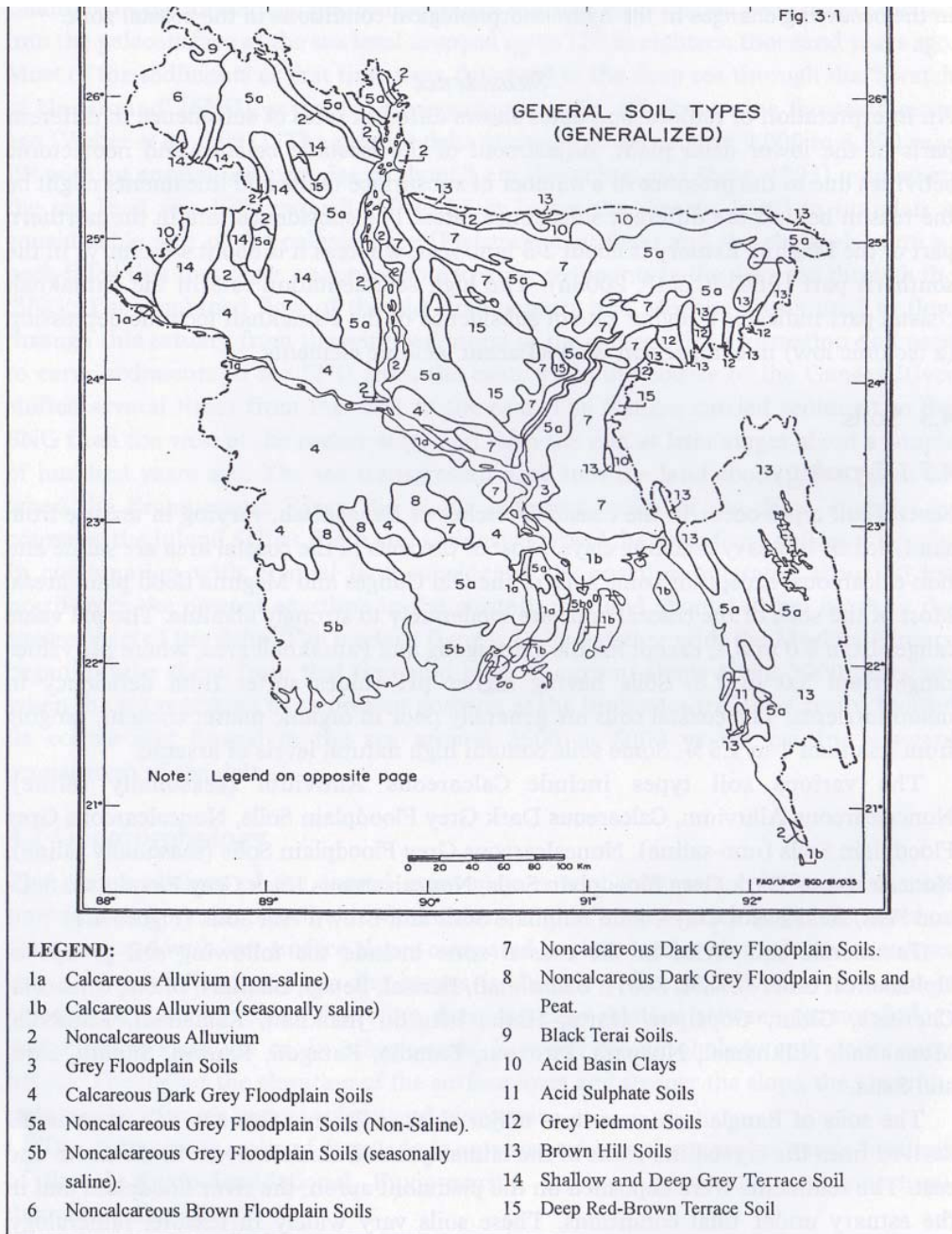
There are several different soil types in coastal Bangladesh including “Calcareous Alluvium (seasonally saline), Noncalcareous Alluvium, Calcareous Dark Grey Floodplain Soils, Noncalcareous Grey Floodplain Soils (non-saline), Noncalcareous Grey Floodplain Soils (seasonally saline), Noncalcareous Dark Grey Floodplain Soils, Noncalcareous Dark Grey Floodplain Soils and Peat, Acid Basin Clays, Acid Sulphate Soils and Brown Hill Soils.”<sup>126</sup> Most of the coastal soils range in texture from a “sandy loam to a heavy cracking clay.”<sup>127</sup> “The pH values range from 6.0 to 8.4, except for the Chittagong and Patuakhali area, where pH values range from 5.0 to 7.8. Soils containing higher pH values suffer from deficiency in micronutrients.” Soils of the coastal region are usually poor in organic matter containing only 1 to 1.5% of organic matter, and some soils also have high levels of arsenic. Soils of Bangladesh taken “from the crystalline rocks of the Himalayas and small rivers in the north and east,” are packed with minerals. “These soils vary widely in texture, mineralogy, drainage, and age.”<sup>128</sup>

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126. Islam 2004, 25

127. Ibid., p.25

128. Ibid., p.25



Source: FAO, 1988

Figure 4.1: General Soil Map of Bangladesh

Image 23: Soil Map of Bangladesh

### Flooding

There are several different factors responsible for the flooding of Bangladesh that can be categorized into both natural and human causes. Some natural attributes include the fact that 79.1% of the country consists of floodplains, rising less than 1 meter above sea level, making Bangladesh an ideal candidate for sea level rise. <sup>129</sup>

### Monsoons

Meteorologists see monsoons as a matter of wind versus rainfall, a seasonal wind that shifts direction twice a year. <sup>130</sup> Bangladesh is affected by four main seasons, "Pre-Monsoon Season (March-May), Monsoon Season (June-September), Post-Monsoon Season (October-November) and Dry Season (December-February)." <sup>131</sup> Cyclonic storms occur during the pre-monsoon season followed by heavy rainfall during the monsoon months and then by additional cyclonic storms on the coast during the post-monsoon season. <sup>132</sup> Monsoons are sometimes mistaken for typhoons; the difference is that a monsoon "is not a single aberrant storm, but the first wave of a sustained season." <sup>133</sup> Asia relies on the monsoons for their supply of water. Although monsoons can cause heavy damage, they are nonetheless welcomed as they also sustain life. Monsoons are also highly unpredictable. They never arrive right on time and no one can predict their force or the paths they will take. <sup>134</sup> In India the summer monsoon develops in two branches. Powerful vortices develop over the Arabian Sea in the western branch. An air mass steeped in humidity flows over Sri Lanka and India's Malabar Coast, battering the western ghats with prolonged, nourishing rain, which spills into the central plateau. It buffets the coast in waves, moving north, traditionally reaching Bombay by June 10. <sup>135</sup>

The other branch occurs over in the Bay of Bengal where thundershowers known as the *kal baisakhi* hit Bangladesh, West Bengal, and Assam. Tropical depressions push north from the

129. BBHS CASE STUDY - Bangladesh - The causes and impacts of the 1998 Flood. Accessed March 1, 2010.

<http://www.sln.org.uk/geography/schools/blythebridge/GCSEBangladesh.htm>

130. "Monsoons: Life Breath of Half the World." National Geographic 166, no. 6 (December 1984): 722.

131. The Encyclopedia of Earth. "Water Profile of Bangladesh." Accessed February 13, 2010.

[http://www.eoearth.org/article/Water\\_profile\\_of\\_Bangladesh](http://www.eoearth.org/article/Water_profile_of_Bangladesh)

132. Encyclopedia of Earth

133. National Geographic vol. 166, no. 6, 722

134. Ibid.

135. National Geographic vol. 166, no. 6, 727

bay, are deflected west by the southern flanks of the Himalayas, and storm across the scorching Gangetic Plain. Cherrapunji, a perennially soggy village on the south slopes of the Khasi Hills, is overwhelmed with one of the highest average yearly rainfalls on earth, 1,142 centimeters. The two branches usually merge over central India by the second week of July. By the end of September the monsoon has played out against the Himalayas.”<sup>136</sup>

Bangladesh is in a constant state of flooding for most of the year. Contributing to the floods are three main rivers that flow through Bangladesh: the Ganges, Brahmaputra, and Meghna, emptying into the Bay of Bengal via Bangladesh. On average, Bangladesh receives 2,320 millimeters of rain annually. During the dry season, drought can occur, and the people rely heavily on the flooding from March for about 80% of their water supply. This water is used for crops as Bangladesh depends on agriculture to fuel their economy.

Global warming especially affects places like Bangladesh where floods are more frequent and wilder than in the past. It is estimated that with a 1 meter sea level rise, 15 million people will be displaced in Bangladesh as the sea takes with it 30,000 square kilometers of land.<sup>137</sup> The invasion of sea water on freshwater sources has now turned the water brackish, affecting agriculture, livestock, and drinking water.<sup>138</sup> Snow melting from the Himalayas in the late spring and summer months also contributes to the flooding. The melting of the icebergs of Antarctica and Greenland will greatly affect Bangladesh too. According to Sir David King, U.K. Science Advisor to Tony Blair, if “Greenland melted or broke up and slipped into the sea—or if half of Greenland and half of Antarctica melted or broke up and slipped into the sea, sea levels worldwide would increase by between 18 and 20 feet.”<sup>139</sup> An estimated 60 million people from Bangladesh and Calcutta would be displaced.<sup>140</sup>

Some human contributors include the deforestation of Nepal and the Himalayas. This increases run off deposit in the river as well as flooding downstream.<sup>141</sup> Urbanization in the flood plain zones is also a contributing factor. The high concentration of people in these areas has “increased the magnitude and frequency of floods.” Meanwhile, dams constructed in India

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136. National Geographic vol. 166, no. 6, 728

137. Popham, Peter. “Bangladesh: Life on the Edge” The Independent. Accessed March 8, 2010.  
<http://www.independent.co.uk/environment/climate-change/bangladesh-life-on-the-edge-402127.html>

138. Popham, Accessed March 8, 2010

139. Gore, Albert. *An Inconvenient Truth: the Planetary Emergency of Global Warming and What We Can Do about It*. New York: Rodale Press, 2006. 196.

140. Gore 2006, 206

141. BBHS, Accessed March 1, 2010



have increased the issue of sedimentation in Bangladesh and poorly maintained embankments tend to “leak and collapse in times of high discharge.”<sup>142</sup>

One such case was the flood of 1991. On April 29, 1991, Bangladesh was hit with a massive cyclone. Winds blew in at 270 kilometers per hour causing waters 6 meters high to flood most of the country. One hundred and forty thousand people died, largely due to the fact that Bangladesh had not implemented an early warning system.<sup>143</sup> As a reaction to the 1991 flooding, efforts have been made of the reduce damage rendered by such floods. Embankments along the coastline have been strengthened and increased. Mangrove forests were planted in shallow waters near the coast and serve to absorb a majority of flood forces and stabilize silt banks. An additional 17 new cyclone shelters have also been added thanks to overseas aid.

Another deadly flood occurred in 1998. “Over 57% of the land area was flooded while 1,300 people were killed. 7 million homes were destroyed leaving 25 million people homeless.” Diseases such as bronchitis and cholera erupted as a result of contaminated water. Agricultural fields were destroyed as 2 million tons of rice were ruined and half a million cattle and poultry were lost. The total damage was estimated at 1 billion U.S. dollars.<sup>144</sup>

Bangladesh both honors and fears water. Floods have always wreaked havoc on human life and infrastructure there, and several different measures have been taken to prepare for such catastrophes.

### *Flooding in Holland*

Holland is another country that immediately feels the consequences of sea level rise. One-third of Holland is already underwater. This country relies heavily on dykes and dams to hold back the water, but current conditions are already too much for them to contain.<sup>145</sup> Without these dykes protecting the shoreline, this threatened area would be exposed to the severe consequences of storm surges, possibly affecting 10 million people. Thanks to the

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142. Ibid.

143. Molnar, Mike. “The 1991 Bangladesh Cyclone And Its Impacts on Flooding.” University of Wisconsin-Eau Claire. Accessed September 11, 2011. <http://www.uwec.edu/jolhm/eh2/molnar/home.htm>.

144. BBHS Accessed March 1, 2010

145. Westerbeek Van Eerten, Thijs. “Climate Change in the Netherlands: Flood Protection.” Climate Change in the NetherlandsL Flood Protection. Accessed April 8, 2010. <http://www.euranet.eu/eng/Dossier/UN-Climate-Conference/Warming-up/Climate-change-in-the-Netherlands-Flood-protection>.

dykes set in place, this risk is reduced to 1%, or 24,000 people affected. With sea level on the rise, however, increasing from 20 to 110 centimeters by 2100, stronger dykes will need to be implemented.<sup>146</sup> Contrary to Bangladesh, Holland used technological advances to prevent water from entering its landscape while Bangladesh tries to adapt to increases in water.

Despite all of Holland's economic and technological advances over Bangladesh, it is Bangladesh who ultimately serves as a leader in dealing with rising water levels. This society has long understood the power of the natural world and learned to adapt to rising water levels by allowing it to flow into its structures and integrating the element into its cultural practices. This will ultimately be the solution for sea level rise. Regardless of the approach, rising water levels cannot be dismissed. Studying both countries' failed and successful strategies for dealing with this issue will provide the rest of the world with a precedent for our own preparation.



Image 24: Netherlands: 1m sea level rise flood map.

146. Germanwatch 2004, Accessed April 8, 2010

## 2 CHARS



Image 25: Netherlands: 7m sea level rise flood map.

# 3 CHAR PEOPLE

The *Choura or Char* people are a subculture of Bangladesh who reside on char lands. They are seen as the poorest and most desperate people because they have chosen to reside in such unstable areas. An estimated 6.5 million people reside on these islands, contributing to 5% of the total population of Bangladesh. Five of the 6.5 million live on chars created along rivers, and 1.5 million people live on coastal chars. <sup>147</sup>

## Char Demographics

An ISPAN study on the demographics of the char lands revealed that population density appeared to be more concentrated on attached chars than on island chars, across all rivers. The Upper Meghna holds the highest density numbers while the lowest density numbers can be found on the Ganges chars. <sup>148</sup> According to the tables below, there was an overall increase of people migrating to char lands, as much as 26%, from 1984 to 1993. This also coincides with Bangladesh’s growing population rate during this time period. <sup>149</sup>

**Table 4.2: Charland population density (per sq. km)**

River/ River reach	Total char		Island char		Attached char	
	1981	1993	1981	1993	1981	1993
Jamuna	344 <sup>2</sup>	402 <sup>3</sup>	233 <sup>4</sup>	353 <sup>3</sup>	455 <sup>1</sup>	451 <sup>1</sup>
Ganges	198 <sup>6</sup>	194 <sup>6</sup>	95 <sup>6</sup>	89 <sup>6</sup>	264 <sup>4</sup>	261 <sup>4</sup>
Padma	228 <sup>5</sup>	201 <sup>5</sup>	126 <sup>5</sup>	104 <sup>5</sup>	312 <sup>3</sup>	281 <sup>3</sup>
Upper Meghna	532 <sup>1</sup>	731 <sup>1</sup>	532 <sup>1</sup>	731 <sup>1</sup>	–	–
Lower Meghna	281 <sup>4</sup>	556 <sup>2</sup>	281 <sup>2</sup>	556 <sup>2</sup>	–	–
Total char	314 <sup>3</sup>	366 <sup>4</sup>	239 <sup>3</sup>	353 <sup>2</sup>	402 <sup>2</sup>	381 <sup>2</sup>

Image 26: Char land population comparison Chart

147. Kabir, Rowena. “THE STATE OF CHAR EDUCATION IN BANGLADESH : FOCUS ON SELECTED CHARS OF GAIBANDHA DISTRICT” Asian Affairs, Vol. 28, No. 3, 5-24, July - September 2006. CDRB publication. Accessed April 1, 2010. <http://www.cdrb.org/journal/2006/3/1.pdf>

148. EGIS 2000, 44

149. Ibid., p.44

**Table 4.3: Estimated charland population**

River/ River reach	Total char		Island char		Attached char	
	1984	1993	1984	1993	1984	1993
Jamuna	308,155	397,015	104,361	174,311	203,794	222,704
Ganges	48,217	68,916	9,038	12,362	39,179	56,554
Padma	14,262	30,732	3,547	7,153	10,715	23,579
Upper Meghna	26,845	33,823	26,845	33,823	–	–
Lower Meghna	31,104	100,497	31,104	100,497	–	–
Total	428,583	630,983	174,895	328,146	253,688	302,837

Image 27: Char land populations

ISPAN conduct a survey to obtain the average household size of a typical char family. The average char household is 6.38, while the national average of Bangladesh is 5.44. These char households tend to be run by the women as the men are usually separated from the family unit for labor jobs on the mainland.<sup>150</sup>

The Choura people take a risk by settling along the char lands of Bangladesh, never knowing when the floods will come, wiping out all prosperity. The char people are 13 times more likely to be affected by natural disasters than those in any other parts of Bangladesh.<sup>151</sup> They choose to live on char lands for two main reasons: the soil is rich and the government has no hold on these “virgin lands,” leaving it free for the taking.<sup>152</sup>

The rich soil of char land is composed of silt deposits from flooding rivers. When first formed, char land is comprised mostly of sand. *Figure 39*. Farmers make wise use of the large quantity of sand, selling it to the construction industry of Dhaka or mixing it with fertilizing silt from the Himalayas to grow catkin grass.<sup>153</sup> The growth and decomposition of catkin grass accelerates the conversion of new soils into rich agricultural ones suitable for growing banana palms, bamboo, jackfruit, guavas, and mangos.<sup>154</sup> *Figure 40*. The grass can also be used for roofs, fences, cow fodder, small shelters, and fuel. The grass is also piled in large heaps to protect cattle from flooding.

150. Ibid., p.45 - 16

151. “Life in the Chars of Bangladesh.” Helen Keller World Wide. 2003. Accessed April 1, 2010.

[http://pdf.usaid.gov/pdf\\_docs/PNACT449.pdf](http://pdf.usaid.gov/pdf_docs/PNACT449.pdf)

152. Popham, accessed March 8, 2010

153. Ibid.

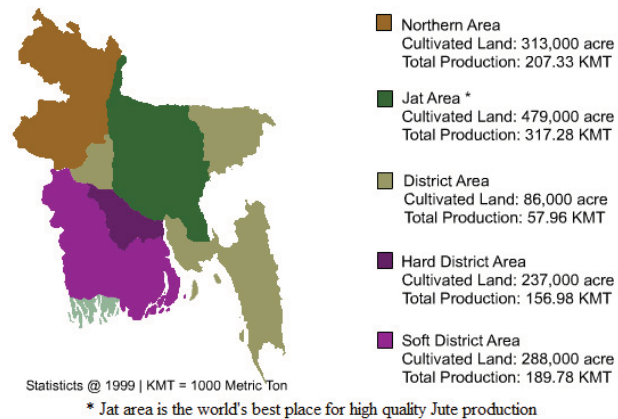
154. Ibid.

## Agriculture

Agriculture is an important practice in char communities as it provides income. Char land develops into highly fertile soil because of the bed material brought down by the rivers and deposited over time. Agricultural products vary by char location.

Agriculture along the Ganges Delta produces products such as jute, tea, and rice. Jute is the number one exported agricultural product produced by Bangladesh. India is currently the largest producer of raw jute, but Bangladesh is known to have higher quality fibers and currently “85% of the world’s production of jute is cultivated from Bangladesh.”<sup>155</sup> Since Bangladesh occupies most of the Ganges Delta, it is the largest cultivator of jute although India is the largest manufacturer thanks to its technological advances over Bangladesh.<sup>156</sup>

Jute grows in warm and wet climates, thus occurring during the monsoon or fall season. The Ganges Delta contains rich loams and riverine silts that provide the minerals and nutrients needed to grow jute. The Brahmaputra Alluvium contains soil of an acidic nature with a texture varying from “sandy loam to a clayey loam.” This region is inundated and replenished each year as floodwaters carry new silt deposits. The best jute known as *jat* is grown in this area and most of the cultivated jute of Bangladesh is also harvested from this region. The Ganges Alluvium is known to produce district jute, a medium grade quality of jute, right under *jat*. The soil of this area ranges from clay loam to a light loam. The last region, the Tessta Silt, produces northern jute which is the lowest grade of commercial jute cultivated in Bangladesh. The soil of this region is an acidic one made up of mostly sand and has a lower moisture capacity than other



Map of Jute Cultivation Area in Bangladesh (Major portion of Ganges Delta)

Image 28: Jute production Map

155. Ganges Delta: World's Best Land for Cultivating Quality Jute and Allied Fibers. accessed Sept. 14, 2010. [http://www.tradezone.com/tradesites/ganges\\_delta.html](http://www.tradezone.com/tradesites/ganges_delta.html)

156. Ganges Delta: World's Best Land for Cultivating Quality Jute and Allied Fibers.

### 3 CHAR PEOPLE

soils. <sup>157</sup>

With the rich soil of these areas comes a heavy burden. As quickly as the prosperity appears, it also disappears. Since there is no way of knowing when the floods will come, the char people live in a community devoid of any infrastructure; no schools, churches, or roads exist. It is possible for one to lose everything and have to start all over within a matter of months to several years. <sup>158</sup>

The char people have developed different strategies for dealing with these flood prone lands. <sup>159</sup> The floods of Bangladesh can be broken down into two terms, each referring to a different state of flooding. The term *barsha* refers to the annual flood of minimal consequences while the term *bonna* refers to high and damaging flood waters. Barsha floods are welcomed while bonna floods mean destruction and chaos. There are different defense tactics for both barsha and bonna floods. Three main categories of defense are structural, agricultural, and human. <sup>160</sup>

Structural defenses are adjusted according to either barsha or bonna conditions. One main concern is the protection of the *bhiti* or plinth of the home. For barsha defenses, the *bhiti* is plastered with a paste composed of mud, jute fibre, and *toosh*. <sup>161</sup> Bonna defenses require the *bhiti* to be supported with bamboo stakes placed at intervals along the plinth and between the *bhiti* and bamboo. This ensures running water from hitting the plinth directly and minimizes erosion. Side walls are usually structurally

**TABLE 8.1**  
*Structural Measures*

Categories	During <i>Barsha</i>	During <i>Bonna</i>
<i>Bhiti</i> (plinth)	Coating the plinth with paste made of jute and <i>toosh</i>	Putting fence around the plinth
<i>Dewal</i> (wall)	Checking the joints	Removed to let flood water pass
<i>Pair</i> *	Checking the joints	Tying iron wire
Main Structure	Putting <i>thekas</i> in four corners of the structure	<i>thekas</i> are coiled with wires

Note : \*bamboo or wooden poles placed horizontally underneath the ceiling.  
Source : Field Survey, 1993-94.

Image 29: Structural measures taken for flooding Chart

157. Ibid.

158. Popham, accessed March 8, 2010

159. Bāki, Moh. Ābadula. 1998. *Peopling in the land of Allah Jaane: power, peopling, and environment : the case of Char-Lands of Bangladesh*. Dhaka: University Press Ltd. Pg. 1

160. Baki 1998, 163

161. Ibid., p.163

weak and are removed to “reduce the threat of a collapse of the main structure.”<sup>162</sup> Structural poles are strengthened by “tying ropes around [them] and linking the main joints.”<sup>163</sup> *Thekas*, “bamboo poles set diagonally to support the dwelling units,”<sup>164</sup> are also used to ensure the structural stability of the home. Bonna conditions also require ropes or wires to be tied to trees “around the four corners of the house.”<sup>165</sup> When the water rises 1.5 meter above the plinth, structures are dismantled and moved by boat to a safer area.

A lifestyle built around flooding leads to furniture also designed for flooding scenarios. Beds called *chouki* are flat wooden cots containing four to six legs. During times of bonna flooding, *choukis* are raised on *machans*, high platforms made of bamboo used when water levels are higher than the *bhiti*. If the water levels reach chest height, side walls are taken down to lower the pressure on structural poles as well as the main structure.<sup>166</sup> *Matkas* are large earthen vats which “are used to protect seeds and food grains from dampness and the rising water.” *Matkas* are used during monsoon seasons and only by the rich, as low-income families do not usually have extra food to protect. *Shikas* are “reticulated bags made of jute strings or ropes hung from the wall” that serve to protect and store lightweight foods while *choukis* protect heavy and bulkier goods.<sup>167</sup>

Measures are also taken to protect crops and domestic animals both before and after flooding. After flooding, efforts are made to “initiate agricultural activities as early as possible.”<sup>168</sup> During each year’s initial *barsha* flood waters, char people observe “the number of rainy days and [the] duration of rain on an average day,” in order to estimate when bonna will strike.<sup>169</sup> Crops are harvested only if they are mature enough at this stage.<sup>170</sup>

The Chouras have adapted well to the land, strategically planting certain crops at different elevations according to specific growth patterns. Ground nuts and sweet potatoes are grown at the highest level while aman paddies are planted at the water front as they are adaptable to deep waters. “[Amans] can grow at [a] rate of 6” per day and [reach] [heights] of

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162. Ibid., p.164

163. Ibid., p.164

164. Ibid., p.164

165. Ibid., p.165

166. Ibid., p.166

167. Ibid., p.167

168. Ibid., p.167

169. Ibid., p.167

170. Ibid., p.167



### 3 CHAR PEOPLE

12 feet [keeping] pace with rising flood waters.”<sup>171</sup> A method of “inter-culture” is used as an insurance policy guaranteeing the production of at least one crop.<sup>172</sup> Short-stemmed *aus* is a short stemmed, flood sensitive crop that is sown together in the same field with the aman. Normal flooding ensures the production of two crops, while a dry year yields *aus* with no aman and rough flood waters yield aman with no *aus*.<sup>173</sup>

Animals are also an important asset to Choura culture. Livestock and poultry are kept in separate shelters during floods or placed on machans, floating platforms. The machan is composed of “layers of straw and water hyacinth placed over

**TABLE 8.3**  
*Agricultural Adjustments*

Categories	Before Flooding	After Flooding
<b>Crops</b>	Bamboo fences around fields Pulling water hyacinth away from crop fields	Interculture of crops
<b>Animals</b>		
Chicken/Ducks	Keeping the minimum and the rest are sold out or shifted to safer places	Remaining chickens /ducks are sold out for cash needs
Cows/Goats	Sold out or shifted to safer places	Sold out for cash needs, Hiring of animals for cultivation

Source : Field Survey, 1993-94.

Image 30: Agricultural Adjustment Chart

a horizontal structure made of bamboo with banana trunks underneath.”<sup>174</sup> The platform not only safeguards the animals above water, but also provides fodder for the animals to digest.<sup>175</sup>

Post-flooding periods are critical for the Chouras to account for their losses and act accordingly. After a flood, people first arrange seedlings to be sown in the ground. Farmers look to plant their seeds on higher ground, but if they have no access to higher grounds, a temporary solution is found in floating seedbeds. These floating seedbeds are created by placing banana trunks on the water and covering them with water hyacinth plants. Once the water hyacinth plants begin to rot, earth is placed over them and followed by the planting of seeds.

The main concern with flooding is human safety. Char people protect themselves

171. Ibid., p.168

172. Ibid., p.168

173. Ibid., p.168

174. Ibid., p.169

175. Ibid., p.169

### 3 CHAR PEOPLE

from disasters with their machans. When water levels rise high enough to deter the door from opening, the false ceiling is the next step in their defense. "One side of the roof is kept open and used as an entrance."<sup>176</sup> Boats serve as a method of escape. When the water exceeds the height of the ceiling, families disassemble their homes, load up their boats, and search for higher ground. Unfortunately, not everyone is privileged enough to own a boat, and therefore, it is usually only the wealthier families who are able to escape. Lower income families manage on *bhelas*, or rafts, constructed from banana trunks.<sup>177</sup>

The environment of the char people limits their access to food, health care, schools, and work. Char people also have diets with lower nutrient levels compared to the rest of rural Bangladesh. Char children consume far fewer animal products than other children, and are thus often lacking in proteins essential to a healthy diet. Night time blindness is also a common ailment among char mothers, which reflects their poor diet, specifically a vitamin A deficiency.<sup>178</sup> Sanitation is also a large problem. Only 11% of char households contain an enclosed latrine, compared to 29% throughout rural Bangladesh. Diarrhea which can lead to dehydration is also more common in the char lands than the rest of rural Bangladesh.

**Figure 1.** Percentage of children aged 24-59 months who consumed animal foods at least twice in the previous week in the chars (n=563) and in rural Bangladesh (n=6,225) in Dec 2001-Jan 2002. Bars indicate 95% confidence intervals.

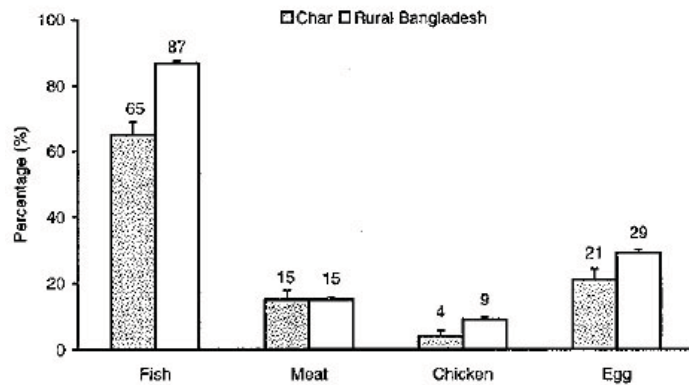


Image 31: Diet Comparison of Char people and Rural Bangladesh

176. Ibid., p.170

177. Ibid., p.170

178. Helen Keller World Wide 2003, accessed August 30, 2010

#### Conclusion: Modernity

Bangladesh and Holland are unique in terms of their respective relationships to water; one embraces it while the other opposes it. What it means to be modern in one society greatly differs from what it means in another. In Bangladesh, "People have accepted these events as natural and inevitable, and adapted their living and farming habits accordingly."<sup>179</sup> People in Holland, on the other hand, have always rejected water. While the two countries are at opposite ends of the spectrum in many ways, they have the same problem and Holland is now considering following Bangladesh's example of learning to live with the encroaching water. The best solution may be a combination of both approaches.

Overall, the people of Bangladesh have embraced water in their culture. This is evident in a variety of daily activities from farming to religious practices. They have learned early on to respect water as a force that both sustains and destroys. The char people are an example of a society capable of adapting to and living with rising water levels. They achieve a delicate balance in their efforts to coexist with their natural surroundings. Ultimately, I hope to use the ideas and values of the char people to develop a system that can be applied not only in Bangladesh, but also other places in danger of sea level rise and flooding.

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179. Hossain, Mosharaff, and A. T. Aminul Islam. 1987. *Floods in Bangladesh: recurrent disasters and people's survival*. Dhaka: Univ. Research Centre. Pg. 1

### 3 CHAR PEOPLE

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Image 32: Photo by Jonas Bendiksen for National Geographic. Image displays typical flooding in one's front yard.



Image 33: Photo by Jonas Bendiksen for National Geographic. Children climb bamboo Macha to escape rising flood levels.

### 3 CHAR PEOPLE

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Image 34: Photo by Jonas Bendiksen for National Geographic. Image displays flood waters in Char home.



Image 35: Photo by Jonas Bendiksen for National Geographic. Children board floating solar power school.

### 3 CHAR PEOPLE

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Image 36: Photo by Jonas Bendiksen for National Geographic. Image displays rebuilding of Mosque.



Image 37: Photo by Jonas Bendiksen for National Geographic. Social worker from NGO BRAC makes home visit to check up on women's health.

# PART 2: DESIGN

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CHAR ABHINAVA

## 4 INTENTIONS

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Due to the physical makeup of Char lands, a system that is adjustable and adaptable to a fluctuating site will need to be implemented. Past and current models used in such spaces prove to be inadequate solutions as flood levels leave most families trapped, clinging to rooftops, waiting for help to arrive. In studying Bangladesh and other water dwelling communities, I have learned of Bangladesh's unique ability to live with rising water levels. Most other water dwelling societies reject water as their sense of modernity also rejects the notion of water in the home. It is Bangladesh's model of living with water from which I take my inspiration.



# 5 CHAR ABHINAVA SITE ANALYSIS

## Background Info: Char Abhinava Site Information

The char selected contains no formal name and in the design process I have appropriately named "Char Abhinava." The Bangla term *Abhinava*<sup>180</sup> translates as new or innovative and is fitting to the new implemented system planned for it. It is located in the Upper Meghna River region near Chak Chariali, Panam City, roughly 11 miles away from Dhaka. This site was selected based on its relative stability in comparison to other river chars. Chars in the Upper Meghna area are the most stable, lasting around 70 years.

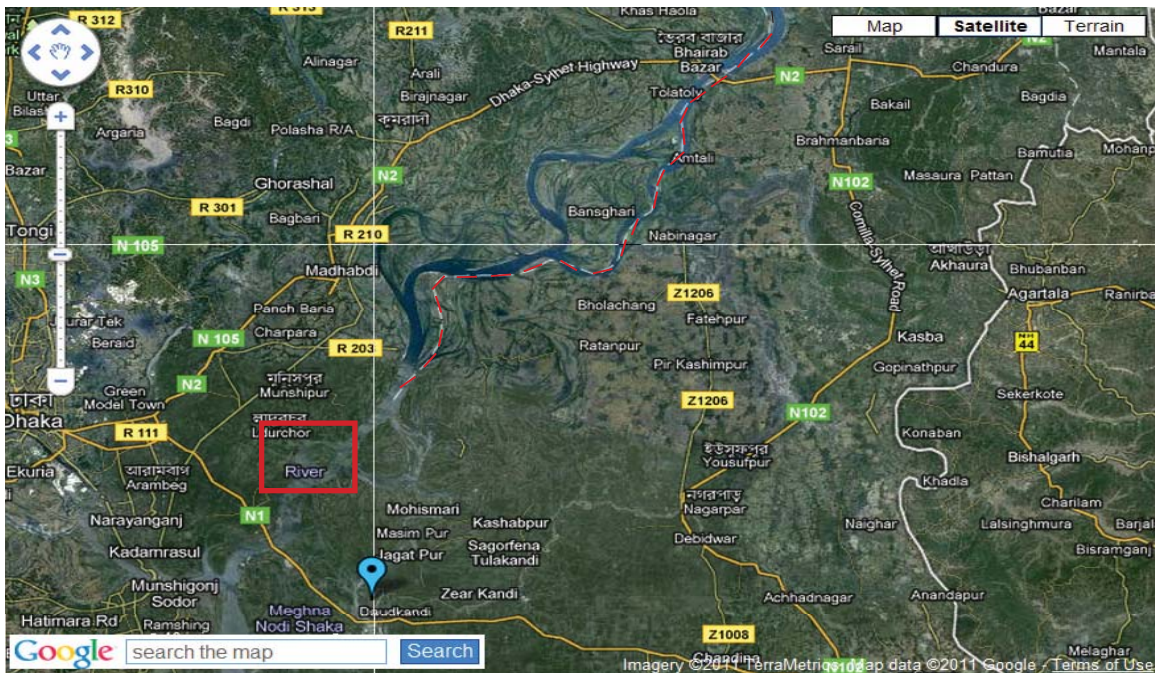


Image 38: Char Abhinava site location

180. Tamilcube.com "New" Accessed Nov. 6, 2011. <http://www.dictionar.tamilcube.com/bengali-dictionary.aspx>

### Weather conditions

Research conducted in Appendix A reveals Char Abhinava's site conditions experiences 3 seasons: Pre-Monsoon, March through May, which brings cyclones; Monsoon Season, June through October, which produces heavy rainfall; and the dry season, November through February. This area is known for extreme hailstorms and cyclone winds that blow up to 150 miles per hour. Wind averages are taken from Chak Chariali with winds mostly blowing in from the south/southeast while the western side of the island receives the least amount of wind. Typical wind speeds average about 6.2 kilometers per hour in April at the windiest and 1.7 kilometers per hour in November at the least windy time. Average monthly temperatures range from 33.7 degrees Celsius in April to 24.4 degrees Celsius in January. Rainfall is the heaviest in April, averaging roughly 360 millimeters, and just roughly 10 millimeters in December. Water flows down from the north and continues south.<sup>181</sup> Char Abhinava will contain a style of architecture typical of this region, which consists of stilt and mud homes as referenced in Appendix E.

### Flooding

Although the chars in this region tend to flood often during monsoon season, they are rarely affected by flash floods, tidal floods, or cyclonic flooding.<sup>182</sup> They do however suffer from storm surges with winds coming in from the southwest.<sup>183</sup> Highest water levels are expected during August and October with the lowest water levels occurring during April and January. Normal flood waters during monsoon season (June through October) reach between 6 and 9 feet inland. Two extreme cases of flooding occurred in 1988 and 1998 with water levels reaching 7.66 meters inland. The chars in this area will not be affected by sea level rise until it reaches 1.5 meters. On average, this region receives 1,900 millimeters of rainfall each year.<sup>184</sup>

Embankment systems are readily employed throughout Bangladesh, some using intricate techniques as well as building materials while others make use of readily available

181. Weather Online. "Dhaka" Accessed Sept. 4, 2011.

[http://www.weatheronline.co.uk/weather/maps/city?LANG=en&PLZ=\\_\\_\\_\\_&PLZN=\\_\\_\\_\\_&WMO=41923&CONT=asia&R=0&LEVEL=162&REGION=0020&LAND=BW&MOD=tab&ART=WST&FMM=01&FY=2000&LMM=12&LY=2008&NOREGION=1](http://www.weatheronline.co.uk/weather/maps/city?LANG=en&PLZ=____&PLZN=____&WMO=41923&CONT=asia&R=0&LEVEL=162&REGION=0020&LAND=BW&MOD=tab&ART=WST&FMM=01&FY=2000&LMM=12&LY=2008&NOREGION=1)

182. Hofer, Thomas, and Bruno Messerli. *Floods in Bangladesh: History, Dynamics and Rethinking the Role of the Hima layas*. Tokyo: United Nations University Press, 2006. 31.

183. <http://www.waikato.ac.nz/igci/downloads/BriefingDoc4.pdf> accessed Sept. 27, 2011 pg. 5

184. Ericksen, Neil J., Qazi Kholiquzzaman Ahmad, and A. R. Chowdhury. *Socio-economic Implications of Climate Change for Bangladesh*. Dhaka: Bangladesh Unnayan Parishad, 1997.

## 5 CHAR ABHINAVA SITE ANALYSIS

material and techniques. One technique incorporates a combined method of carved away earth and sandbags. This defends land edges from raging river flows.

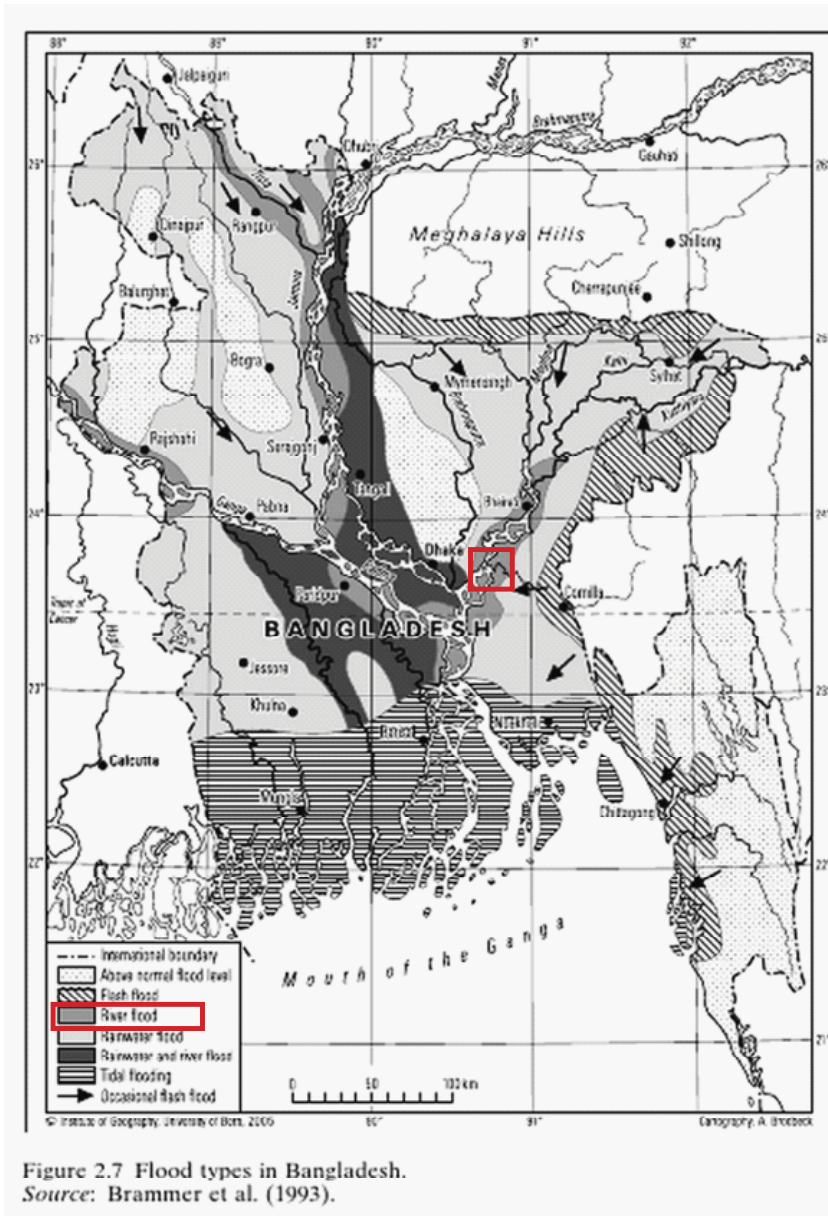


Figure 2.7 Flood types in Bangladesh.  
Source: Brammer et al. (1993).

Image 39: Flood Type by location Map

## 5 CHAR ABHINAVA SITE ANALYSIS

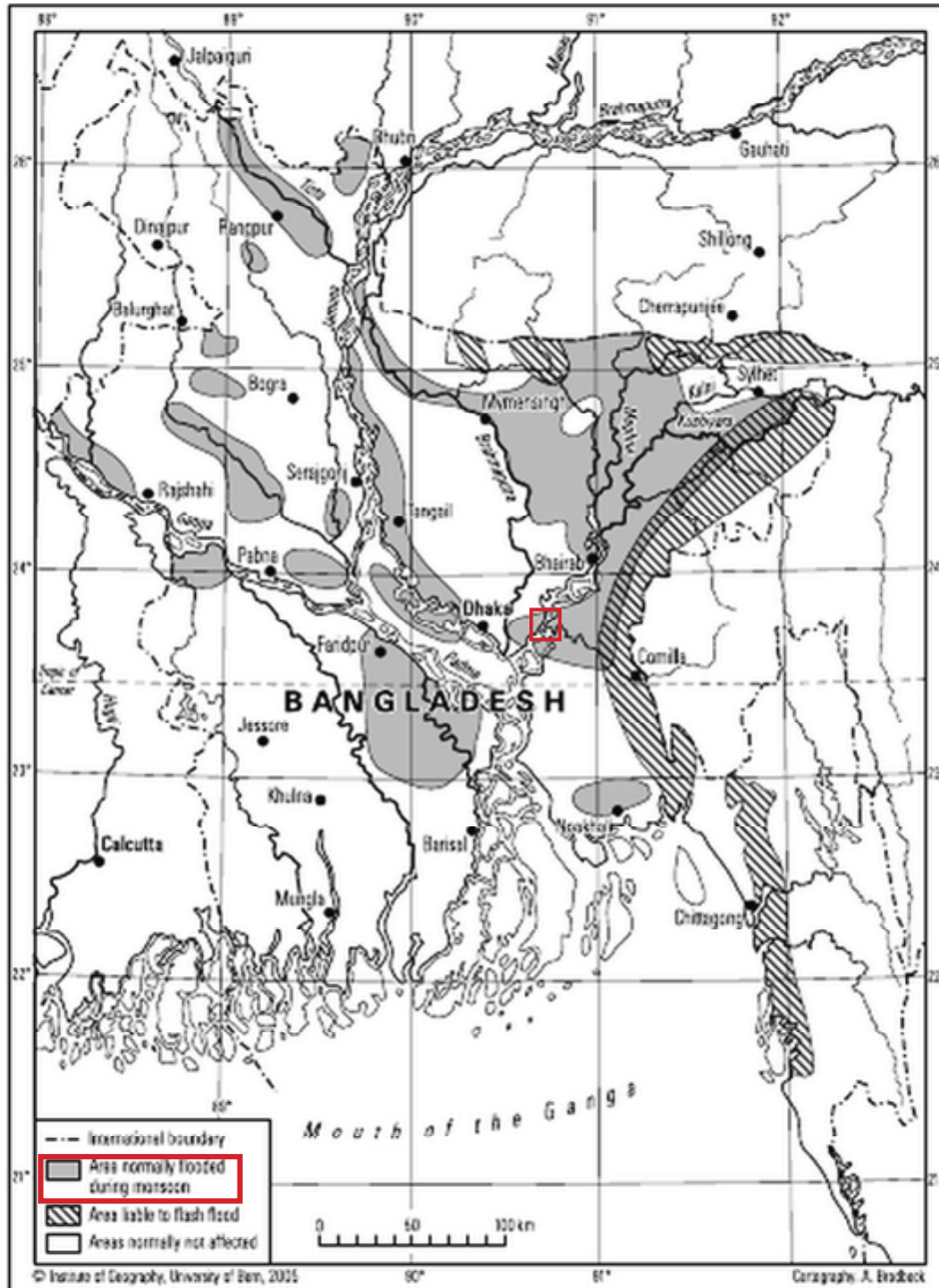


Figure 2.8 The extent of normal flooding in Bangladesh.  
Source: BWDB (1991a).

Image 40: Flood Type by location Map

## 5 CHAR ABHINAVA SITE ANALYSIS

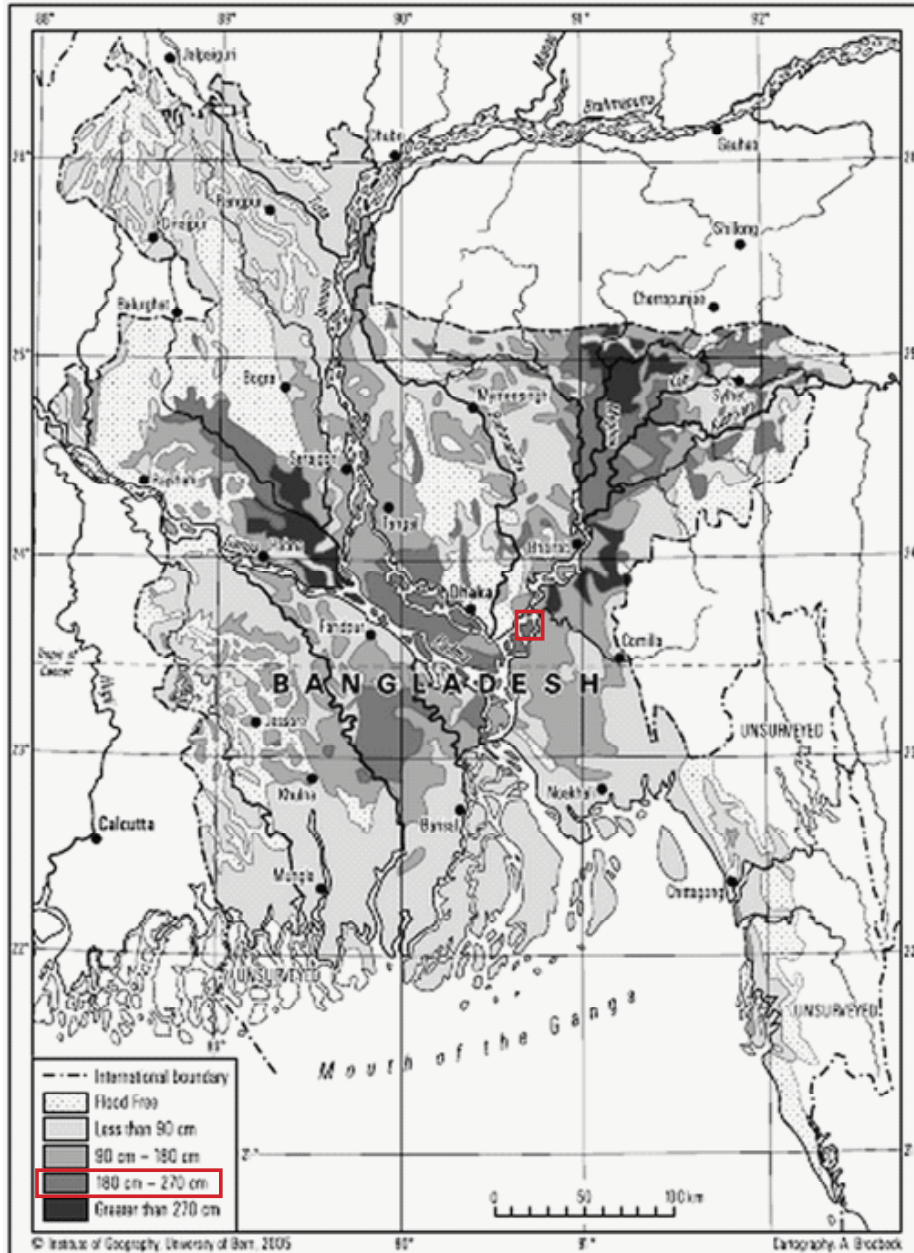


Figure 2.9 Average depth of inundation, slightly generalized.  
Sources: Brammer (1994); Pasche (1990).

Image 41: Flood levels by location map.

## 5 CHAR ABHINAVA SITE ANALYSIS

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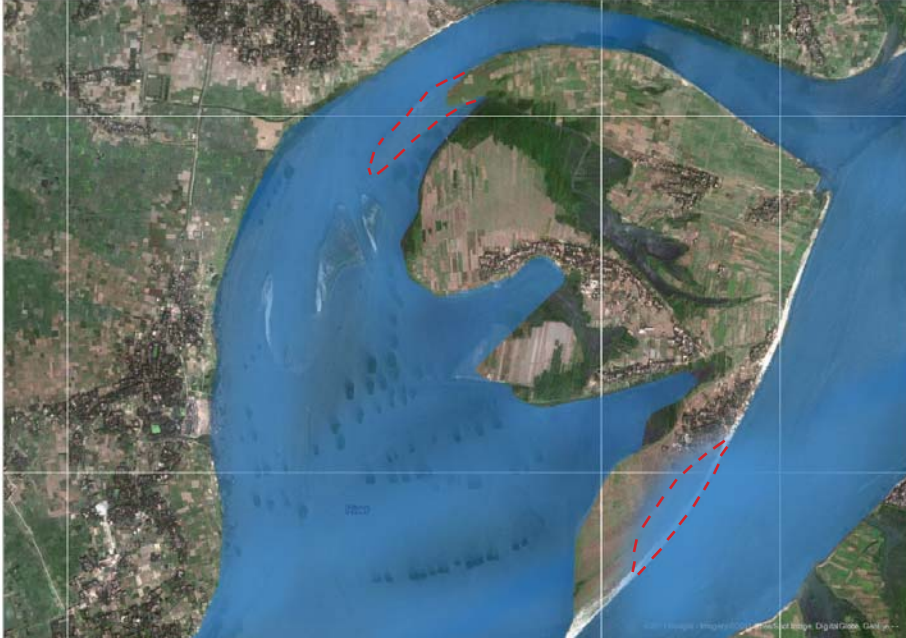


Image 42: Char Abhinava under normal flood conditions



Image 43: Char Abhinava under extreme flood conditions

## Meghna River

The Meghna River is a meandering river with hydrology that dictates both silt drop off and land erosion. River erosion and accretion occurs on the outer bends of a curved path and inner bends, respectively. This is due to the change in velocity that occurs as the flowing water moves around curves. The velocity of the moving water is greatest around the outer curve and slowest in the inner curve.<sup>185</sup> It therefore erodes away land from the outer bank and drops off silt on the inner. The Meghna River contains a 2 centimeter per kilometer slope with a bed material of 0.14 millimeters. The average depth of the upper Meghna River is 1,620 feet, and on average, it transports 13 million tons of sediment per year. The Meghna River has proven to be at satisfactory standards set by the government of Bangladesh and is used for both domestic and bathing purposes.<sup>186</sup> Salinity levels are low in this area as sea level rise hasn't encroached upon this area yet.

In order to design for this fluid landscape, I've conducted a series of mappings based on the known river hydrology and site conditions of the area that will predict future occurrences in Char Abhinava. I've discovered that Char Abhinava will continue to grow land on the

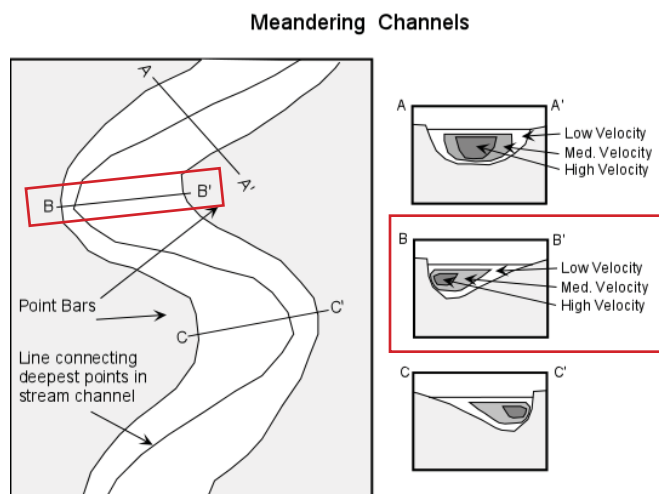


Image 44: River Velocity Diagram

southern and western sides of the island and erode on the northeastern side. With this information, I can place embankment and sediment catchments accordingly.

Water quality in the Meghna River has also proven to be at adequate sanitary levels as determined by the Bangladesh government. This will therefore serve as a safe source of drinking and utilitarian purposes for the citizens of Char Abhinava.

185. Nelson, Stephen. "River Systems and Causes of Flooding." Tulane University. Nov. 2010.

186. Ministry of Power, Electricity, and Mineral Resources for the Asian Development Bank. "Bangladesh: Power System Efficiency Improvement Project." Accessed September 24, 2011. <http://www.adb.org/Documents/Environment/BAN/37113/37113-01-ban-eia-draft.pdf>.

## 5 CHAR ABHINAVA SITE ANALYSIS

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Image 45: Char Abhinava river velocity mapping



## 5 CHAR ABHINAVA SITE ANALYSIS

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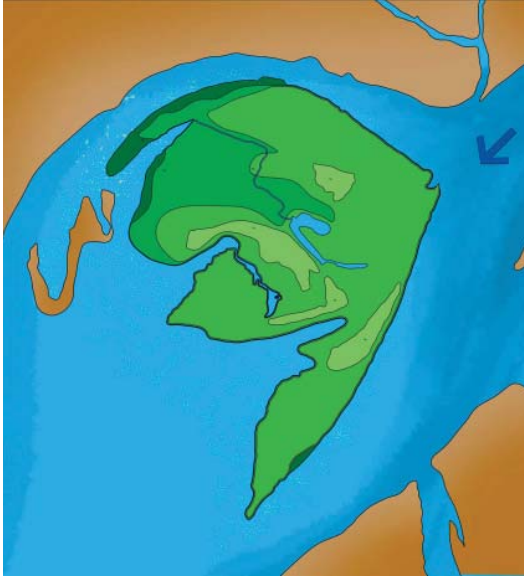


Image 46: Char Abhinava existing conditions



Image 47: Char Abhinava in 5 years

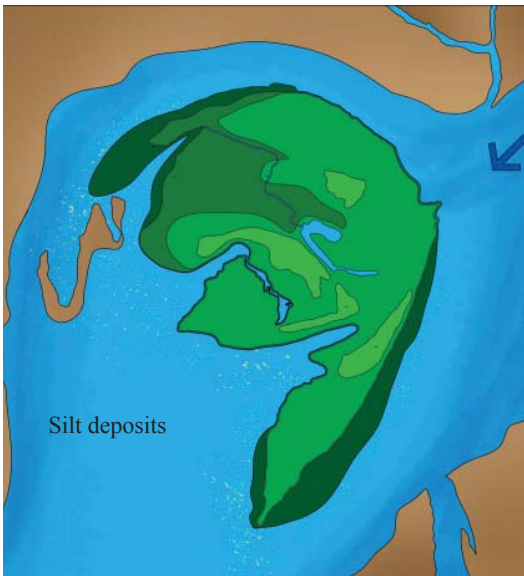


Image 48: Char Abhinava in 10 years

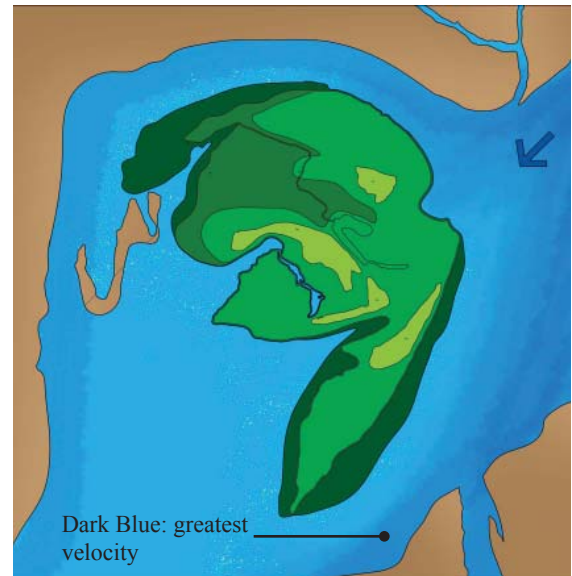


Image 49: Char Abhinava in 15 years

## 5 CHAR ABHINAVA SITE ANALYSIS

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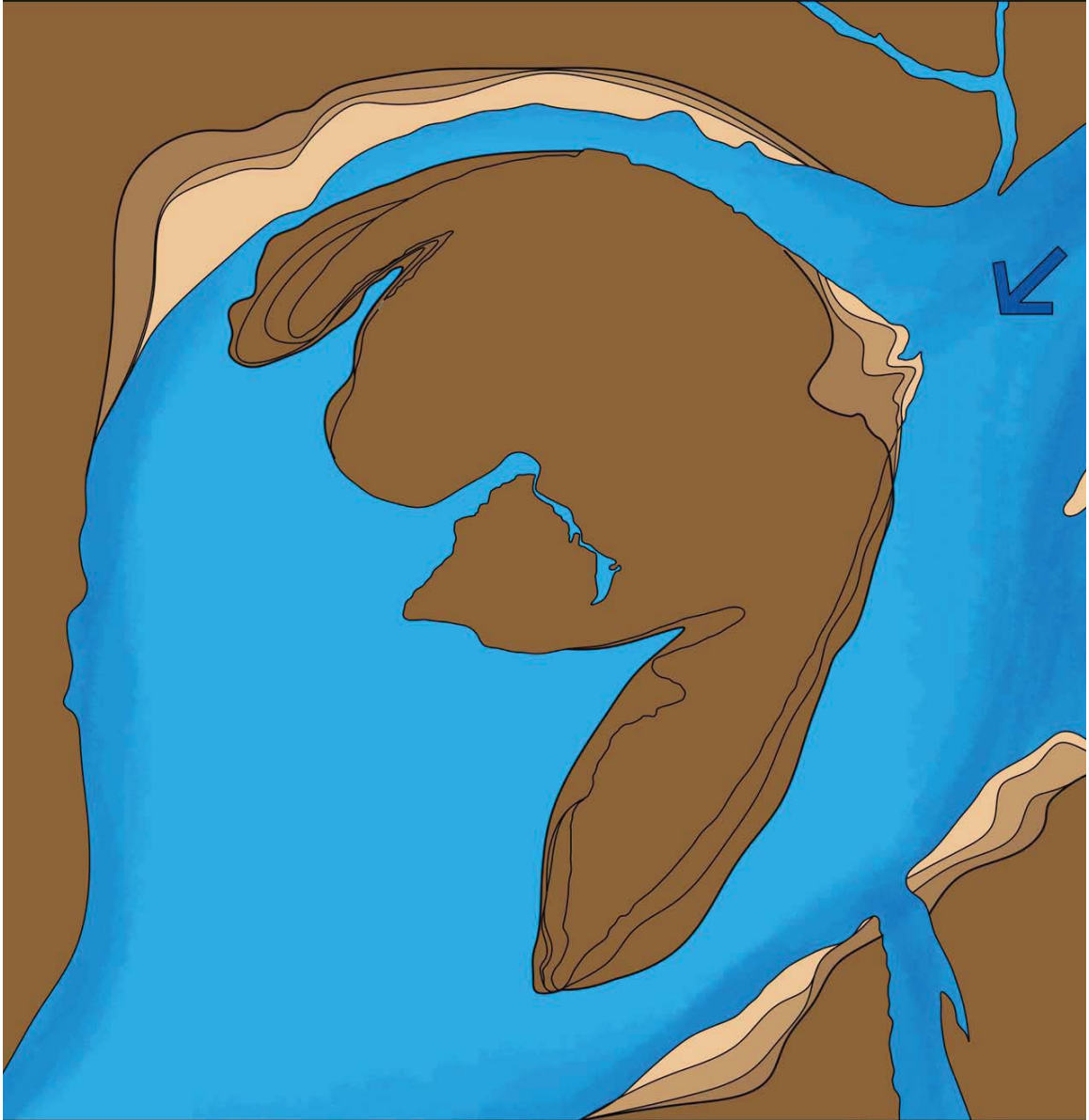


Image 50: Composite Image of Char Abhinava over 15 years.

## Fishing

Fishing is an important contributor to the char lands' economy. A surplus of different fish species exists in this river and serves as a source of food and income for the char people. Fishing usually occurs at night with sales transactions taking place directly on the river between fishermen and wholesalers who then sell the fish in major marketplaces around Bangladesh. Species include Jat puti, Boal, Chital, Shol, Ghawra, Bata, Raik, and Tit puti. Some of the poorer fishermen who can't afford their own fishing equipment will rent equipment with a rental fee of half of their catch. This usually occurs when large fishing nets costing 50,000 TK or more are employed. Other less fortunate fishermen also fish as employees on a fixed wage.<sup>187</sup>

## Farming

Along with aquaculture, the people of this region rely on agriculture for their income and survival. Agricultural work is conducted during the day while aquaculture occurs at night. Agriculture in this region includes catkin grass, betel nuts, aus, bananas, palms, bamboo, jackfruit, guavas, mangos, aman, sweet potatoes, and local boro. Low land crops include catkin grass and local boro; crops grown in midland plains include aus, amans

**Table 2.4 Common Charland Crops**

Crop	Percentage of Mauzas Reporting	
	Island Char	Attached Char
B. Aus (L)*	96	91
Wheat	76	83
Pulses	64	75
Local Boro	60	41
Groundnut	52	50
Chilies	52	33

Source: Charland RRA  
\*Often mixed with B. aman.

[http://pdf.usaid.gov/pdf\\_docs/PNABW815.pdf](http://pdf.usaid.gov/pdf_docs/PNABW815.pdf) accessed 8/31/11

Image 51: Composite Image of Char Abhinava over 15 years.

and catkin grass; and highland crops include groundnuts and sweet potatoes. The soils of Char Abhinava contain a 37% sandy soil content and are not located in a drought affected zone. The soil of the surrounding area contains a noncalcareous grey floodplain soil, and is of not-saline content. Chars of this area are located in a medium intensity earthquake zone, with no major earthquakes reported in recent or past years.<sup>188</sup>

187. Ministry of Water Resources Flood Plan Coordination Organization. "Bangladesh Flood Action Plan."

ISPAN. Virginia: April 1995. Accessed August 31, 2011. [http://pdf.usaid.gov/pdf\\_docs/PNABW815.pdf](http://pdf.usaid.gov/pdf_docs/PNABW815.pdf)

188. Ministry of Power, Energy, and Mineral Resources for the Asian Development Bank (ADB), 42

Floating agriculture land practices also known as *vasoman chash*, which translates as “floating agriculture,”<sup>189</sup> has been employed in Bangladesh some 300 years.<sup>190</sup> It has a similar process to hydroponics, which is a system where “plants are grown in the water and they derive their nutrients from the water instead of from the soil.”<sup>191</sup> Crop production includes okra, cucumber, ridged gourd, snake gourd, amaranth, red amaranth, eggplant, pumpkin, Indian spinach, taro, wax gourd, and turmeric during monsoon season and season spinach, bottle gourd, yard long bean, tomato, potato, cauliflower, cabbage, kohlrabi, turnip, radish, carrot, ginger, onion, chili, and garlic during the winter season.<sup>192</sup>

Floating agriculture land is created during the beginning of the monsoon season with the collection of water hyacinths, a “bulbous plant with bell shaped racemes especially purplish blue which grows in the water.”<sup>193</sup> Straw and rice stubble are also collected to be used in a similar way as the water hyacinths. The depth of the water is not a concern in the formation of floating agriculture land.<sup>194</sup> There are no guidelines for the size of these floating agriculture lands, but most are around 8 meters long and 2 meters wide with 1 meter in thickness.<sup>195</sup> Although no formal guidelines exist, one general rule is that in order to produce one floating bed, one will need

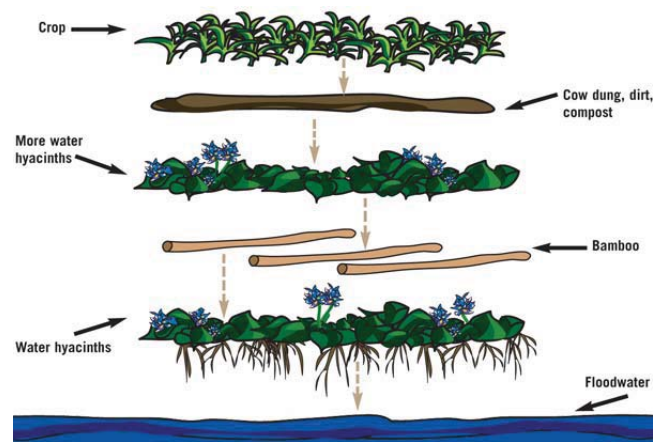


Image 52: Floating Agriculture land construction diagram. [http://practicalaction.org/climatechange\\_floatinggardens](http://practicalaction.org/climatechange_floatinggardens)

an area of water hyacinths five times

189. Assaduzzaman, Md. Asia Pacific Environmental Innovation Strategies. “Floating Agriculture in the flood-prone or submerged areas in Bangladesh (Southern Regions of Bangladesh).” August 2004.

190. Assaduzzaman 2004, pg. 3

191. Ibid., p.1

192. Haq, A.H.M., Ghoaal, T.K., Ghoah, Pritam. “Cultivating Wetlands in Bangladesh.” LEISA Magazine, 20.4, December 2004. Accessed Sept. 20, 2011.

<http://www.agriculturesnetwork.org/magazines/global/farming-with-nature/cultivating-wetlands-in-bangladesh>

193. Assaduzzaman 2004, pg. 2

194. Ibid., p.2

195. Noble, Neil. “Cultivating Wetlands in Bangladesh — AgriCultures Network.” AgriCultures Network. 2006. Accessed October 9, 2011.

<http://www.agriculturesnetwork.org/magazines/global/farming-with-nature/cultivating-wetlands-in-bangladesh>.



Image 53: Floating agriculture land

greater than the bed itself.<sup>196</sup> Overall, the size is completely up to the discretion of the farmer whose circumstances ultimately determine the size. These circumstances may consist of availability of materials and space.<sup>197</sup>

Once all materials are gathered, the first layer is formed with mature water hyacinths. It is important to use mature water hyacinths because they decompose slower than green water hyacinths.

This first layer is the most important because it provides the needed stability in buoyancy and thickness. The next layer is composed of bamboo poles placed over the floating mass. This adds another level of stability for this floating mass and will be later removed once the floating mass proves sufficient for buoyancy. On top of the bamboo layer, another layer of water hyacinths is added until the desired thickness is achieved. It is then woven together into a raft form. Once this is achieved, the bamboo poles are removed. After 7 to 10 days, another layer of water hyacinths is added as well as a mulch mixture. Next, a mixture of soil, compost, and cow dung roughly 25 centimeters thick is layered on.<sup>198</sup> This provides the base on which seeds can now be sown. One technique used to ensure seed development is planting them in “round balls of compost comprised of decomposed water hyacinth and an organic fertilizer known locally as Tema,” prior to planting them on the floating rafts.<sup>199</sup> Two to three seeds are each planted into each ball and left in the shade while germination occurs. Then, once these seedlings start to grow, they can be planted in the floating beds. These floating beds of land can either be towed around behind boats or anchored to land. They are also sometimes constructed over seasonally affected flooded land, and when the water levels recede, they

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196. Haq, Ghoaal, Ghoah 2004

197. Noble 2006, 2

198. Ibid., p.2

199. Ibid., p.3

provide a fertilizer in the dry winter season.<sup>200</sup> These lands typically only last one season, and are therefore broken down during the winter season to be used as a rich fertilizer. They can be reconstructed during the winter season, but most times are not needed because winter in Bangladesh is their dry season.<sup>201</sup>

There are some issues that arise with these floating agriculture beds. One large issue is that they attract ducks, rats, and other animals that are interested in the crops. In this case, fencing can provide a sound solution. This fencing is arranged around the perimeter of the agriculture land using any material available including broken fishing nets or sticks.<sup>202</sup>

Harvesting these crops is done on foot in shallow waters or by boat in deeper waters. Crops can be harvested every two to three weeks and are sold in local markets or through intermediary whole sellers.<sup>203</sup>

### Sustainable Power

Bangladesh has many opportunities for sustainable power. Many rural communities cannot afford electricity and therefore rely on other sources for power. Currently, most rural villagers use kerosene lamps which provide poor illumination and burn dung and wood for cooking fires. These power sources cause olfactory irritation and respiratory problems in many residents.<sup>204</sup>

The char people in the Upper Meghna River receive 4 to 4.5 natural kilowatt hours per square meter per day.<sup>205</sup> This amount of sunlight is adequate to produce power from both solar thermals and photovoltaic panels. Although a solar powered system would work in this area, it doesn't always provide a sound solution for the rural poor. It is usually expensive to set up and purchased mainly by middle economic classes. This solution can also be unpredictable during monsoon season. Wind power was also considered as an energy source, but can only be useful certain times of the year and can prove to be costly to maintain and purchase.<sup>206</sup>

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200. Haq, Ghoaal, Ghoah 2004

201. Noble 2006, 3

202. Ibid., p.3

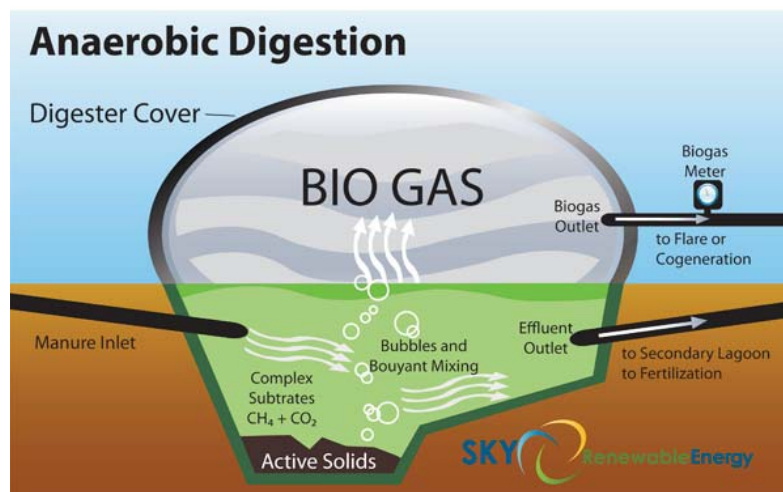
203. Ibid., p.3

204. Wahidul, Biswas K., Paul Bryce, and Diesendorf Mark. "Model for Empowering Rural Poor through Renewable Energy Technologies in Bangladesh." Accessed September 25, 2011. <http://www.sustainabilitycentre.com.au/BanglaEnergy.pdf>. Pg. 5

205. Ministry of Power, Energy, and Mineral Resources for the Asian Development Bank. *Bangladesh: Power System Efficiency Improvement Project*. Report no. 37113. March 2011. Accessed September 24, 2011. Wahidul, Biswas K., Paul Bryce, and Diesendorf Mark. "Model for Empowering Rural Poor through Renewable Energy Technologies in Bangladesh." Accessed September 25, 2011. <http://www.sustainabilitycentre.com.au/BanglaEnergy.pdf>.

206. Ministry of Power, Energy, and Mineral Resources for the Asian Development Bank. *Bangladesh: Power System Efficiency Improvement Project*, 45

What works in most rural poor communities are biogas plants. Biogas plants can be fueled by materials readily available in these rural areas, such as crops and dung, providing power for village households as well as additional outlying villages. The use of biogas can also improve health conditions of women who can use the power source for cooking.<sup>207</sup> “Biogas is the gaseous product of the anaerobic digestion (decomposition without oxygen) of organic matter.”<sup>208</sup> The absence of oxygen enables anaerobic bacteria to ferment biodegradable matter into methane and carbon dioxide, a combination known as biogas. About 90% of this energy is preserved in the form of methane leaving little excess sludge. This sludge is also useful and provides a slurry byproduct that can be used as highly fertile fertilizer. Agricultural waste AD (anaerobic digestion) will be useful to char people who already tend to cattle and crops. Agricultural waste can produce “63% methane and make the process more stable.”<sup>209</sup> There are two types of application for agricultural waste AD systems. One is a small-scale unit



that provides enough gas for cooking and lighting for one household, and another is a farm-scale biogas production which can provide heat and electricity.<sup>210</sup> To make use of this technology, gas stoves will need to be installed in homes as well as biogas lamps.<sup>211</sup>

Image 54: Biogas Digester Plant process

207. Ministry of Power, Energy, and Mineral Resources for the Asian Development Bank. *Bangladesh: Power System Efficiency Improvement Project*.

208. U.S. Department of Energy. “Alternative Fuels and Advanced Vehicles Data Center: What Is Biogas?” EERE: Alternative Fuels and Advanced Vehicles Data Center Program Home Page. Accessed October 6, 2011. [http://www.afdc.energy.gov/afdc/fuels/emerging\\_biogas\\_what\\_is.html](http://www.afdc.energy.gov/afdc/fuels/emerging_biogas_what_is.html).

209. Wellinger, Arthur, and IEA Bioenergy. *Biogas Production and Utilisation*. Report no. T37:2005:01. 2006. Accessed October 6, 2011. [http://www.biogasmax.eu/media/2\\_biogas\\_production\\_utilisation\\_068966400\\_1207\\_19042007.pdf](http://www.biogasmax.eu/media/2_biogas_production_utilisation_068966400_1207_19042007.pdf).

210. Wellinger 2006

211. Ghimire, Prakash C. *Technical Study of Biogas Plants Installed in Bangladesh*. Report. December 2005. Accessed October 7, 2011. Pg. 30 [http://www.snvworld.org/en/Documents/Technical\\_study\\_of\\_biogas\\_plants\\_installed\\_Bangladesh\\_2005.pdf](http://www.snvworld.org/en/Documents/Technical_study_of_biogas_plants_installed_Bangladesh_2005.pdf).

### Grameen Bank

Grameen (meaning “rural” or “village” in Bangla) Bank was founded by Nobel Peace Prize winner Muhammad Yunus, head of the Rural Economics Program at the University of Chittagong. He is responsible for creating a credit delivery service providing banking services for the rural poor. The system extends banking services to both poor men and women, but focuses mostly on micro credit loans for women. This system aims to abolish the exploitation of these rural people, (such as the citizens of Char Abhinava) by money lenders as well as to create self-employment opportunities for the poor.

The bank differs from traditional banks in a number of ways. Grameen believes that “credit should be acceptable as a human right, and builds a system where one who does not possess anything gets the highest priority in getting a loan.” Most banks judge a potential borrower on the basis of how much credit a person has, but Grameen bases loan distribution on a person’s potential. Grameen Bank also goes out to the community rather than waiting for people to come to them. They currently have 8.35 million borrowers in 81,379 villages all around Bangladesh. When people cannot make their weekly loan payments, Grameen doesn’t punish, but rather allows them to reschedule their repayment plans in such a way as to not inflict guilt on the borrower. Grameen representatives also assist borrowers falling behind in payments to bring them back up to speed.

Grameen borrowers are encouraged to make “16 decisions” that promote education and sanitary health conditions. Some of these decisions include no dowry, education for children, sanitary latrines, planting trees, eating vegetables, and arranging clean drinking water. Loans are distributed in small groups of 5. A borrower may receive additional loans once the current one is paid in full. A successful outcome is measured in terms of the following criteria:

1. The family occupies a home valued at Tk. 25,000 or a home including a tin roof and a bed for each family member.
2. Family members drink clean potable water free of arsenic or have access to purifying tablets or pitcher filters.
3. All children over the age of six attend primary school.
4. Weekly loan installments of Tk. 200 are met.
5. The family uses a sanitary latrine.
6. All members have adequate clothing for everyday use, warm clothes for winter and mosquito nets.



## 5 CHAR ABHINAVA SITE ANALYSIS

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7. Family members have a backup source of income.
8. Borrowers maintain an average annual balance of Tk. 5,000 in their savings accounts.
9. All family members eat three square meals a day throughout the year.
10. Family members have access to health care.<sup>212</sup>

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212. Khandker, Shahid, and Hassan Zaman. Grameen Bank | Bank for the Poor - Home. Accessed September 27, 2011. <http://www.grameen-info.org/>.

## 5 CHAR ABHINAVA SITE ANALYSIS

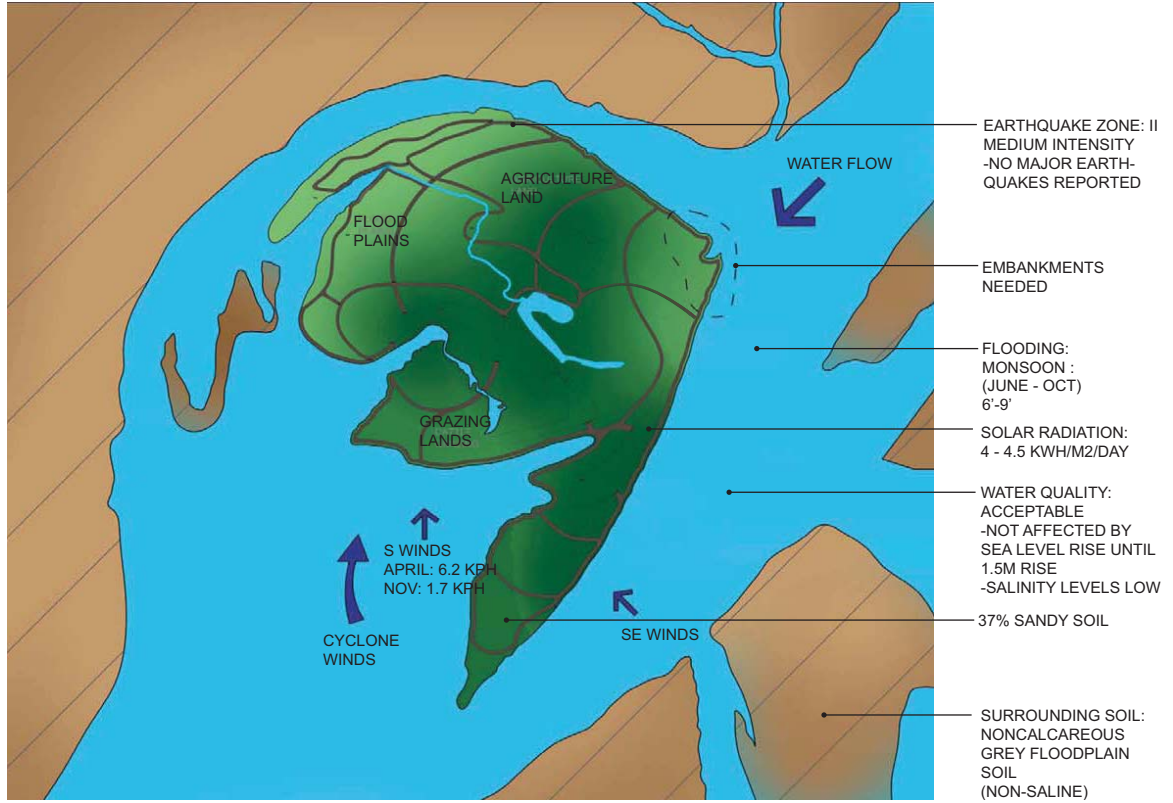


Image 55: Char Abhinava Site Conditions

# 6

## DESIGN PROPOSALS FOR CHAR ABHINAVA

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It is my intention to design a system of living with unpredictable water levels. The end product will be an economic plan, self-governing system, three proposed site plans and a prototype of a floating home. Design decisions will be dictated by two integrated models proposed for Char Abhinava, reflecting its social and spatial fabric. The design will be based on data collected from the Upper Meghna char area as well as yearly averages from Dhaka.

Char Abhinava has a population of 638 people accounted for in 33 extended family units with three homes per family producing a total of 100 households. This is based on demographic studies of char families that contain 6.38 people per household.

The location on the Upper Meghna River dictates living circumstances relative to site conditions. Low lands in this area will produce local boro, midlands will yield aus and amans along with catkin grass and bamboo, and high lands will produce sweet potatoes and groundnuts. Floating agriculture is also a part of the char lifestyles. These floating lands will yield pumpkin, gourds, cucumber, and eggplant during monsoon seasons, and potatoes, long beans, chili, and cabbage during winter seasons. Cattle and chickens will be held in sanctioned areas reserved for roaming. Char livestock will yield eggs, milk, and occasionally provide meat in desperate times. Transportation to and from larger markets will be easily arranged as Char Abhinava is not too far from Dhaka or other populated surrounding sites.

### *Char Abhinava Economic Plan*

Char Abhinava's economy will be structured as a self-reliant community, one that will contain a variety of different occupations. These occupations include biogas operators, farmers, livestock handlers, aquaculture farmers, potters, textile workers, basket weavers, and silt barrier operators. Char Abhinava occupational demographics will be broken down into 30 families dedicated to farming practices, 20 families dedicated to aquaculture practices which

include both fishing and floating agriculture, 15 workers dedicated to biogas plant operations, 12 workers dedicated to silt barrier operations, and 5 families dedicated to miscellaneous occupations such as pottery, textiles, and basket weaving. The number of families dedicated to livestock is directly proportional to the amount of cows needed to power the biogas plants.

A large contributor to Char Abhinava's economy will be three biogas plants. These will be made possible through the Grameen Shakti Bank system with assistance from various NGOs such as BRAC and ASA, which will set up and monitor a loan for the village of Char Abhinava, more specifically, a few collectives formed by groups within the community. Men will form three communal groups, and the women will assemble in smaller groups of five to form collectives of their own. The men will take out three loans to purchase three biogas plants of different sizes and power loads. A representative from the bank will instruct the men in the use and operation of running a biogas plant. These plants will then produce additional jobs such as maintenance and repair operators, gas distributors, bill collectors, slurry distributor, and dung collector. The three plants will provide each household of Char Abhinava with an adequate amount of energy at discounted rates, except for livestock handlers who will receive free biogas in exchange for animal dung. The plants will also produce an excess amount of energy for 22 additional households. These 22 households worth of energy will be sold to outlying homes in the area. The profits from outside households, after weekly loan repayment figures are deducted, will be distributed accordingly to the amount of "stock" each person has in the biogas plant. Stock is determined by job position. Maintenance and repair jobs require the most labor and education, and thus will be given 20% stock, gas distributors will be given 15%, bill collectors will be given 15%, the slurry distributor will be given 15%, the dung collector 15%, and additional contributors 20%. Additional contributors include other financial investors or community members. This 20% may also be used for infrastructure repairs made on CharX.

These three biogas plants will be categorized into small, medium, and large sizes. The small biogas plant measures 19 cubic meters (m<sup>3</sup>), powers 15 households at 11 gigajoules (GJ) per day, requires 29 cows, and will cost 60,077 Tk or 794.93 USD. The medium-sized plant will be 58m<sup>3</sup>, power 46 households with 32 GJ of power, require 85 cows, and cost 116,140 Tk or 1536.75 USD to construct. The last plant, the large one, will measure 77m<sup>3</sup>, power 61 households with 43 GJ of power and require 113 cows at a starting cost of 138,021 Tk or 1,826.28 USD. <sup>213</sup>

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213. Wahidul, Paul, Diesendorf, Accessed Sept. 25, 2011

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

**Table 1: Resources requirement for community digester**

No. of households	Demand of gas per day in GJ	No. of cows	Size of digester in m <sup>3</sup>	Investment <sup>a</sup> in Tk. <sup>b</sup>	O&M <sup>c</sup> in Tk.	Pay back period in yr
15	11	29	19	60,077	2,922	0.9
31	22	56	38	91,060	4,429	1.0
46	32	85	58	116,140	5,649	1.2
61	43	113	77	138,021	6,713	1.3

<sup>a</sup> Investment includes total construction cost and transmission (piping, cylinders etc.) cost. The costs were taken from LGED <sup>58</sup>.

<sup>b</sup> US\$ = 49 Tk. (1998)

<sup>c</sup> O & M costs do not include the wages. These include mainly costs of instruments, cement etc.

**Table 2: Returns from the biogas plant**

No. of households	Unit gas cost in Tk <sup>a</sup>	Annual bill collection in Tk (X)	Annual wages in Tk (A)	Loan repayment in Tk (B) <sup>b</sup>	O&M in Tk (C)	Savings in Tk (D)
15	19.86	110,556	28,800	67,779	2922	11,056
31	15.05	167,572	57,600	88,786	4429	16,757
46	12.8	213,726	86,400	1,00,304	5649	21,373
61	11.41	253,992	115,200	1,06,680	6713	25,399

<sup>a</sup> Life time of the plant has been considered as 10 year and the discount rate is 10% p.a.

<sup>b</sup> Loan repayment = annual bill collection - annual wages - annual O&M - annual savings

**Table 3: Cost and benefits from a poultry business (Tk.)**

Capital cost			Annual Income	Annual biogas bill	Annual feed requirement	Loan repayment	Personal use
Chicken	Cage	Cooker					
4000	500	500	38,310	7,250	21,900	6,000	3,160

Biswas, Wahidul, Bryce, Paul. Diesendorf, Mark. "Model for Empowering Rural Poor through Renewable Energy Technologies in Bangladesh." Environmental Science and Policy 2001

Image 56: Biogas plant figures.

These biogas plants require a supply of organic matter. Therefore, single women and other livestock handling families will play a huge role in Char Abhinava's economy. They will receive micro credit loans from Grameen Bank, which will be used to purchase cattle and chickens. The fecal matter from the livestock will provide the fuel necessary to produce biogas energy. This then creates a symbiotic relationship between the two, empowering single women in this Muslim community. In exchange for the dung, the women and livestock handling families will receive free biogas. Two hundred and twenty-seven cows will be needed in order to run the three biogas plants. With 20 "units" dedicated to livestock handling, this is roughly 12 cows each. A "unit" in this case is an individual contributor to the livestock handling group and may be a single woman or a family of 5.

With the formation of these collectives, a self-ruling government should be put in place. With the assistance of NGO and government representatives, the citizens of Char Abhinava will elect leaders and spokespeople to run community meetings, and people will vote on decisions made concerning their char. Along with an elected town leader, a board of representatives, with one person per occupation, will be formed. A representative from the Bangladeshi government will visit and work with elected leaders to help address any issues surrounding Char Abhinava. Through the government, people will be issued documents stating their right to live on Char Abhinava. Those without papers will be welcomed and housed in a temporary shelter until documents can be produced and space becomes available. A lot and work assignment will then be issued. If the number of citizens grows enough to produce and support another biogas plant, NGO and government workers, or even now educated Char Abhinava citizens will work with new families to establish their economic place on Char Abhinava.



## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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### Site Elements

**Floating Agriculture Land:** Floating agriculture land will be incorporated into daily routines and will be strategically placed to collect silt from the flowing river, thus speeding up the process of land growth and also providing a system of collection. This floating agriculture land will therefore need to be placed in the western part of Char Abhinava where the velocity of the river is slowest. The collected silt will be sold in local marketplaces, thus providing mainland farmers with rich soil, and can also be used for sandbags in the creation of embankment systems.



Image 58: Floating agriculture land planned for Char Abhinava. Photograph taken by Jonas Bendiksen for National Geographic.



**Silt Barriers:** Concrete silt barriers will also be implemented as a means of collecting silt on site. These barriers will contain a concrete base anchored to the bottom of the river and will serve to trap silt build up. With a man-operated pulley system, silt will be scooped and dropped directly onto boats located on the other side of the barrier. These docking stations will eliminate the need for divers as well as docking boats as the load can then be directly transported to be sold in marketplaces on the mainland.

**Embankments:** Embankments will also be strategically placed where erosion will likely occur. On Char Abhinava, this is the northeastern point where the char first encounters the flowing river. A cut slope and the use of sandbags created from material found on site will prove useful in protecting the bank.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

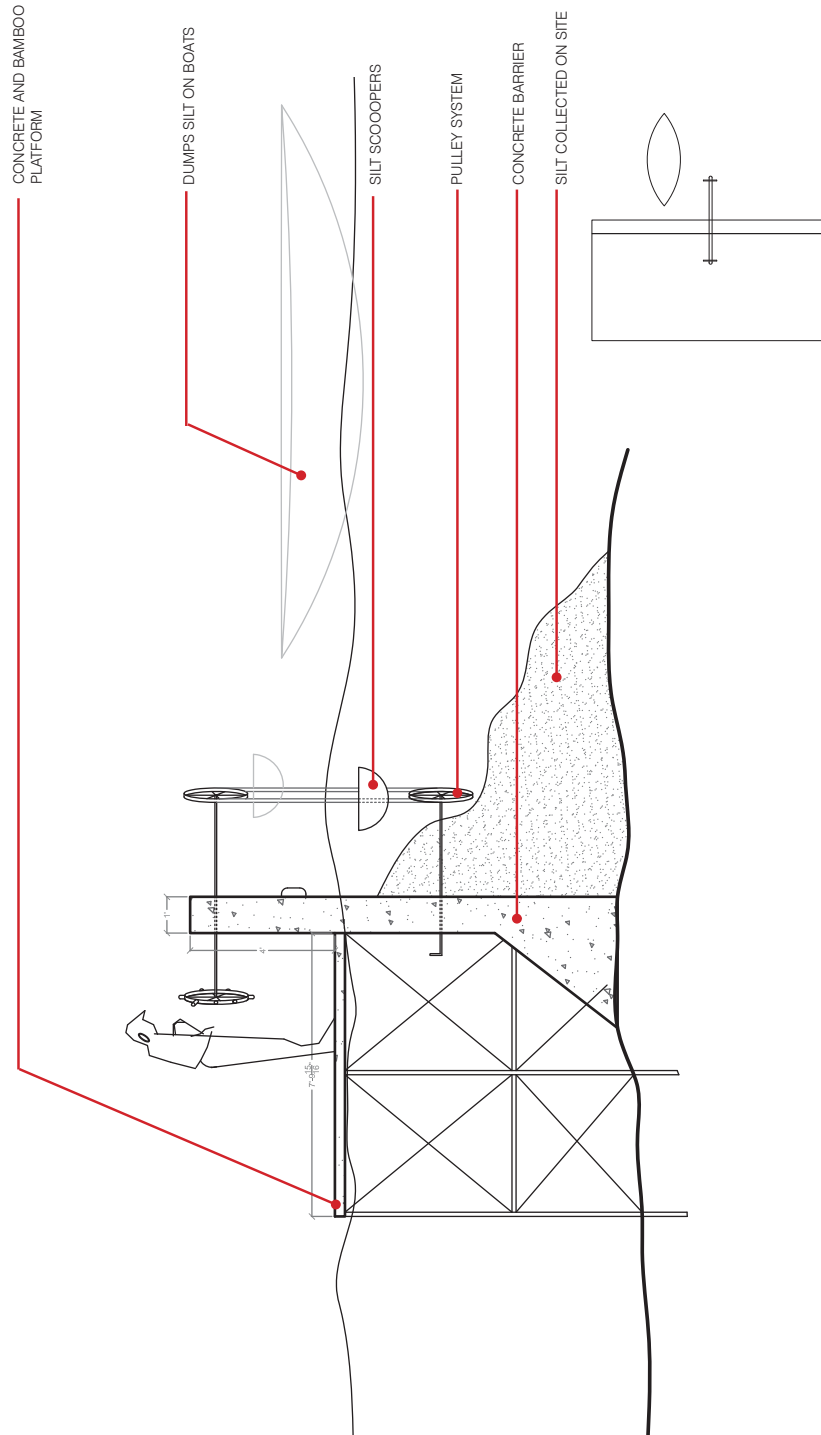


Image 59: Concrete silt barrier tectonics

### Zoning

Char Abhinava can be broken down into three main areas: the lowlands, agriculture lands, and grazing lands reserved for livestock. All three areas are connected through a network of pathways. The lowlands are located in the north to northwestern area of the site, the agriculture lands in the east, and the grazing lands on the mid-western side of the char. The location for the grazing lands was selected based on the natural barrier this site provides. This area is surrounded by higher topography levels, which help to prevent the livestock from grazing in agriculture lands.

### Site Planning

Currently, Char Abhinava contains a haphazard arrangement of houses set at the highest elevations. Clues may be derived from this current set up as to what aspects of their lifestyle the char people regard as permanent. The home appears to have an element of permanence despite its fluctuating environment. Other permanent spaces planned for Char Abhinava include a mosque, a community center, a marketplace, and three biogas plants. These spaces will be located near neighborhoods and will create a "Char center" that will serve to gather people. The community center will be the main gathering hub and will be used as a communication center equipped with computers and an internet station. This will connect the char people to the rest of world, enabling them to seek help or information. The community center will also serve as a training center for both men and women, a meeting place for town meetings, as well as a school for the children of Char Abhinava. There are three different design options planned, two extreme scenarios and one that forms a compromise between the two extremes: a purely stationary lifestyle, a purely floating lifestyle, and a combination of the two based on different char occupations. All permanent aspects and site innovations are implemented in all three site plans, except for floating agriculture land, which is excluded from the purely stationary layout, as this concept contradicts the principles of this setup.

### Purely Stationary

A purely stationary layout is one plan for Char Abhinava. This lifestyle places all residences and community spaces on the highest ground for safety, thus when flood waters come, inhabitants have time to plan accordingly. This provides a sound solution for normal

flood waters, which at 6 to 9 feet, affect only the lowlands. Only under extreme flood conditions, as experienced in the past, may people be trapped. Past extreme flood levels reached 7.66 meters which is right at the highest land level of Char Abhinava. In this extreme scenario, escape is made possible through the home itself, which can transform into a floating vessel allowing residents to float on the water's surface. This layout will also feature silt barriers located in the southwestern part of the site. These will serve as a docking station for boats to load up collected silt to sell in nearby marketplaces. These barriers will also help to speed up additional land growth of Char Abhinava, thus providing more agriculture land.

### Purely Floating

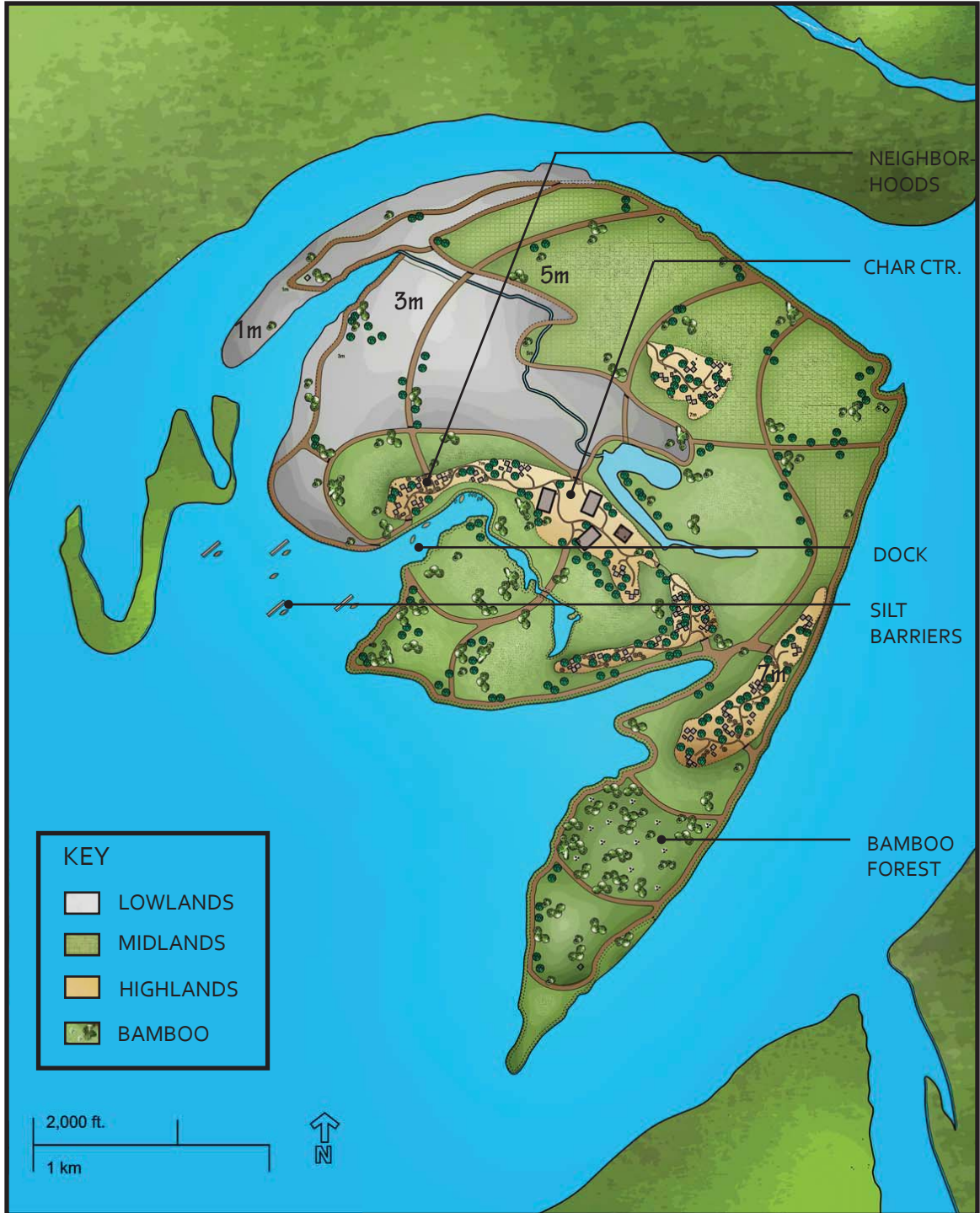
The best solution to rising waters is one that can take on any and all water levels. With a floating lifestyle, the char people will have the autonomy to escape flood waters. This solution provides a sense of permanence (their home, the floating vehicle) in an ever-changing landscape. It also keeps true to Bangladesh's doctrine of living with rising water levels.

A floating lifestyle recognizes the scarcity of agricultural land in the Upper Meghna char area. Therefore, all land will be dedicated to supporting the inhabitants' livelihoods. Char Abhinava is organized around low, mid, and high land locations. The residential community will float on water along the char perimeters where land inlets provide a safe haven from harsh monsoon winds as well as immediate flood waters. This option allows for homes to be easily transformed into floating vessels when heavy floods arise. The three inlets are located on the western side of the char. Floating agriculture land is also located along the inlets of the southwestern part of the char, trapping the silt that flows downstream. These agriculture lands will also produce crops according to different seasons. The midlands will be reserved for agriculture and livestock and the highlands for crops as well as community spaces.

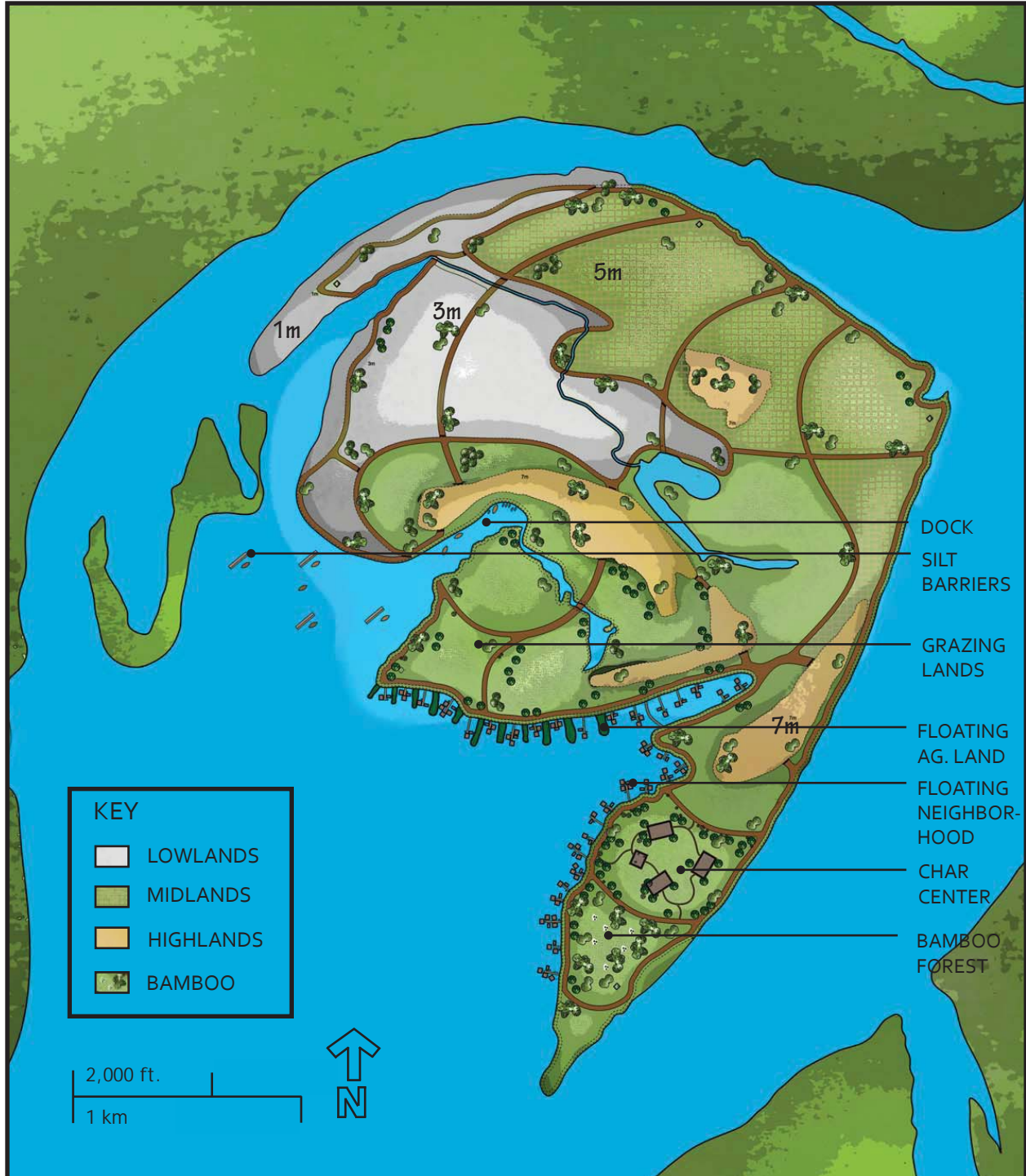
### Hybrid Layout

The third layout is organized around the different occupations of the char people. A combination of both stationary and floating lifestyles provides a viable solution, as people with aquatic occupations will occupy the water in a floating lifestyle and farmers who have land onshore will live on high ground. Aquatic occupations include both fishermen and floating agriculture land farmers. These homes will be disbursed between the floating agriculture lands

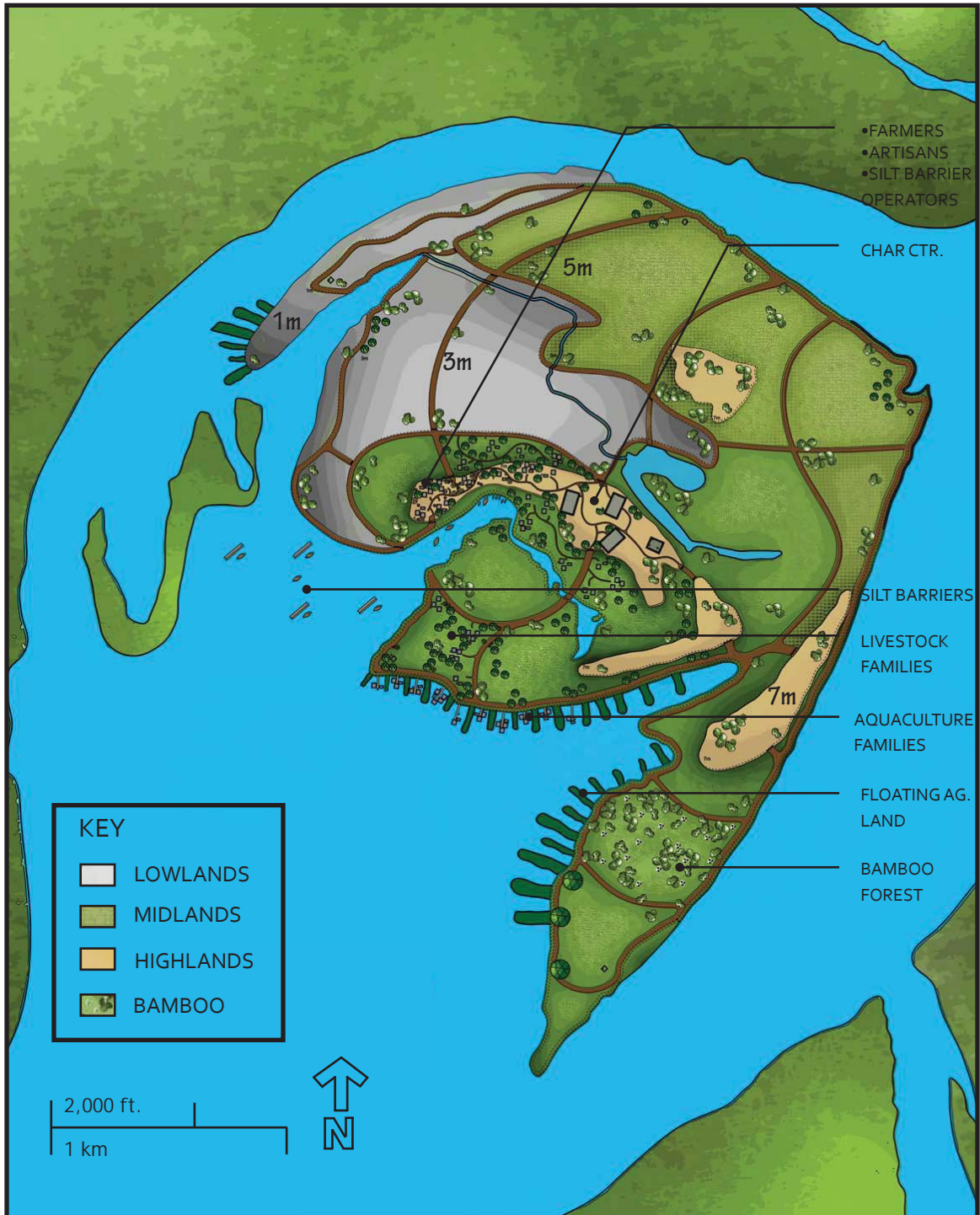
## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA STATIONARY LAYOUT



## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA FLOATING LAYOUT



## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA HYBRID LAYOUT



located in the southwestern part of the char. Concrete silt barriers will also be implemented in this scenario, and these operators will also reside on the water. Inland occupants will be families who farm land onshore as well as biogas operators. Both communities will be placed in tight knit groups, within close proximity to one another for safety reasons. This way, everyone is informed when flood waters invade. The Char center will be centrally located on site, in close proximity to both floating and land based neighborhoods. The community center, mosque, market place and biogas plants will be placed on the highest elevation, thus protecting these important buildings from immediate danger and outsiders.

With the three layouts proposed, it is predicted that the Char people will select the layout that best suits their lifestyle. One that can be adapted in their lifestyle to improve current living conditions relative to the Char people. All three layouts have both pros and cons and the layout predicted to have the most success is the Hybrid layout, which combines the best of the two extreme layouts. One pro of the Purely Stationary layout, is that it provides the Char people with more time when flash floods should arrive, since neighborhoods are arranged on highground. Some cons of this layout include less land for profitability and no future expansion of "space" for Char Abhinava since all settlement is planned only for land and doesn't consider settlement on water. Pros for the Purely Floating layout includes the fact that more land can be devoted to making a profit and some cons include less preparation time during flooding and more frequent repairs made on the home. The Hybrid solution provides a compromise between the two, lessening the cons of the two other layouts. It provides the best elements of the two, with the possibility of future expansion since settlement is not limited to purely land or water.

### Char Center

Char Abhinava will be a self-sustaining community, and thus its citizens will need to develop strong relations with one another. These relations extend to both work and societal layouts. It is important for the citizens of Char Abhinava to function as a whole, relying on one another for food and safety. The Char center will be composed of a community center (21,296 ft<sup>2</sup>), marketplace, and a mosque (15,972 ft<sup>2</sup>), arranged around an open courtyard. The biogas plants will also be located in the Char center and will measure 64 ft<sup>2</sup>, 121 ft<sup>2</sup>, and 169 ft<sup>2</sup>. The citizens of Char Abhinava will also take advantage of a floating health care facility already



## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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implemented in Char lands. The community center will serve as a meeting place for town gatherings, a school for the children of Char Abhinava, a training center for men and women, as well as a media center, housing computers with connections to the internet. This center is envisioned as a gathering space, set as the heart of Char Abhinava.



Image 60: Char center. Creates a courtyard used for town gatherings.

### Household Cluster

Residences will be grouped together in tight knit neighborhoods. This is planned for safety issues, allowing for immediate notification of imminent natural disasters. Within each neighborhood, each extended family lives in a “cluster” of three to four households arranged around an interior courtyard. This is modeled after households of Bangladesh, with a few buildings shared between the households such as the kitchen, granaries, and outdoor latrines. Refer to Appendix D for further information. The home will be used primarily for sleeping and storage. Homes will measure 900 ft<sup>2</sup>, kitchens and granaries will measure 687 ft<sup>2</sup>, and outdoor latrines will measure 88 ft<sup>2</sup>.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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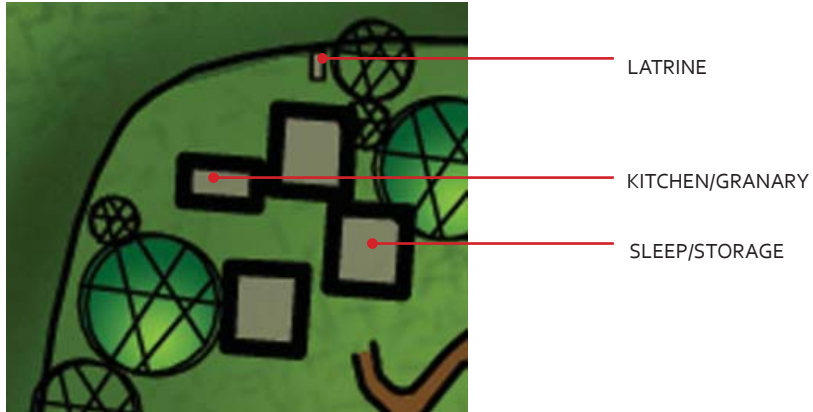


Image 61: Typical stationary household cluster. Buildings face inward to create a shared courtyard.

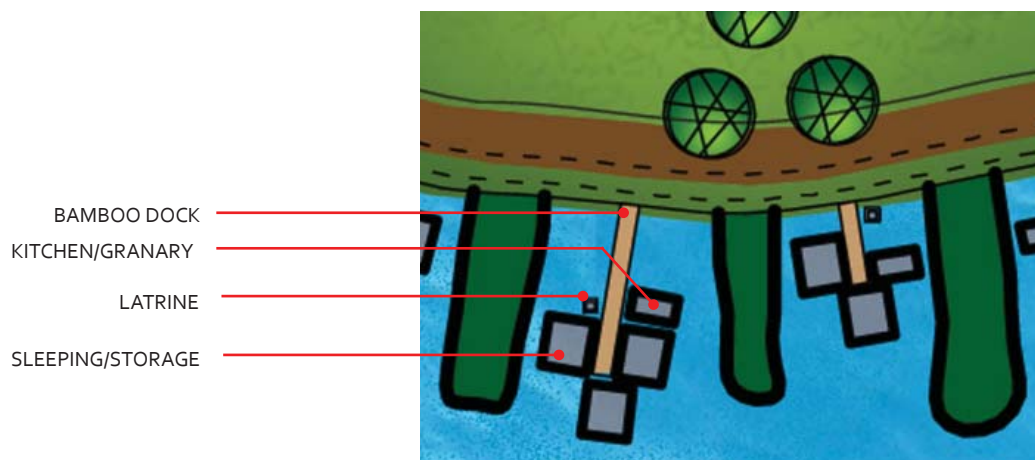


Image 62: Typical floating household cluster.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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Image 63: Typical Char Abhinava prototype arranged in planned cluster setting.



Image 64: 2 prototypes altered, one fitted with corrugated metal and the other altered with mud.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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Image 65: Planned Floating neighborhood.



Image 66: A land cluster altered by Char Abhinava inhabitants to better fit their lifestyle. Shed and granary is covered with vines.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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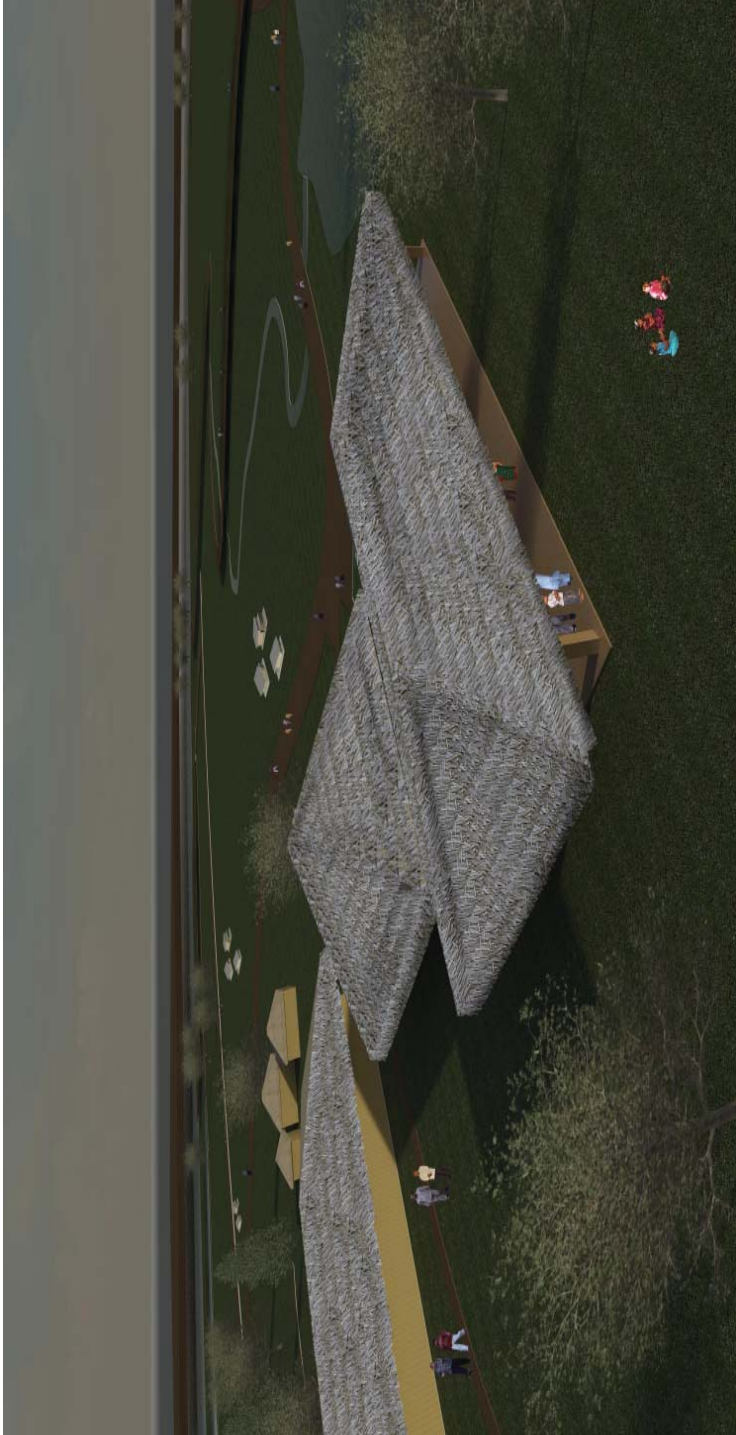


Image 67: Char Center: mosque, community center, and market place.

## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

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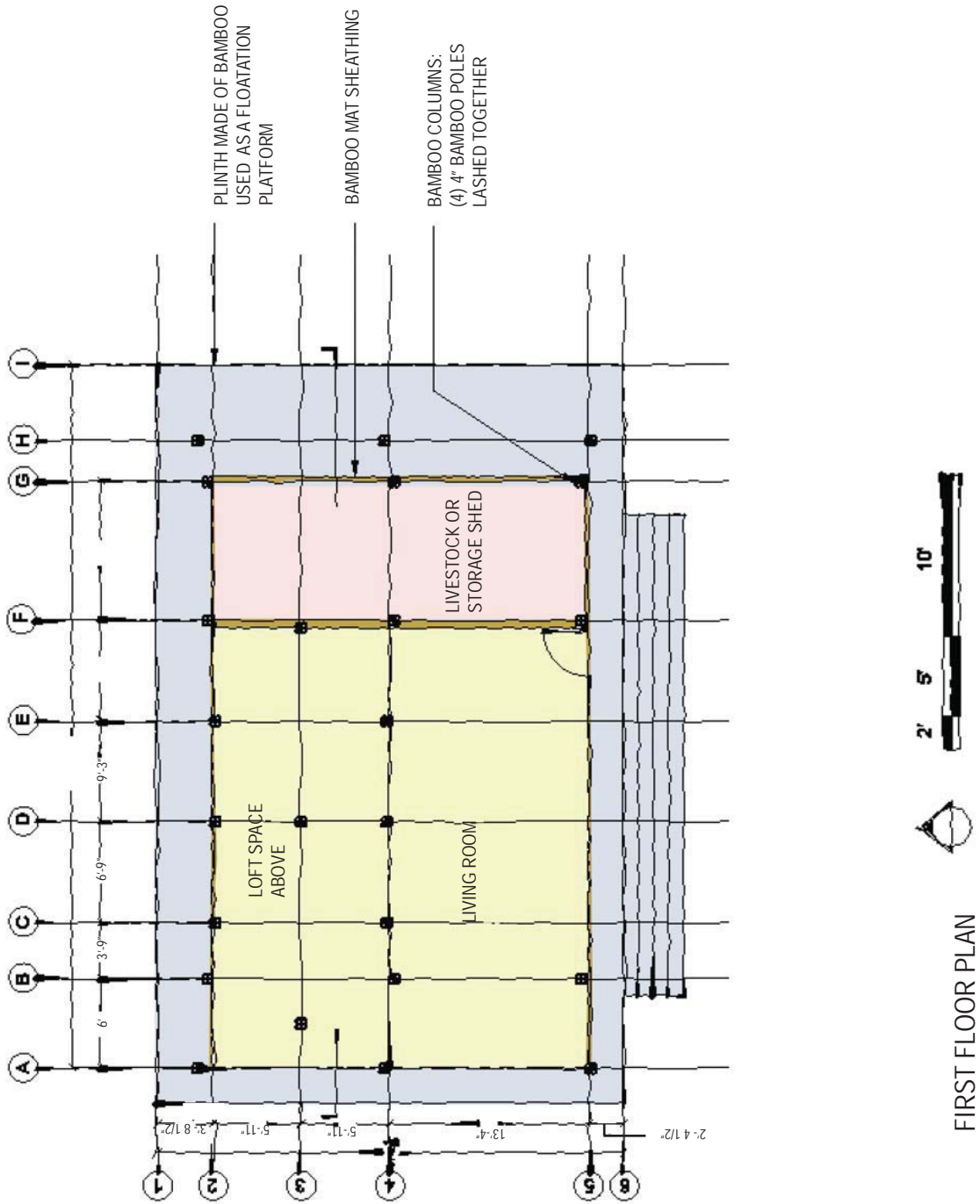
### Prototype for Home :

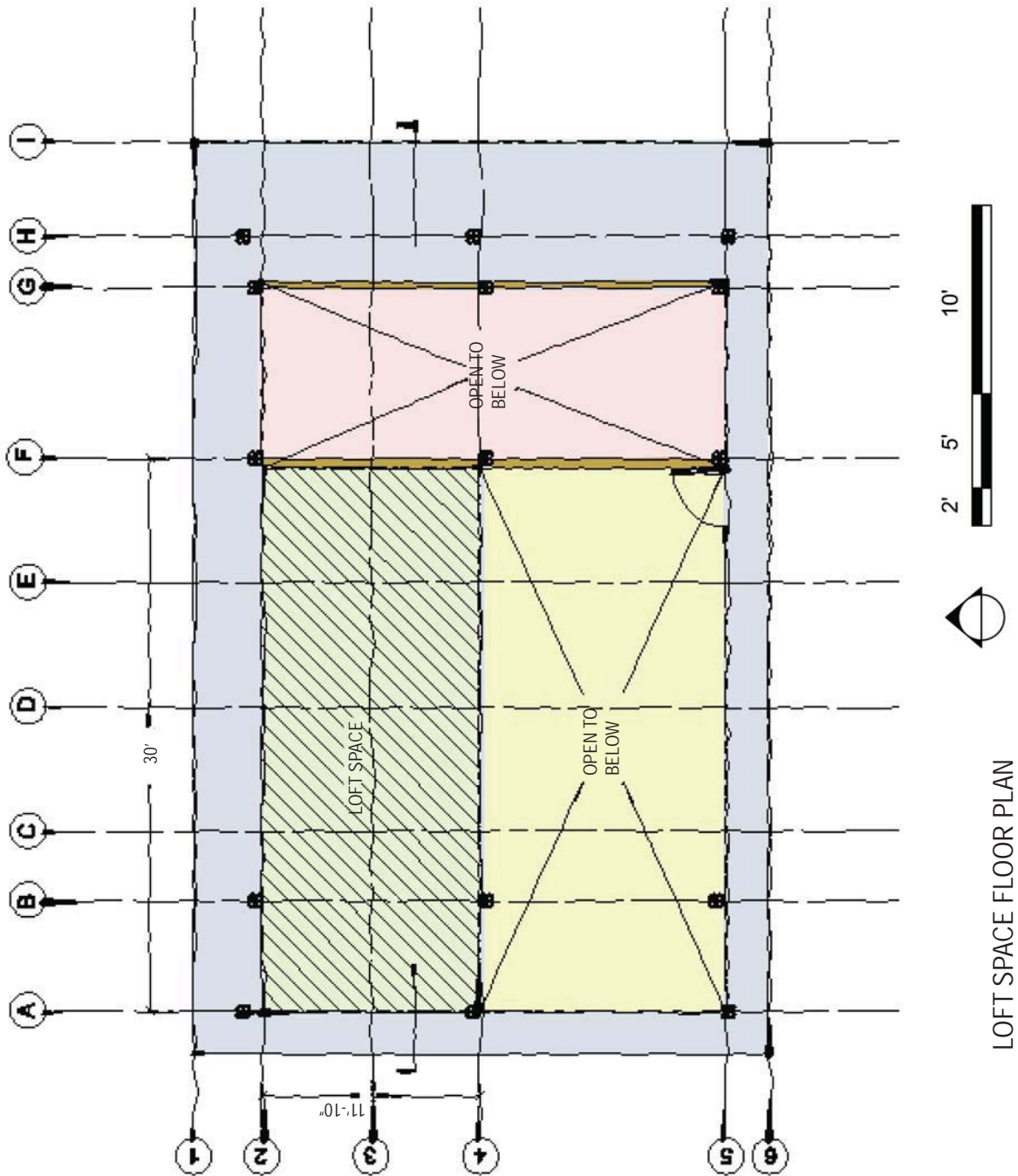
The prototype will have the ability to exist both on land and on top water. This makes the home adjustable to any future water logged conditions. The prototype will feature three main spaces, a living room for household activities and sleeping, a loft space above used for sleeping, and a storage shed used to house either items or livestock. The entire structure is made of bamboo with the skeletal frame composed of bamboo poles and the side sheathing made of bamboo mats. Lashing and joinery techniques are employed to hold the structure together. The entire structure is built on a 2' bamboo plinth which makes use of floating wooden barrels filled with air as a floating device similar to a pontoon system.



Image 68: Early Study Model of Prototype

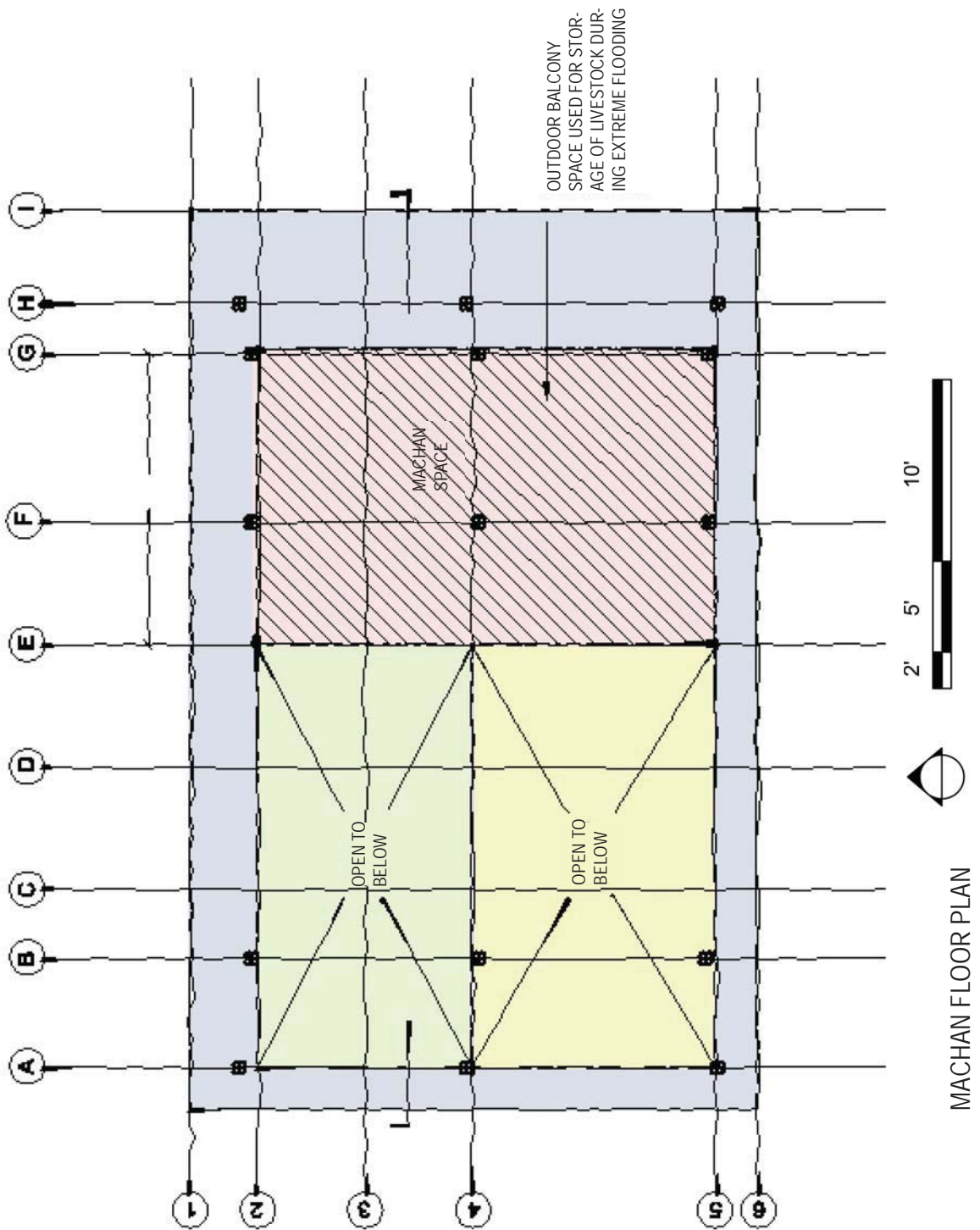
# 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

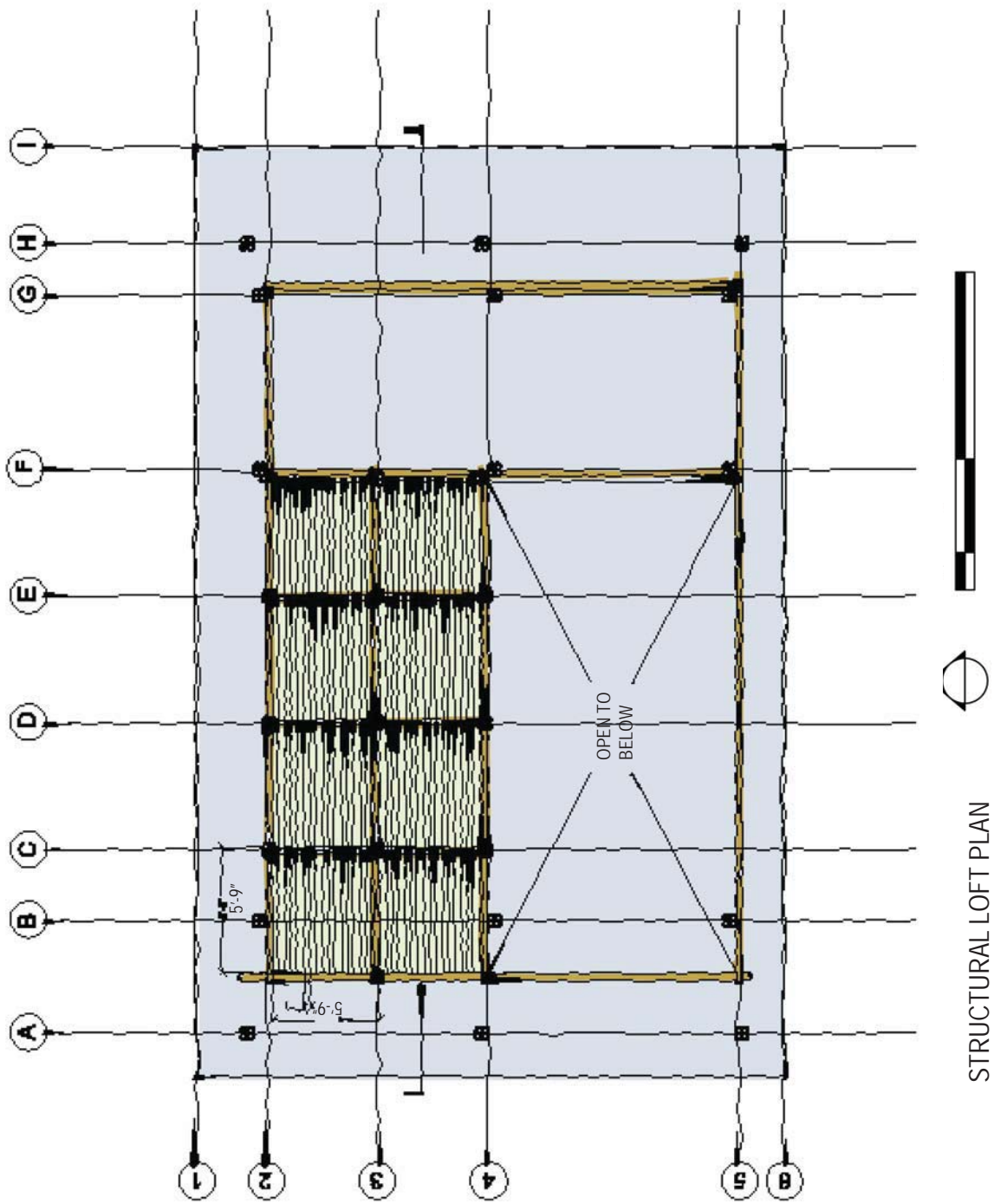




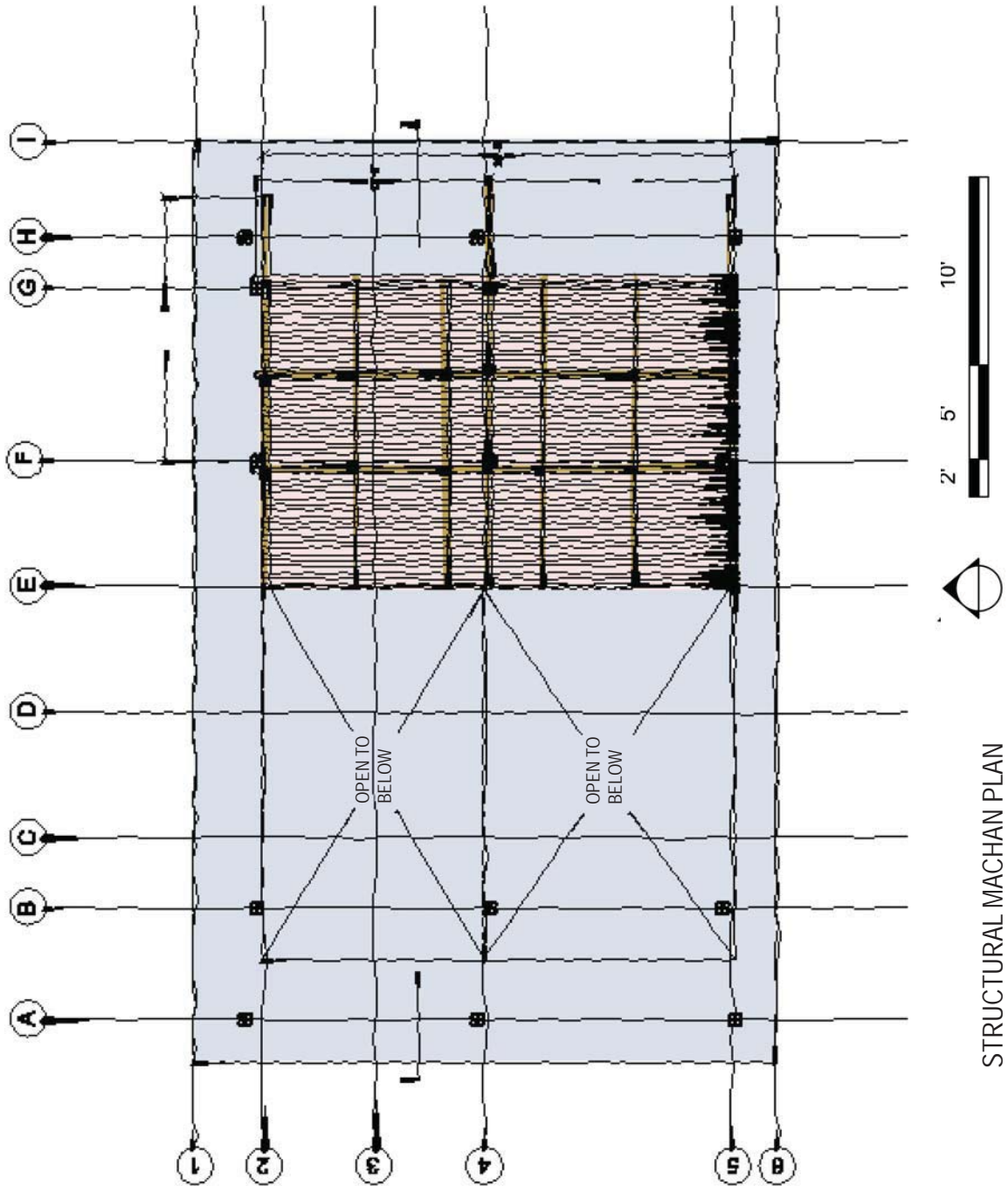


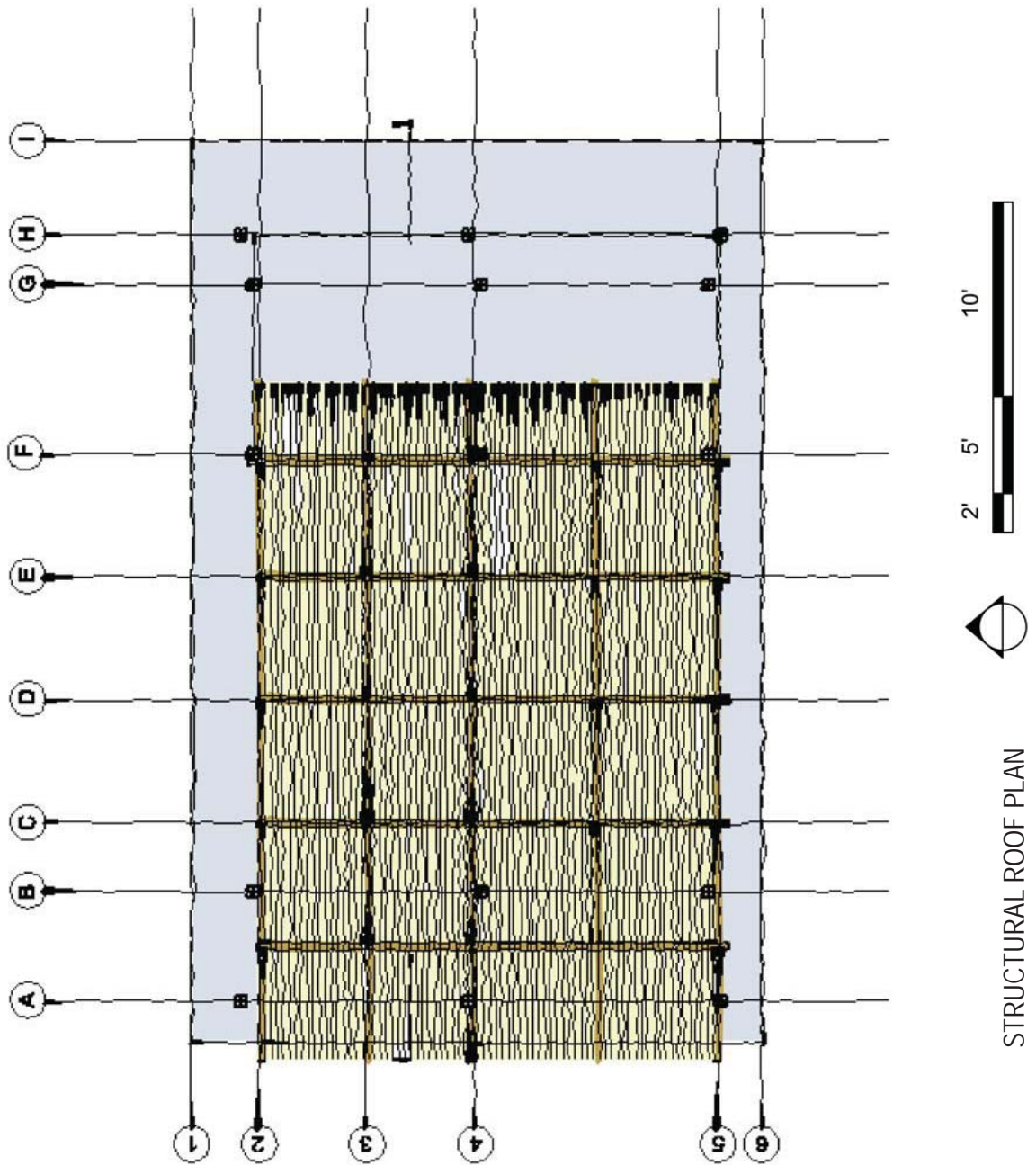
## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA



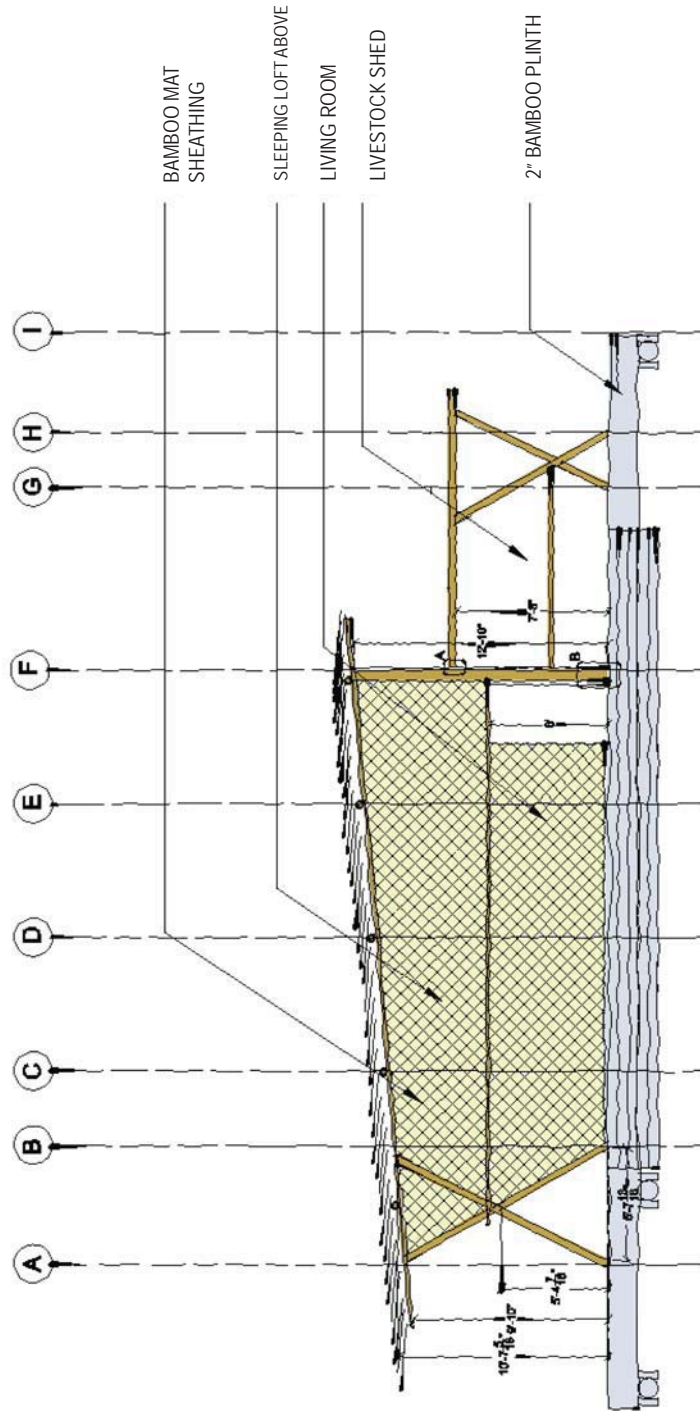


## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

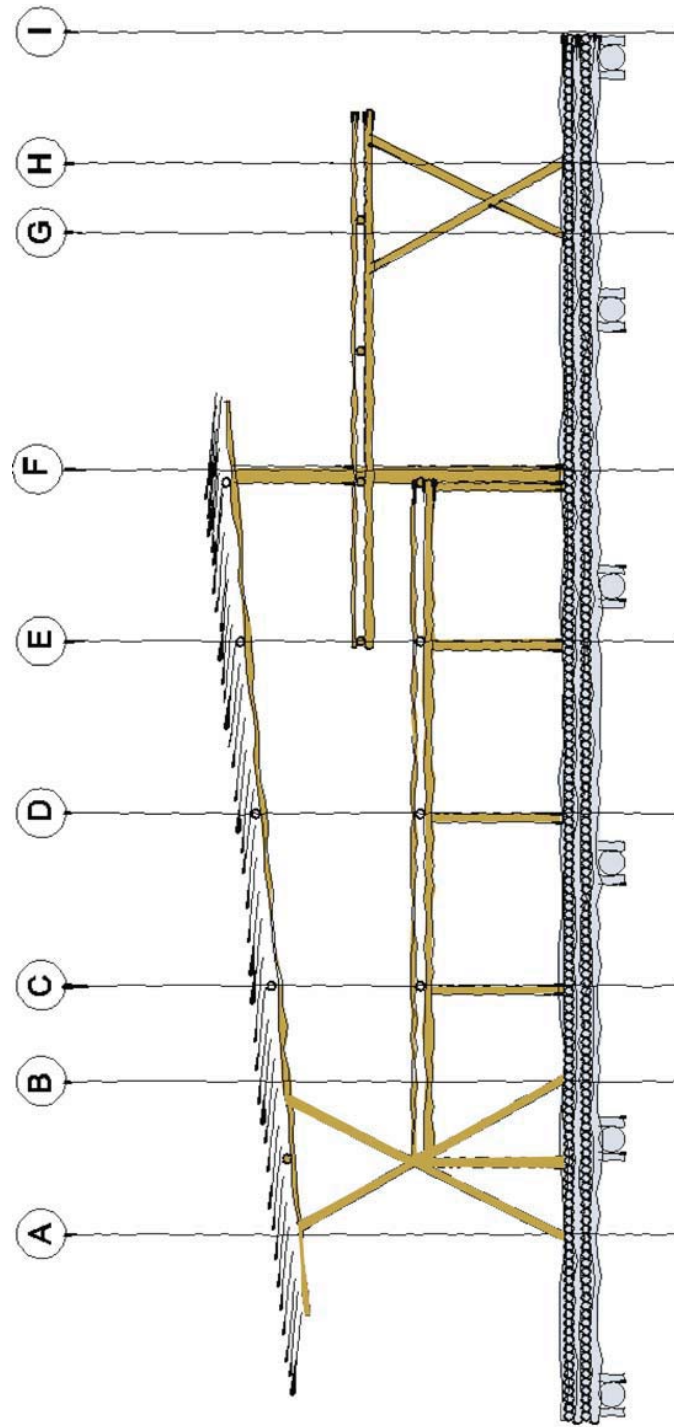


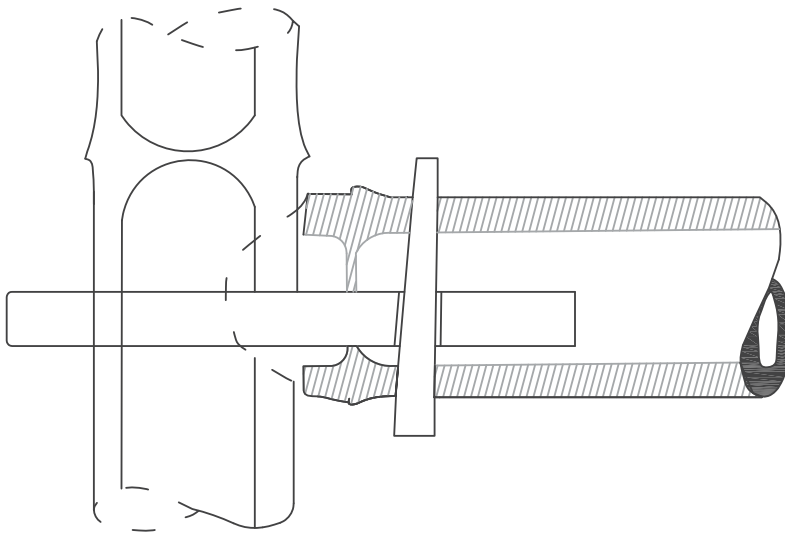


# 6 DESIGN PROPOSALS FOR CHAR ABHINAVA

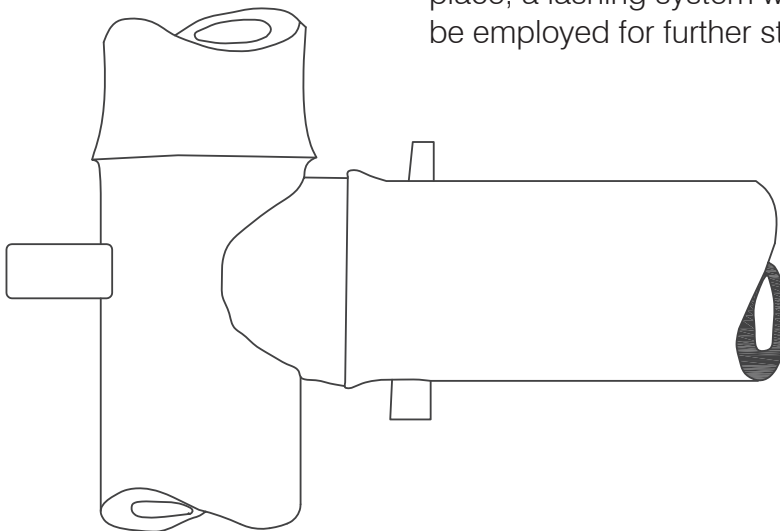


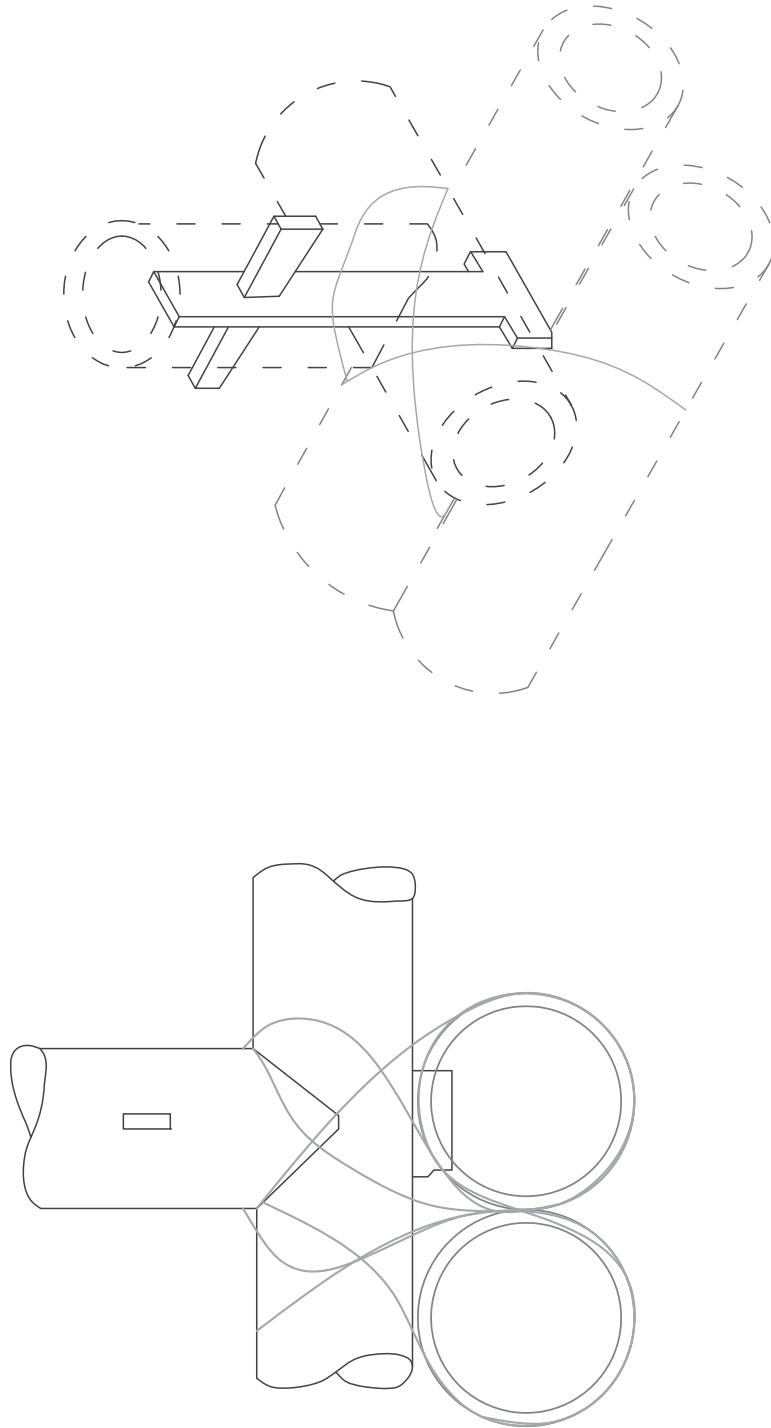
## 6 DESIGN PROPOSALS FOR CHAR ABHINAVA





DETAIL A: Connects Bamboo column to bamboo beam through an interlocking wedge system. Once wedged in place, a lashing system will also be employed for further stability.





DETAIL B: Interlocking wedge system connects bamboo flooring to bamboo columns. Catkin grass lashing ties floor and column together.



# 7 CONCLUDING THOUGHTS

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Designing for the Char people of Bangladesh was a rewarding thesis topic, one that I feel if not directly, will still somehow make a difference in their lives. When first selecting my thesis topic, I wanted to design and research one that was close to my heart, something I was passionate about and a topic that put something positive in this world. Through my travels, I've found that I have a compassion for impoverished communities, realizing how truly fortunate I am.

Growing up in Hawaii has made me aware of sovereignty issues and the importance of preserving a unique sense of place. As an outsider designing for Char Abhinava, I found it difficult gaining the confidence to jump in and propose a system of living, especially for a cultural context that is not of my own. Relying on books, videos, and photographs helped me to gain an understanding of this foreign cultural context and perpetuate this unique sense of place rather than implement a completely foreign system. This was ultimately my goal, was to design a system that improves upon the vernacular of Bangladesh.

Another challenge I faced was designing with the inconsistency of a changing landscape. Designing for a fluid landscape involved many predictions and guesswork that can't be 100% proven but need to be considered. The only way to know if my model is truly successful is through the passage of time. I've learned that like the Bangladeshi people, I too cannot control nature and therefore a flexible plan was needed to be implemented.

In the end, I've learned that any culture has the ability to adapt to challenging situations. What we all perceive as a fixed culture or setting has the capability to change, and humans will most definitely continue to evolve and adjust our cultures in our quest to survive. As this occurs, other cultures can look to Bangladesh for inspiration in dealing with rising water levels.

# A BANGLADESH GENERAL INFORMATION

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## General Information

Bangladesh is located between India and the Bay of Bengal. *Figure 1.* The people are a homogenous group composed of 98% Bengali ethnicity with 2% tribal and non-Bengali Muslims.<sup>214</sup> Religious beliefs are broken down into 83% Islamic, 16% Hindu, and 1% others.<sup>215</sup> It is one of the fastest growing countries with a 1.2% growth rate evident in population changes from 1960 to 2009. There were 54,138,214 inhabitants as of 1960 and 156,050,883 inhabitants as of 2009, equaling 1,146 inhabitants per square kilometer (km<sup>2</sup>).<sup>216</sup> The country has a total area of 144,000 km<sup>2</sup> with 13,830 km<sup>2</sup> of water and 130,186 km<sup>2</sup> of land.<sup>217</sup> Bangladesh relies heavily on agriculture for its gross domestic product, with 61% of the labor force dedicated to agriculture.<sup>218</sup> Other workforces include 11% in industry related fields and 26% in service related fields.<sup>219</sup> Bangladesh's agricultural products include jute, rice, tobacco, tea, sugarcane, vegetables, potatoes, and pulses. Other industry products and services include sugar, paper, textiles, fertilizers, cigarettes, cement, steel, natural gas, oil refinement, newsprint, power generation, rayon, matches, fishing and food processing, leather, soap, carpet, timber, shipbuilding, and telephones.<sup>220</sup> In recent years, there has been a shift in industry from agriculture to services and manufacturing.<sup>221</sup>

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214. "Bangladesh." U.S. Department of State. May 24, 2010. Accessed February 23, 2010. <http://www.state.gov/r/pa/ei/bgn/3452.htm>.

215. Infoplease. 2011. "Bangladesh" Accessed February 25, 2010. <http://www.infoplease.com/ipa/A0107317.html>

216. Google. "World Bank, World Development Indicators-Google Public Data Explorer." Google. Accessed February 24, 2010. [http://www.google.com/publicdata/explore?ds=d5bncppjof8f9\\_](http://www.google.com/publicdata/explore?ds=d5bncppjof8f9_)

217. Central Intelligence Agency. "The World Fact book: Bangladesh." Accessed February 25, 2010. <https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html>

218. "Water Profile of Bangladesh." Encyclopedia of Earth. Accessed February 13, 2010. [http://www.eoearth.org/article/Water\\_profile\\_of\\_Bangladesh](http://www.eoearth.org/article/Water_profile_of_Bangladesh).

219. Infoplease 2011

220. "Virtual Bangladesh : History : Overview." Welcome to Virtual Bangladesh. Accessed February 25, 2010. <http://www.virtualbangladesh.com/history/overview.html>.

221. International Financial Statistics Yearbook; World Development Indicators; UNICEF.

## A BANGLADESH GENERAL INFORMATION

	1990	2000	2003
<b>Economy</b>			
GDP per Capita (US\$)	194	279	389
GDP growth rate (year on year)	4.3	5.9	5.3
Value added in agriculture (% of GDP)	28	26	22
Value added in manufacturing (% of GDP)	24	25	27
Value added in services (% of GDP)	48	49	52
X/M (%)	46	72	78
Current Account Balance (millions of US\$)	-222	-337	294
Debt service as a % of exports	17	9	7
<b>People</b>			
Total Fertility Rate	4.6	2.8	3.1
Under 5 mortality rate	144	77	--
Male Adult Literacy Rate	44	49	--
Female Adult Literacy Rate	24	30	--
Poverty rate (Headcount)	58.8	49.8	--
Population (millions)	109.9	130.4	138.4

Image69: Bangladesh economy chart

## Weather

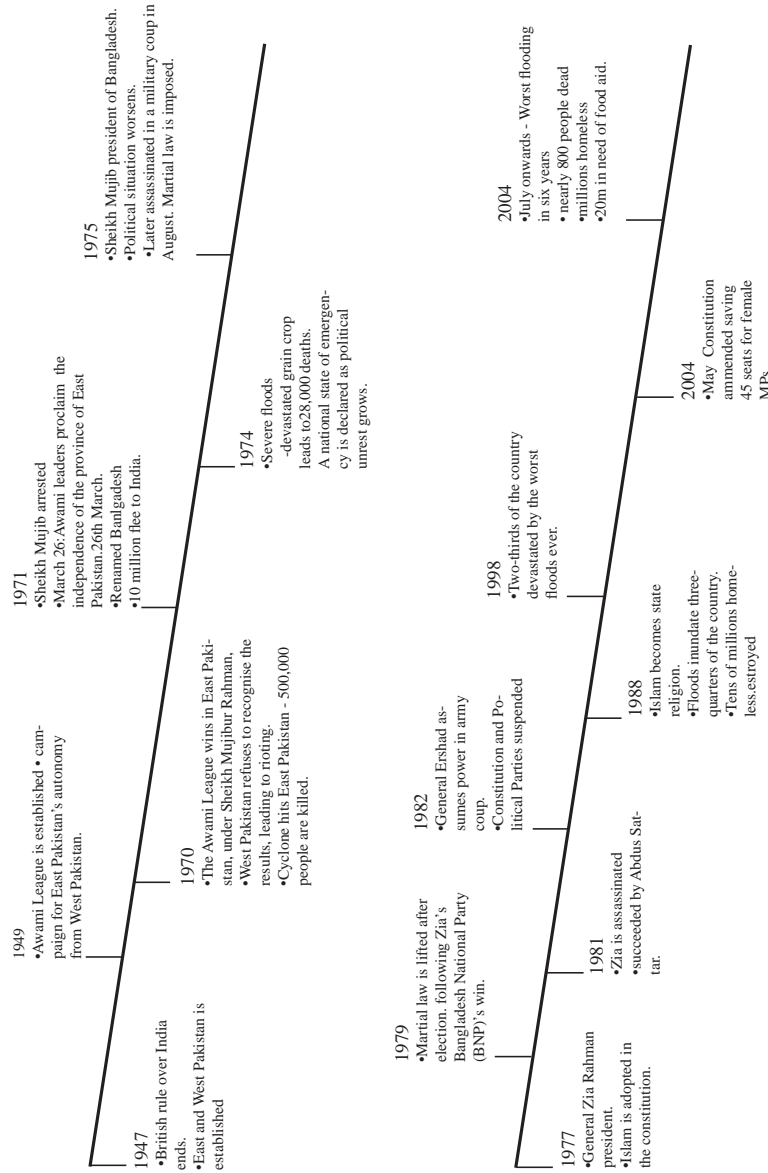
Bangladesh has six distinct seasons and is also known as *Sadartu*, the land of six seasons. Each season is broken down into two months. *Grisma* is summer, *barsa* is the rainy season, *sarat* is autumn, *hemanta* is late autumn, *shhit* is winter, and *basanta* is spring. Bangladesh has a mainly temperate climate with warm and humid temperatures. These six seasons are then further categorized into three separate seasons: pre-monsoon (March through May), monsoon season (June through October), and the dry season (November through February). During pre-monsoon season, April is the hottest month of the year with averages ranging from 27 degrees Celsius (°C) in the east to 31°C in the west-central district. Rainfall during this time provides 10 to 25 percent of the total average. Monsoon season produces heavy rainfall, accounting for 70 to 85 percent of the total average. One can expect high humidity levels as well as winds blowing in from the south during this time. The dry season is characterized by low temperatures blowing in from the west or northwest with little to no

# A BANGLADESH GENERAL INFORMATION

rainfall. Average temperatures range from 17°C in the northwest to 20°C in coastal areas. <sup>222</sup>

## Bangladesh History

### Bangladesh Timeline



"Timeline Bangladesh." BBC NEWS. March 8, 2011. Accessed September 17, 2011. [http://news.bbc.co.uk/2/hi/south\\_asia/country\\_profiles/1160896.stm](http://news.bbc.co.uk/2/hi/south_asia/country_profiles/1160896.stm)

### Bangladesh Culture

The traditions of Bangladesh are based on those of settlers including hundreds of different aboriginal tribes such as the Negritos, proto-Australoids, Proto-Mongoloids, and Caucasoids. Bangladesh is known as a highly fertile land, and many have come in search of its wealth. Therefore many traditions and customs are based on agricultural and aquacultural practices. One such practice is *Navanna*, the festival of new harvest. This festival takes place in the month of *Agrahayana* (November through December), also known as the “month of plenty.”<sup>223</sup>

Another festival is the marking of *Pahela Baishakh* (Bengali New Year’s). The day begins with a breakfast made of *pantabhat* (soaked rice with fried fish) or *cheera* (gud and yogurt). Everyone then dons their best clothes and visits fairs set up under banyan trees or near riverfronts. These *melas* (fairs) offer a variety of different foods, sweets, clay and plastic dolls, bangles, and also feature an assortment of entertainment such as opera, games, horseback riding, and merry-go-rounds. It is during this day that businessmen will also pen new *halkhatas*, new account books.<sup>224</sup>

Families in Bangladesh are arranged in extended family units. Respect for women and elders as well as love and care of children are both important. “Old parents and elderly dependents are taken care of by the families of their sons and daughters or relatives as their good wishes and prayers are deeply valued as propitious for receiving God’s kindness.” Muslims greet their elders according to their tradition known as *Assalamu Alaikum* in which the “right hand [is] raised to touch the forehead.”<sup>225</sup> Hindus do the same with their tradition known as *Namashkar*, which is conveyed with folded palms.<sup>226</sup>

Childbirth is celebrated with sweets passed out to relatives and friends of the parents. A naming ceremony is then held shortly after, and guests bring gifts to celebrate. A son’s circumcision known as *Khatna* or *mussalmani* is a typical practice among Muslims and also celebrated with a feast. “Newborn babies are also given a black spot on their foreheads as protection against the evil eye, and a *tabiz* (tiny copper case containing a religious verse, or a

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223. Islam, Sirajul 2006

224. Ibid.

225. Ibid.

226. Ibid.

holy man's words of blessing)" is secured around the baby's neck. <sup>227</sup> This tradition is believed to have roots in tribal prehistory. Other practices and superstitions that date back to prehistory are exorcisms of evil, cures for disease through incantation, and the belief of empty pitchers, broomsticks, cawing crows, and black cats to be bad omens. <sup>228</sup>

One important holiday celebrated by Muslims is *Eid-Ul Fitr*. This occurs at the end of Ramadan, lasts three days, and is recognized as a national holiday. A donation known as *fitra* composed of rice or wheat is donated to the poor. The men then make their way to mosques to pray for one another's "positions in society in the spirit of Islamic brotherhood." <sup>229</sup> An elaborate meal is prepared for lunch by the women and then in the afternoon people visit close relatives.

An important Hindu ceremony is that of *Durga Puja*. This festival begins in September when followers worship the goddess Durga by honoring a clay image of her. Young children will dance and sweets are handed out to all nearby communities. Believers wear new clothes and special dishes are prepared for eating. Hindus will also bathe in nearby rivers as a symbol of washing away one's sins. <sup>230</sup>

A national holiday known as National Day commemorates Bangladesh's independence from Pakistan in 1971. This holiday occurs on March 26 and is celebrated with "parades, sports and cultural functions." <sup>231</sup>

### Bangladesh Infrastructure

Bangladesh, although heavily populated, lacks a developed infrastructure. This lack of infrastructure can be blamed on economic reasons, natural disasters, and corrupt government officials. In order for Bangladesh to reach a middle class economic status by 2020, a reliable infrastructure needs to be set in place. <sup>232</sup>

Currently, the longest network road in Bangladesh is 204,022 kilometers (km) long, and the country has a high network density although most roads are dirt. Bangladesh also contains

227. Ibid.

228. Ibid.

229. Ibid.

230. Ibid.

231. Ibid.

232. United Nations ESCAP. 2011. Accessed April 9, 2010.

[http://www.unescap.org/drrpad/publication/lcdc\\_2121/lcdc\\_no4\\_text-6.pdf](http://www.unescap.org/drrpad/publication/lcdc_2121/lcdc_no4_text-6.pdf).

a railway network of 2,745km, measuring 718 million ton kilometers for freight services and 5,348 million kilometers for passenger services. Its civil aviation includes 135.7 thousand tons for freight services and 1.252 thousand for passengers.<sup>233</sup>

Telecommunication in Bangladesh is also a problem as there are only 2.6 telephones per 1,000 inhabitants.

Bangladesh also has a deficient supply of electricity despite the high demand. *Figure 6.* The supply of power is not always reliable as much of the power is supported by donors whose funding does not always arrive on time. Additional causes include a “lack of coordination between the gas and power sectors, lack of preventative repair and maintenance, and a weak governance of the system.”<sup>234</sup>

### Bangladesh Slum Reality

Forty percent of Bangladesh citizens fall below the poverty line and as a result its vernacular architecture is defined by the shanty towns in which these citizens reside. Located near its capital, Dhaka, is an array of shanty towns. An area known as Bashantek-Kafrul-Mirpur is a neglected area of the city filled with “squatter” homes for the poor. This area is heavily populated because it is the cheapest living area near Dhaka. It is estimated that 3.4 million people reside in the 5,000 slums here.<sup>235</sup> The people who live in this area tend to be “day laborers, rickshaw pullers, domestic workers, and garment workers.” Many of these workers are tied to Dhaka for their economic survival. According to a health survey, an estimated 93% of the residents of these temporary homes moved here from the outlying countryside for reasons including insufficient jobs, family conflict or violence, and the loss of land to either flooding or land erosion. These shanty towns do not provide safe living conditions for the 3.4 million residents whose estimated average monthly income is 56.4 USD. Chronic health problems including rheumatic fever, tuberculosis, leprosy, abscesses, epilepsy, disabled hands or legs, and kidney disease, persist in these often poor sanitation conditions.<sup>236</sup> The people here struggle to pay rent to live in these poorly built structures, which are under the constant

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233. United Nations ESCAP 2011, 6

234. *Ibid.*, p.6

235. Podymow, Tina, Jeff Turnbull, Mohammed A. Islam, and Mahmud Ahmed. “Health and Social Conditions in The Dhaka Slums.” Accessed April 6, 2010. <http://www.isuh.org/download/dhaka.pdf>.

236. Podymow 2010

threat of destruction ordered by the government. <sup>237</sup>

A system known as *basti* is used throughout these slums with the property owner charging rent for space where a person or family can build a bamboo dwelling. These “landlords” are often times not true land owners but rather “muscle men” who use force to stake claim to these lands. They pay no government taxes and do not monitor the conditions



Image70: Slum in Bangladesh

of the slums they run. Other charges on top of rent are for the use of the bathroom, electricity, drinking water, bathing water, gas, and “security fees.” These toilets are often holes dug outside one’s home, shared by 100 or more families, and bathing facilities are the river. <sup>238</sup>

### Holland Comparison

A country vastly different from Bangladesh is the Netherlands, yet this country can relate to the threats of sea level rise. Information about the Netherlands is provided here to provide a contrast to Bangladesh.

The Netherlands is located in western Europe, near the North Sea coast. *Figure 8* It is a

237. Amin, Aasha. “POVERTY IN BANGLADESH’S CROWDED CAPITAL. :: Contemporary Review :: 2009 -- Britannica Online Encyclopedia.” Encyclopedia - Britannica Online Encyclopedia. 2009. Accessed April 6, 2010. <http://www.britannica.com/bps/additionalcontent/18/37797200/POVERTY-IN-BANGLADESHS-CROWDED-CAPITAL>.

238. Podymow 2010



## A BANGLADESH GENERAL INFORMATION

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country with much of its territory in low lying areas. It has a total area of 41,543 km<sup>2</sup> with 33,893 km<sup>2</sup> in land area and 7,650 km<sup>2</sup> in water area. The Netherlands contains a temperate weather, with “cool summers and mild winters.” Land use is broken down into 21.96% for arable land, 0.77% for permanent crops, and 77.27% for other uses. Similar to Bangladesh, the Netherlands suffers from flooding issues as it too is located at the mouth of three contributing rivers: the Rhine, Maas, and Schelde. <sup>239</sup>

The Netherlands has a population of 16,847,007 as of 2011, yet unlike Bangladesh and most other countries, its growth rate remains relatively steady at 0.371% compared to Bangladesh’s 1.20%. Holland is ethnically 80.7% of Dutch ancestry, 5% European Union, 2.4% Indonesian, 2.2% Turkish, 2% Surinamese, 2% Moroccan, 0.8% Caribbean, and 4.8% classified as other. The religious makeup is 30% Roman Catholic, 11% Dutch Reform, 6% Calvinist, 3% Protestant, 5.8% Muslim, 2.2% other, and 4.2% non-religious. The literacy rate is set at 99% of the total population, and in comparison to Bangladesh’s 55% <sup>240</sup>, demonstrates a strong contributing factor to its economic advantage over Bangladesh. The Netherlands GDP also reveals its advantages with only 2.6% in agricultural practices and 24.9% in industry related fields, with the majority of their revenue coming from the service sector at 72.5%. The Netherlands also contains a low poverty rate at 10.5%, <sup>241</sup> while Bangladesh’s rate is 40%. <sup>242</sup>

Although intrinsically different from one another, both countries battle the onslaught of sea level rise, having already lost much of their land to the ocean. However, the two countries deal with this situation differently. What it means to be modern in one country greatly differs from the other. Bangladeshis accept water as a part of daily life. Living with water in one’s home is a testament to their attitudes toward nature and modernity. While Bangladeshis choose to reside with water, the Dutch idea of civility involves being dry. Large technological embankment systems have been set in place to keep water out and to recover low land areas. It is Bangladesh though that provides the most viable answer to sea level rise. To understand both sides, we must first understand the need for such a solution.

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239. Central Intelligence Agency. “Netherlands.” *The World Fact Book*. Accessed September 11, 2011.

<http://webcache.googleusercontent.com/search?q=cache:4tf0Mpc5EhYJ:https://www.cia.gov/library/publications/the-world-factbook/geos/nl.html+netherlands&cd=2&hl=en&ct=clnk&gl=us>.

240. “UNICEF - Bangladesh - Statistics.” UNICEF - UNICEF Home. March 2, 2010.

[http://www.unicef.org/infobycountry/bangladesh\\_bangladesh\\_statistics.html](http://www.unicef.org/infobycountry/bangladesh_bangladesh_statistics.html).

241. CIA 2011

242. “Bangladesh Population below Poverty Line - Economy.” *Index Mundi - Country Facts*. 2011. Accessed September 11, 2011. [http://www.indexmundi.com/bangladesh/population\\_below\\_poverty\\_line.html](http://www.indexmundi.com/bangladesh/population_below_poverty_line.html).

# B GLOBAL WARMING CONCERNS

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## Global Warming

Sea level rise is a natural result of global warming, an epidemic plaguing Earth's environment. The main cause of global warming is man's reliance on coal among other non-renewable energy sources. There are currently six main factors producing global warming: methane, carbon dioxide, halocarbons, nitrous oxide, black carbon, and VOCs. <sup>243</sup>

Methane gas is produced by the warming of the land located around the Arctic Ocean. As this land heats up, methane gas is released into the atmosphere. Microbes then digest the carbon contained in the tundra thus causing it to melt away. <sup>244</sup>

A new contributing factor is the dispersion of black carbon. Black carbon or soot, is not considered a gas but instead, tiny black particles present in our air. <sup>245</sup> It is produced by the burning of biomass such as forests and grasslands destroyed for agricultural purposes. This black carbon absorbs the sun's rays while prevailing winds carry them to the Arctic where they melt glaciers and snow cover. <sup>246</sup> Especially harmful to the environment are the forest fires of Siberia and eastern Europe, which contribute large amounts of black carbon that drift over to the Arctic. Additional contributors of black carbon include the "burning of wood, cow dung, and crop residue from South Asia and China [used] for cooking and heating." <sup>247</sup>

Two places specifically affected by black carbon are China and India. Both India and China go without rain for six months between monsoon seasons. The rain is imperative to these areas because it helps to wash the black carbon from the air. Although the rain provides a sound solution to the problem, it can't keep up with the production of this carbon. The six

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243. Gore, Albert. *Our Choice: a Plan to Solve the Climate Crisis*. Emmaus, PA: Rodale, 2009. 46.

244. Gore 2009, 41

245. *Ibid.*, p.41

246. *Ibid.*, p.41

247. *Ibid.*, p.42

## B GLOBAL WARMING CONCERNS

rainless months of intense exposure to black carbon are highly dangerous to the Himalayas and the Tibetan Plateau. These are two areas where the black carbon collects and ultimately melts the snow cover, causing a higher percentage of water flow down the adjacent streams. An estimate predicts that at this rate, 75% of all the glaciers of the Himalayas will disappear in less than ten years time. <sup>248</sup>

With the melting of snow cover and glaciers, Earth's albedo is lowered, allowing the sun's rays to penetrate and be absorbed. Currently, as much as 90% is reflected back into space thanks to our existing glaciers and snow cover. <sup>249</sup> In the case of Arctic ice, up to 70% of the sunlight is reflected back, leaving only 30% absorbed, but as the ice continues to melt

at an accelerated rate, leaving less surface area to reflect back, the ocean falls prey to the sun's rays. Only 6% is now reflected back, with 94% of the sun's heat absorbed. The warmed water then contributes to melting ice cover. <sup>250</sup>

As a result of global warming, storm surges are on the rise. As temperatures heat up, more energy radiates throughout the atmosphere, resulting in more frequent and destructive storms than in the past. An increase in major flood disasters is evident as 6 were recorded in the

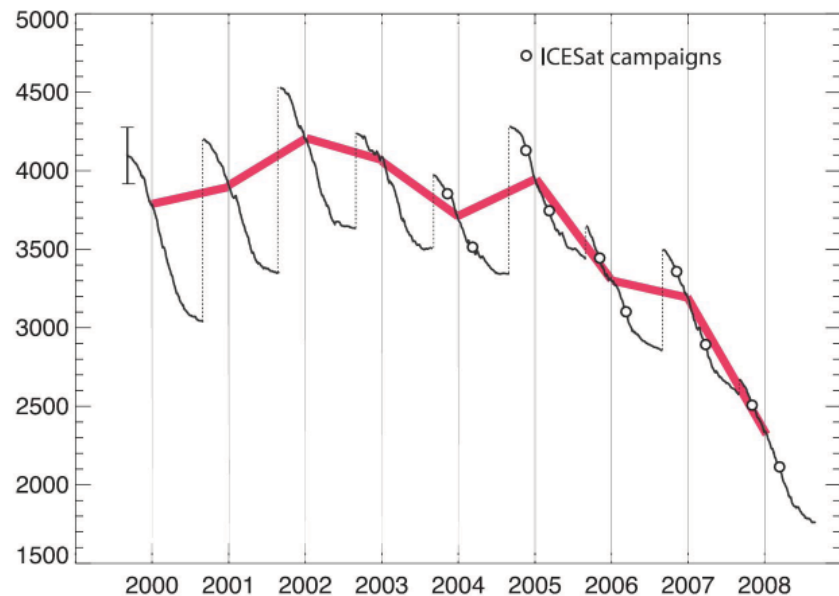


Image 71: Rapid loss of ice in the Arctic

248. Gore 2009, 42

249. Gore 2009, 45

250. Brown, Lester Russell, and Lester Russell Brown. *Plan B 3.0: Mobilizing to save Civilization*. New York: W.W. Norton, 2008. 58.

1950s and 26 in the 1990s. <sup>251</sup>

Irresponsible agricultural practices are also responsible for sea level rise. Farmers used to refresh nitrogen rich soil by planting legumes and using natural animal manure. Today, farmers use a synthetic ammonia fertilizer to replenish the nitrogen, which causes runoff into local streams, algae blooms, and oxygen depletion. This lack of oxygen in the water creates “dead zones” where fish and other aquatic animals cannot survive. <sup>252</sup>

Another factor contributing to sea level rise is the sudden growth in population. Within the last century, the population has risen at an alarming rate. In the 1900s, the population was set at 1.6 billion; in 2009, an astounding 6.8 billion people were recorded. <sup>253</sup>

Population increases in recent years have wreaked havoc on the environment. Ultimately, the more people there are in the world, the more CO<sup>2</sup> will be dispersed in the atmosphere. Many third world countries clear out forests to make way for agricultural fields, which in turn take away trees needed to absorb CO<sup>2</sup> and destroy a rich-biodiversity. The conversion of forests to agriculture fields also leads to less rainfall. <sup>254</sup>

Overpopulation also leads to the draining of fresh water supplies. The draining of reservoirs and aquifers of Mexico City is a prime example of the effects of overpopulation. In 2009, the city experienced a water shortage due to “low levels of rainfall, coupled with an inadequate infrastructure and rapidly growing population.” <sup>255</sup>

Urbanization also poses a threat to the environment and is of concern in relation to sea level rise. More than half of the world’s population lived in urban areas as of 2008 as compared to only 15% for most of the world’s history. <sup>256</sup> This trend is predicted to continue, especially in developing countries. Ninety percent of the population in third world countries is expected to develop in urban areas. While on a trip to Peru, I found this to be true. Most of the homeless people of Lima were actually farmers who migrated from the rural areas where they owned property. They chose a homeless lifestyle five days out of the week because they could

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251. Brown 2008, 63

252. Gore 2008, 49

253. Ibid., p.226

254. Ibid., p.231

255. Ibid., p.231

256. Ibid., p.231

make more money begging on the streets than working hard on their farms. <sup>257</sup> China's urban population has increased from under 200 million to more than 600 million within the last thirty years. Demographers predict that another 350 million people will be added during the next 15 years, which is more than the population of the entire United States. <sup>258</sup>

An intense concentration of people in one area produces issues of pollution and sanitation. Most urban cities are planned around cars and trucks serving as the main method of transportation instead of focusing on mass transit systems. "This leads to a higher concentration of concrete and asphalt, air pollution, higher energy use, and higher CO<sup>2</sup> emissions." <sup>259</sup> Most urban areas are located in low-lying coastal zones and as a result will be affected first when sea level rise begins to take over as a result of the "accelerated ice melting of Greenland and Antarctica [within] this century." <sup>260</sup>

Although populations have been increasing at an exponential rate, scientists are now finding correlations between income and population that they hope will slow down population growth. Higher income nations have considerably lower population growth rates than those of third world countries. This is because of four factors: "one, the widespread education of girls, two, the social and political empowerment of women to participate in the decisions of their families, communities, and nations, three, having higher child survival rates, and four, the ability of women to determine the spacing and amount of children they want." <sup>261</sup> Due to these four factors, scientists now predict a "stabilized population" of a little more than 9 billion people halfway through the 21<sup>st</sup> century. <sup>262</sup>

### Future Climatic Projections

The consequences of global warming have already appeared. Not ten years ago, the topic of climate change was a far away, future scenario. Continuation on our current path will result in a bleak future.

One of the main concerns for earth's future is sea level rise. This is an inevitable result of the melting of the world's glaciers and ice sheets, mainly those of Greenland, Antarctica, and

257. Matsukawa, Celeste. Peru visit 2009.

258. Gore 2008, 232

259. Ibid., p.236

260. Ibid., p.232

261. Ibid., p.229

262. Ibid., p.228

the Himalayans. The sea is currently projected to rise 12 meters if carbon emissions cannot be mitigated. This will result in dire consequences leaving most coastal cities underwater and forcing the relocation of over 600 million people, or one-eighth of the world's urban population.<sup>263</sup> Seven of the 12 meters of sea level rise would be due to the melting of Greenland's sheet ice, while the remaining 5 meters would be a result of the melting of the west Antarctic ice sheet.<sup>264</sup> IPCC projections calculate that within this century alone, 2 meters of sea level rise will occur. Bangladesh is the second most vulnerable country to sea water rise with an estimated displacement of 62 million people. China has a projected refugee count of 144 million people; India, 63; Vietnam, 43; Indonesia, 42; Japan, 30; Egypt, 26; and the United States, 23.<sup>265</sup> Overcrowding will ensue as the world's land mass shrinks. We must plan for future conditions now to ensure our survival, and since the sea covers the most area, it is naturally our most viable solution for livable space.

It is believed that there is no hope of recovering what ice we have lost. U.S. National Snow and Ice Data Center researcher Walk Meier believes that we have reached the "arctic tipping point." It is at this already doomed stage that predictions are made for the Arctic Ocean to be completely ice-free as of the summer of 2030.<sup>266</sup>

### Future of Bangladesh in Terms of Sea Level Rise

Bangladesh already has 90% of its land mass located in flood plains. It is currently losing land due to erosion at a rate of 19,000 acres a year, affecting one million people both directly and indirectly. With a 1 meter sea level rise, 15% to 20% of Bangladesh, or 14,000 to 30,000 square kilometers, will be inundated, displacing 13 million people.<sup>267</sup> With the current factors affecting Bangladesh, scientists expect a permanent loss of 15,600 square kilometers of land with a sea level rise of 45 centimeters. An increase of river flooding is also expected to occur as rivers will then drain into the ocean at a slower rate due to the concurrent rise in sea waters. This will ultimately lead to sanitation problems which in turn can cause a number of diseases to plague local populations. Diseases such as Cholera and Malaria are expected as a

263. Brown 2008, 48

264. Ibid., p.56

265. Ibid., p.60

266. Ibid., p.58

267. Braash, Gary. "Bangladesh Report." Global Warming, Photography, Pictures, Photos, Climate Change, Impact, Science, Weather, Arctic, Antarctica, Climate Zones, Glacier, Arctic Warming, Antarctica Warming, Documentation, Effects, Effects of Climate Change, Paleoclimate, Mountain Glaciers, Coral Reefs, Tide Pools, Phenology. Accessed April 8, 2010. <http://www.worldviewofglobalwarming.org/pages/bangladeshreport.html>.

## B GLOBAL WARMING CONCERNS

consequence of still waters attracting mosquitoes. <sup>268</sup>

In addition to displacing millions of people, sea level rise will severely affect the ecosystem and agriculture in particular. Production of rice will decrease as salinity levels in the soil deter crops from growing, and the production of vegetables such as lentils and

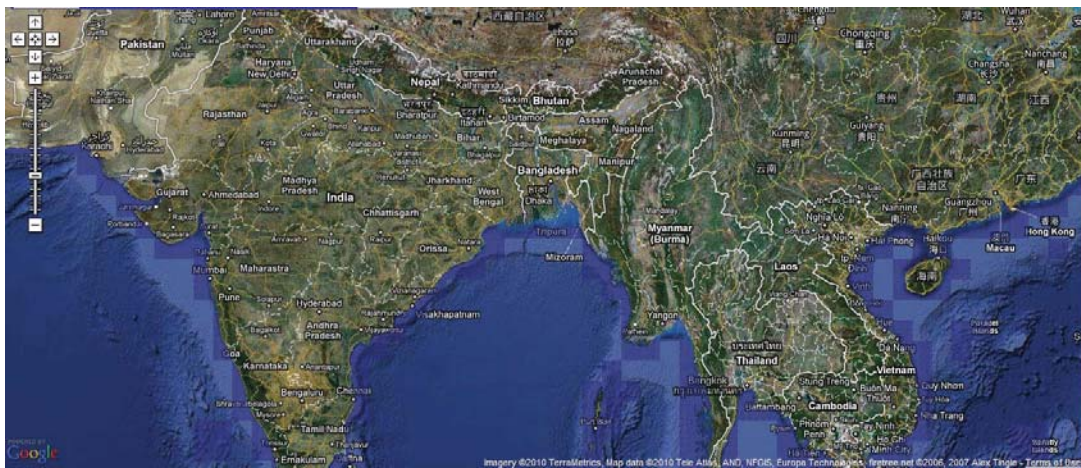
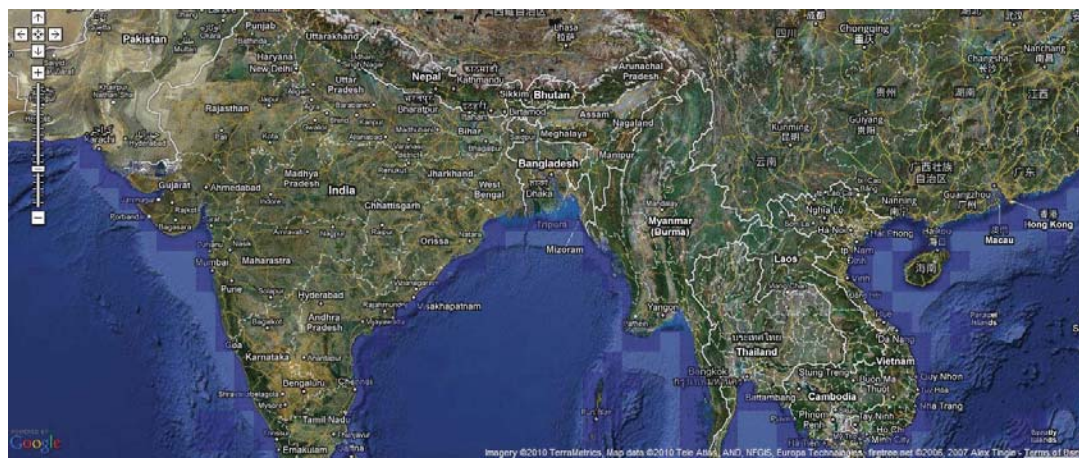


Figure 12: 0M Sea Level Rise Bangladesh

Image 72: current conditions of Bangladesh sea level

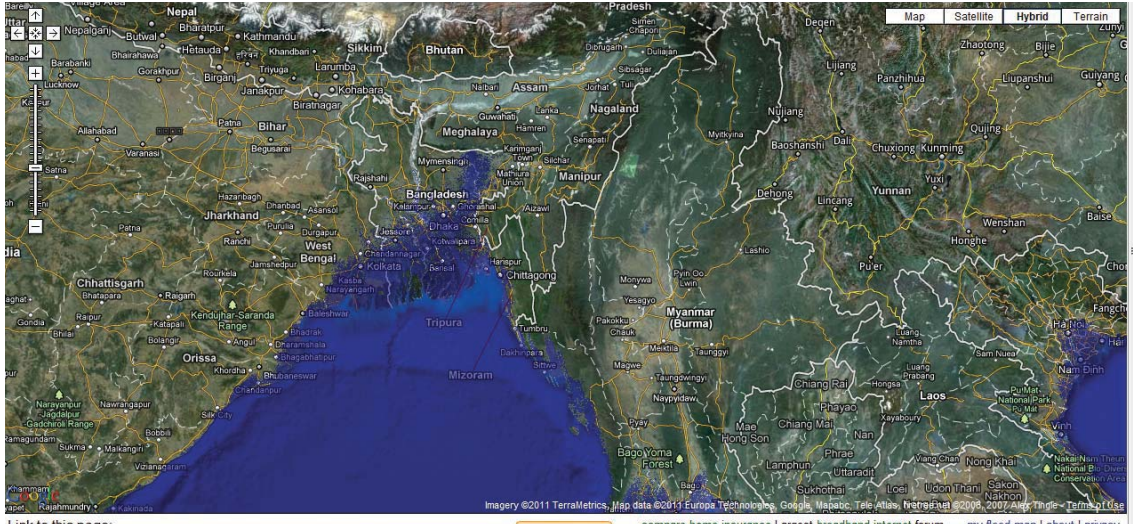


1M Sea Level Rise Bangladesh

Image 73: 1meter sea level rise Bangladesh flood map

268. "Sea Level Rise in Bangladesh and the Netherlands." GERMANWATCH. Accessed April 8, 2010. <http://www.germanwatch.org/download/klak.fb-ms-e.pdf>.

## B GLOBAL WARMING CONCERNS



9M Sea Level Rise Bangladesh

Image 74: 9m sea level rise Bangladesh flood map.

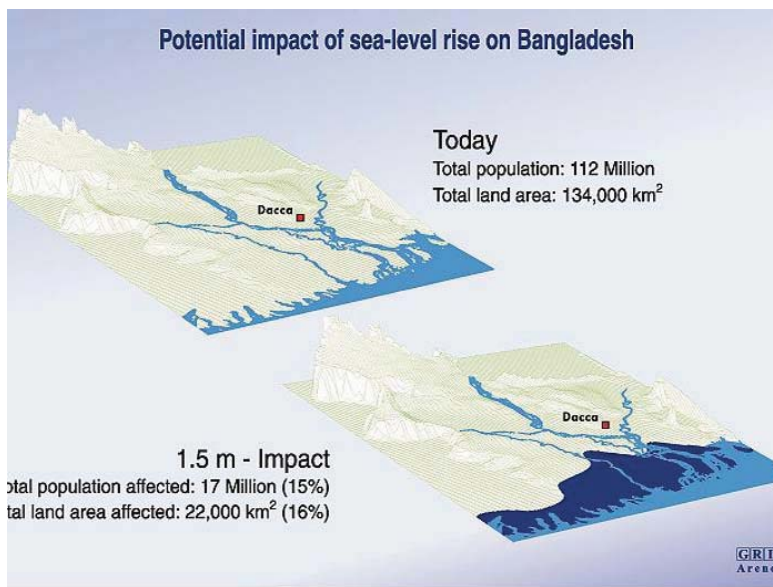


Figure 13

Image 75: Sea level rise impact

onions is also expected to be dramatically decreased. Wildlife located in the Sundarbans will also be at risk. At risk species include Bengal tigers, hundreds of bird species native to Bangladesh, marine turtles, crocodiles, and fresh water dolphins. Bangladeshis also depend on the Sundarbans as a main source of food and natural resources for 2 million people. The mangrove swamp areas provide Bangladeshis with needed crab, fish, honey, shells, and wood. The Sundarban also serves as a



barrier against rising waters. <sup>269</sup> Documenter Gary Braasch visited the area south of Dhaka on a trip in 2005 and recalls architecture already going under. A local mosque no longer exists as it was destroyed by sea level rise. <sup>270</sup>

Bangladesh's loss of land is often seems more critical and severe when compared to its counter crisis country, the Netherlands. Bangladesh doesn't have a dyke system to hold the water back for both economic and cultural reasons. It loses more copious amounts of land in comparison because of a number of factors; flooding in Bangladesh occurs more often, monsoon seasons bring heavy rainfall, tropical cyclones are frequent, and tectonic movements have doubled to quadrupled the speed of land loss.

There are already noticeable changes occurring around the Bay of Bengal. Just recently, it was discovered that an island known as South Talpatti Island, is completely underwater. Scientists such as Professor Hazra of the School of Oceanographic Studies at Jadavpur University in Calcutta, reports that sea level rise increases in the Bay of Bengal at a faster rate than any other place and that the "disappearance" of South Talpatti island is a prequel to the disappearance of other small islands in the area. <sup>271</sup>

### Temperature Rise

Globally, temperature has risen dramatically with the 23 warmest years recorded since 1880 beginning in 1980, according to NASA. Scientists at the Intergovernmental Panel on Climate Change (IPCC) predict that the average temperature of the earth will increase from 1.1 to 6.4 degrees Celsius this century, <sup>272</sup> doubling the average rate of warming over continents than previously experienced during

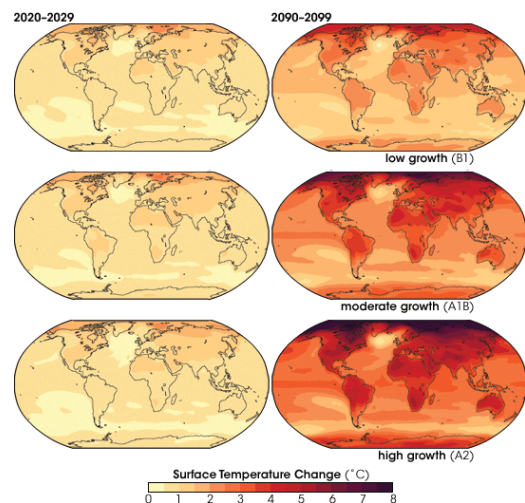


Image 76: Rising Temperatures

269. German Watch, accessed April 8, 2010

270. Braasch, accessed April 8, 2010

271. "BBC News - Disputed Bay of Bengal Island 'vanishes' Say Scientists." BBC News - Home. 2010. [http://news.bbc.co.uk/2/hi/south\\_asia/8584665.stm](http://news.bbc.co.uk/2/hi/south_asia/8584665.stm).

272. Brown 2008, 50

## B GLOBAL WARMING CONCERNS

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the 20<sup>th</sup> century. <sup>273</sup> This increase in temperature will not be evenly distributed throughout the world, as most of the heat will reside over land rather than bodies of water, at high northern latitudes rather than the equator, and in continental interiors rather than coastal regions. <sup>274</sup> These increases will be particularly evident in “most of North America, all of Africa, Europe, Northern and Central Asia, and most of Central and South America.” <sup>275</sup> These temperatures will likely “diminish crop yields, melt the snow/ice reservoirs in the mountains that feed the earth’s rivers, cause more-destructive storms, increase the area affected by drought, and cause more frequent and destructive wildfires.” <sup>276</sup> Increased temperatures have also resulted in an increase in drought occurrences. This has led to an increase in arable land area of 15% to 30% from 1970 to 2002, according to the National Center for Atmospheric Research. These droughts are accredited to both temperature rise as well as a reduction of precipitation. These episodes of newly developed arable land have occurred in Europe, Asia, Canada, Western and Southern Africa, and Eastern Australia, according to scientist Aiguo Dai. <sup>277</sup>

Agriculture is also affected by rising temperatures. Higher temperatures affect soil conditions, drying it out during summer months. Photosynthesis is also affected, resulting either in the deterrence of pollination or the end of photosynthesis all together. This will lead to crop dehydration and lower food production. With an increase of 1 to 2 degrees Celsius, grain harvest will *shrink* in places such as the North China Plain, the Gangetic Plain of India, and the U.S. Corn Belt. <sup>278</sup>

Rainfall is also affected by rising temperatures. According to Shang-Ping Xie, scientist at the International Pacific Research Center at the University of Hawaii, rainfall will be dependent on tropical average temperatures. He is quoted as saying, “The new rule is if local warming is greater than the tropical average, then you can expect to have more rain, whereas if your place is warming at a rate slower than the tropical average, you will see a drop in rainfall.” Currently, it appears that the northern hemisphere warms up more than the southern hemisphere. <sup>279</sup> However, possible countries affected by a limited supply of rainfall include

273. “Future Climate Change - Future Temperature Changes | Science | Climate Change | U.S. EPA.” US Environmental Protection Agency. Accessed April 1, 2010. <http://www.epa.gov/climatechange/science/futureetc.html>.

274. Brown 2008, 50

275. United States Environmental Protection Agency, Accessed April 1, 2010

276. Brown 2008, 50

277. *Ibid.*, p.50-51

278. *Ibid.*, p.52

279. Altonn, Helen. “Hawaii News Archive - Starbulletin.com.” Hawaii Archives - Honolulu Star-Bulletin Archives - Starbulletin.com - Archives.starbulletin.com. Accessed March 25, 2010. [http://archives.starbulletin.com/content/20100316\\_Climate\\_predictions\\_shift](http://archives.starbulletin.com/content/20100316_Climate_predictions_shift).

Bangladesh, which is in the southern hemisphere.

With the increase of arable land and continued crop failure, people might have to turn to the sea for agriculture. Floating agriculture may have a cooling effect on crops, as compared to the temperature increase occurring on land. As most of the river delta lands are flooded with sea water, the added level of salinity to fresh water sources will also likely deter crop production. This paired with high populations residing in what little land is left will leave little to no land for agricultural purposes.

Staples such as rice, wheat, and corn will be drastically affected by temperature rise according to research by the International Rice Research Institute. The rise of 1 degree Celsius above normal conditions will lower crop production by 10 percent.<sup>280</sup> This coupled with the increase in population will have drastic consequences resulting in the starvation of many. Just 1 meter of sea level rise in Bangladesh will destroy half of its rice paddy fields, according to the World Bank.<sup>281</sup>

With an increase in temperature of 1 degree Celsius, flooding will also increase significantly. Snow fall will decrease while precipitation will increase, allowing for copious amounts of water during the rainy season. Meanwhile, glaciers will continue to melt with increased temperatures. Seventy percent of the Ganges River is composed of the Gangotri Glacier, and with its continued rate of melting, the Ganges is destined to become a seasonal river, "flowing only during the rainy season,"<sup>282</sup> with only decades left of flow. Four hundred and seven million people in Bangladesh and India will be directly affected by this as the Ganges provides these people with their fresh water supply.<sup>283</sup>

The termination of one's water supply equates the displacement of one's self. Settlements are arranged around water supplies because water provides sustenance in terms of crop production and drinking water. The absence of water will force communities to either relocate or starve. The already crowded country of Bangladesh cannot afford to lose livable land areas as it is the fastest growing country in the world with a concentration of 1,146 people per square kilometer.<sup>284</sup>

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280. Brown 2008, 53

281. Ibid., p.66

282. Ibid., p.54

283. Ibid., p.54

284. Google. "Public Data explorer: Bangladesh, Fertility Rate." Accessed February 24, 2010

Along with the devastating loss of land, Earth's freshwater sources are running out. Part of the cause for this shortage stems from the tripled demand for water in the last half-century, which resulted in the drilling of millions of irrigation wells.<sup>285</sup> Largely due to rising temperatures, evaporation rates have increased, leading to different rainfall patterns as well as melting glaciers that affect rivers during dry seasons.

According to BBC News, Bangladesh will soon experience a different set of monsoon rains than traditionally experienced. Scientists predict that the monsoon rains of the area will be concentrated in shorter periods of time, creating more extreme flooding as well as longer periods of drought. With the increase of sea level rise, an astounding 30 million people will be displaced, resulting in "climate refugees." Flooding and droughts in Bangladesh have already forced Bangladeshi families to relocate to shanty towns in Delhi, Calcutta, and Bombay, which has in turn affected the Indian economy. This increase in population will no doubt have an impact on India's agriculture, infrastructure, and healthcare. India's inhabitable land areas won't be able to keep up with these new demands for space, which will lead to overcrowding, violence, and issues of sanitation.<sup>286</sup>

### Loss of Culture

With the loss of land comes the displacement of nations all over the world. I believe this will lead to a "flattening effect"<sup>287</sup> and a loss of culture. Due to the current climatic changes, it is estimated that close to one billion people will be displaced in the next 50 years.<sup>288</sup> With population rates on the rise, a scarcity of jobs could transpire, leading to political instability. This could also lead to large groups of immigrants moving into countries with different cultures, values, and beliefs, which could potentially lead to violence as conflicts arise.<sup>289</sup> An example of this was the immigration of a large number of Chadians "into the Darfur region of western Sudan."<sup>290</sup> Secretary General of the United Nations, Ban Ki-Moon, stated that the environmental changes of Lake Chad were responsible for the violence that occurred in Darfur.

Lake Chad significantly dried up due to multiple droughts, and as a result, Chadians had no

285. Brown 2008, 68

286. Harrabin, Accessed February 29, 2010

287. Friedman, Thomas L. *The World Is Flat: a Brief History of the Twenty-first Century*. New York: Farrar, Straus and Giroux, 2005.

288. "What Is Solastalgia? § SEEDMAGAZINE.COM." SEEDMAGAZINE.COM. July 31, 2008. Accessed February 11, 2010. [http://seedmagazine.com/content/article/what\\_is\\_solastalgia/](http://seedmagazine.com/content/article/what_is_solastalgia/).

289. Gore 2008, 240

290. *Ibid.*, p.240

choice but to venture into neighboring Darfur.

The loss of one's country results in many long term effects as well. There are reports of Australian aborigines, Navajos, and other indigenous people who felt a "sense of mournful disorientation after being displaced by their land."<sup>291</sup> Disorientation can even occur in one's own backyard. A new term arising in the midst of the environmental crisis is "solastalgia (sō-lă-stăl-jə)" meaning "a pain or discomfort caused by the present state of one's home environment."<sup>292</sup> It is a combination of three words put together: solace, desolation, and nostalgia.<sup>293</sup> The term first arose in New South Wales of Australia, around the early 2000s. Environmental philosopher Glenn Albrecht came up with the term after analyzing the psychological effects the changing environment had on its residents. He described their feelings as "a form of homesickness one gets when one is still at home."<sup>294</sup> New South Wales was experiencing an invasion of miners digging up their land for coal. Previously known as the "Tuscany of the South," it is now in a constant state of destruction. Plumes of gray dust cover the area landing on rooftops, agricultural fields, and even livestock as explosives are set off several times a day.<sup>295</sup> "Albrecht predicts that physical and mental illness related to the environment will increase dramatically."<sup>296</sup>

### Case Study: New Orleans and Katrina

On August 28, 2005, one of the most tragic hurricanes in history struck the Gulf of Mexico, landing in Southern Plaquemines Parish, Louisiana. Katrina was classified as a category 5 storm with winds reaching up to 125 miles per hour (mph).<sup>297</sup> Storm surge waters broke through levee systems causing 80% of the city to be inundated.<sup>298</sup> The hurricane resulted in 1,836 deaths and \$110 billion in damages.<sup>299</sup> The initial destruction began with a tiny leak in

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291. Smith, Daniel B. "Is There an Ecological Unconscious? - NYTimes.com." The New York Times - Breaking News, World News & Multimedia. January 27, 2010. Accessed February 8, 2010. <http://www.nytimes.com/2010/01/31/magazine/31ecopsych-t.html?scp=1>.

292. SEED 2005-2011

293. Ibid.

294. Smith 2010

295. SEED 2005-2011

296. Ibid.

297. NOAA. "Urrricane Katrina." NOAA Home Page - Hurricane Katrina. Accessed March 12, 2010. <http://www.katrina.noaa.gov/>.

298. NOLA.com. "Katrina: the Storm We Always Feared." 2008. Accessed March 3, 2010. <http://www.nola.com/katrina/archive.ssf>.

299. "Hurricane Katrina Frequently Asked Questions from Hurricane Katrina Relief." Hurricane Katrina Relief - Hurricane Katrina Relief.com. Accessed March 2, 2010. <http://www.hurricanekatrinarelief.com/faqs.html>.

the Interstate 10 high-rise at around 4:30am, which led to the collapse of the floodwalls located on 17<sup>th</sup> Street and London Avenue between 9:30am and 10:30am. As many as “thirty breaches in the system accounted for 84 percent of the metro area flooding, with most of the water coming from the big gaps along the 17<sup>th</sup> Street, London Avenue, and Industrial canals as well as holes in the Mississippi River-Gulf Outlet and Gulf Intracoastal Waterway levees and a gap in the Orleans Avenue outfall canal that flooded much of the City Park area.”<sup>300</sup>

The initial leak should have been held back but the metal gates issued to avert such leaks were damaged by a derailment and so sandbags were used in their place. At 5:00am, the storm surge hadn’t yet breached the levees, but 5 to 7 foot waves pounded against the “poorly” built structures. At dawn, the structure finally gave in and began to crumble. At 6:10am, Hurricane Katrina touched land, arriving at Buras, “the west bank of the Mississippi River in Plaquemines Parish.” “As the storm [proceeded] north with a counterclockwise rotation, high winds from the northeast [drove] a 21-foot surge that roll[ed] over the eastern half of Plaquemines and the river, then over the levees on the west side of the river.”<sup>301</sup> At 6:30am, the MR-GO storm surge met up with the Gulf Intracoastal Waterway in new Orleans, an event which is now known as “the funnel.”<sup>302</sup> The two surges squeezed through a narrow passageway of levees consequently increasing the moving water’s velocity as well as tearing down the levees along its way. At 6:50am, the rushing waters flowed over floodwalls “on both sides of the canal, heading into the Lower 9th Ward, upper St. Bernard Parish, the Upper 9th Ward, Gentilly, Bywater, Treme and even into Broadmoor.”<sup>303</sup> From 7:30am, the flood continued for 12 to 15 hours, reaching areas in the “Upper 9th Ward, Bywater and Treme.”<sup>304</sup> At 10:30am, the last levee was breached as “a section of the I-wall south of Robert E. Lee Boulevard on the west side of the London Avenue Canal [came] down, sending an 8-foot wall of water through homes in Gentilly and contributing to the rising flooding across the city.”<sup>305</sup>

### Sense of Place

Both Louisiana and New Orleans held “the highest rates of nativity in the United States,” meaning people born there tended to remain in their hometowns. Executive Editor

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300. NOLA 2008

301. Ibid.

302. Ibid.

303. Ibid.

304. Ibid.

305. Ibid.

## B GLOBAL WARMING CONCERNS

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Barbara L. Allen of "New Orleans and Katrina: One Year later," feels that "Their attachment to 'place' is [a] part of the identity of these citizens and is not easily changed." Allen coined the term "performative regionalism" to describe a sense of place defined as "a collection of shared identities, behaviors, and practices that circumscribe local public cultures and spaces." She feels that although rebuilding the physical state of New Orleans is important, it is a shallow victory compared to the task of rebuilding the culture. She does believe that people have the "ability to adapt and retrofit environments for their cultural needs."<sup>306</sup>

Southern historian C. Vann Woodward describes the character of the South as being unique from the rest of the United States, claiming four areas "where the Southern



Image 77: New Orleans flood damage.

'consciousness' differs from the rest of the United States." The first three reasons are that Southerners have molded their world around poverty, defeat, and slavery rather than abundance, invincibility, freedom, and liberty. The last difference is the connectedness

306. Allen, Barbara L. "New Orleans and Katrina: One Year Later." *Journal of Architectural Education* 60, no. 1 (2006): 4-6. doi:10.1111/j.1531-314X.2006.00066\_1.x. Pg. 4



Image78: New Orleans flooding

Southerners feel to their home, as compared to a mindset of mobility present in other states. These characteristics prove true as evident in the works of famous Southerners such as writer Eudora Welty who writes, "I am myself touched off by place. The place where I am, the place I know....place opens a door in the mind."<sup>307</sup> The tragic loss of life, architecture, and infrastructure led to the displacement of 1 million people, 290,000 of which have still not returned home.<sup>308</sup>

This incident serves as a preview of events to come. New Orleans has a unique culture and history and is a vital part of the American identity and culture. It is similar to Hawai'i in terms of having a unique sense of place. Hawai'i's rich culture and history could potentially be lost if sea level rise were to wipe out the tiny island state.

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307. Allen 2006, 4

308. Brown 2008, 62



# C VERNACULAR ARCHITECTURE

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The following research was conducted to obtain the understanding and cultural sensitivity necessary to design for a cultural context that is not my own. I believed that studying topics relevant to vernacular architecture would enable me to design an appropriate system of living for the char people.

There are many questions raised in this paper, questions that I may not be able to answer, but that ultimately bring to light issues surrounding the vernacular. In conjunction with the theoretical framework surrounding the vernacular, case studies will be examined to assist me in my pursuit of a balance between the historic and the new. Some questions I hope to answer are: 1. Where is the defining line between the traditional and the new? 2. What aspects of culture need to be kept separate and what aspects can be combined to create a new regional vernacular? 3. How can an outsider successfully design a vernacular structure? 4. What building materials will prove useful for the char lands of Bangladesh?

Through the use of local building materials and native construction techniques, one is able to embed a cultural, environmental, and historical context within a structure. Vernacular architecture is the key to sustaining cultural identities, helping to define a unique sense of place by counteracting today's globalized "flattening" effect.<sup>309</sup> This is not to be understood as a standstill, preservation of culture in a defined setting or time, but rather, as a means of continuation and growth while still maintaining unique characteristics. Through a continuity of the vernacular, cultures are able to ensure a type of permanence, one that will be passed down through generations to come.

## Regionalism

Regionalism can be defined as *continuity through change*. It is a unique sense of place

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309. Friedman 2005

created over time within a culture that has evolved through the influence of outsiders leaving their mark on the region. This amalgamation is evident in “Replications of the model [that] provide those essential elements of continuity through change by which cultures measure their lineage. Transformations of building form are the imprint made on these enduring models by the more particular circumstances of place, programme and history, as interpreted by the builders of the day.”<sup>310</sup> Most vernacular structures are not pure products of tradition nor do they aim to be. Unless rarely isolated from other cultures, outside influences have tended to leave an impression, creating a unique sense of place. This blend is not to be feared or protested, but rather serves as an inevitable and natural evolution of culture. I believe no example of a pure culture exists; it is outside influences, good and bad, that help to mold and shape an individual identity.

Many foreign influences come from contact through trade, conquest, or pilgrimage. A culture’s historical background is therefore visibly displayed through its architecture. One example of this is the vernacular built environment of Malaysia. The stilt homes there reflect cultural influences both imposed upon and adapted by the Malay. “The distinctive tiled stairways of the Malacca houses, for example, derive from the architecture of Chinese immigrants who also settled in the Malacca Straits.”<sup>311</sup> Even the colonial architecture of Malaysia differs from forms elsewhere. British conquerors adjusted their traditional buildings to accommodate local weather conditions of Malaysia. Taking notice of Malaysia’s open design that allowed for passive cooling resulted in a blending of the two, and created a new style of architecture native only to the region, a style now representational of such.<sup>312</sup>

With the surmounting issues surrounding globalization, a renewed interest in the vernacular has arisen among architects looking to translate the values of past buildings into today’s built environment. To discuss the modern vernacular, one must understand its derivative, the modernist movement. Criticism of modernism includes the lack of attention given to cultural context. Modernist principles contribute further to a global identity, ignoring unique cultural characteristics pertinent to architectural design.

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310. Abel, Chris. *Architecture and Identity Responses to Cultural and Technological Change*. Oxford: Architectural Press, 2000. 169.

311. Abel 2000, 165

312. *Ibid.*, p.168

### Modernist Roots

Although criticized as creating a global identity, many of the principles of modernism arose from past examples of the vernacular according to architectural historian Sigfried Giedion.<sup>313</sup> “Architects such as CFA Voysey who stressed the glory of nature and simplicity of life, helped to lay the foundation for Modernism.”<sup>314</sup> He warns of “the danger[s] of architects taking inspiration from [the] vernacular [that] the approach to the past only becomes creative when the architect is able to enter into its inner meaning and content.”<sup>315</sup> I wonder if it is possible to fully understand a culture, ignoring the use of one’s own cultural views as there are cultural concepts that don’t always translate to outsiders.

### Renewed Interest in the Vernacular

Part of the reason for the sudden interest in vernacular principles is the lack of architectural ideological framework, degrading the architecture of today “to the status of fashion, where new materials and styles come and go as fast as the latest skirt length.”<sup>316</sup> There have been some recent initiatives taken to reform modernism, attaching vernacular facades to modernist structures. These represent poor examples of the reformed movement. One example of this is “hat” architectural styles in which modern buildings are assigned roof structures to reflect the indigenous culture.<sup>317</sup>

A successful example of the new vernacular movement is the work of architect Alvar Aalto.

Aalto’s work, which became well known in the 1930s, showed that the conflict between universal ideas of Modernism and the specific characteristics of place could be resolved through design. While his buildings were directly inspired by the curved contours of Finnish lakes and drew on local materials, they also appealed to modern internationalist sensibilities and embraced standardization. Aalto’s work, characterized as ‘new regionalism’ by Giedion, showed that architecture could adopt the spirit of the vernacular without

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313. Richardson, Vicky. *New Vernacular Architecture*. New York: Watson-Guption Publications, 2001. 14.

314. Richardson 2001, 10

315. *Ibid.*, p.15

316. *Ibid.*, p.17

317. Abel 2000, 170

resorting to mimicking its forms. <sup>318</sup>

Other successful examples of new regional architecture are the works of Geoffrey Bawa of Sri Lanka, Jimmy Lim of Malaysia, and the Kampulan Akitek Group in Singapore. <sup>319</sup>

All societies are able to function within the social clues that direct appropriate acts of behavior. These clues tend to be understated in vernacular societies because they are a homogenous blend of people, usually consisting of smaller numbers than their western counterparts, so clear definitions of culture are understood without the need for a gaudy displays of such.

Common to all types of vernacular architecture are three levels of *meaning*. The highest level includes elements pertaining to the "sacred, cosmological, world views and philosophies," the mid level contains elements of "identity, status, wealth, and power," and the third and lowest level of *meaning* concerns issues of the "everyday, instrumental meanings... such as social situations, expected behavior, privacy and accessibility, seating arrangements, movement, and way-finding." <sup>320</sup> Mid-levels of meaning are not important in vernacular societies as these characteristics tend to be fixed and are known rather than shown. High levels of meaning are defined through a clear separation of the ordinary. This may occur in two ways: through the use of archaic forms or as a means of "using new forms and materials." <sup>321</sup>

Most rural cultures define and organize space through geomantic beliefs often based on non-calculated scientific realities and defined by a higher power, which allow cultures to explain the unknown. At what point do cultures consider these interpretations archaic pagan beliefs, dispelled by scientific thought, or do they translate into modern religious beliefs?

Geomancy by definition is "divination by means of lines and figures or by geographic features." <sup>322</sup> Geomancy first arose in the Middle East in the 9<sup>th</sup> century AD. It then spread throughout Europe during the 11<sup>th</sup> and 12<sup>th</sup> centuries alongside other art and science fields.

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318. Richardson 2001, 15

319. Ibid., p.15

320. Oliver, Paul. 1997. *Encyclopedia of vernacular architecture of the world*. Cambridge: Cambridge University Press. Pg. 92

321. Oliver 1997, 93

322. "Geomancy - Definition of Geomancy by the Free Online Dictionary, Thesaurus and Encyclopedia." Dictionary, Encyclopedia and Thesaurus - The Free Dictionary. Accessed March 29, 2011. <http://www.thefreedictionary.com/geomancy>.

Some geomantic fields include “astrology, alchemy, and magic by the rapidly civilizing West.”<sup>323</sup> Geomancy is referred to in Arabic as *ilm al-raml*, which translates as “The science or wisdom of the sand.”<sup>324</sup>

*Feng shui* is a popular geomantic cultural belief of the Chinese. It was an early practice/belief of interpreting the cosmos in order to find a balance between man and nature. “Fengshui sees man and nature as a linked unit within an inherent order.” The natural world was viewed as “a system of balanced forces, react[ing] to every disturbance that happens in it or to it.” The compass was developed thus to deal with these different conditions,<sup>325</sup> and observations of natural occurrences such as wind flow and rainfall provided spiritual and scientific rationality for situating a building in a particular way.<sup>325</sup>

The transmission of knowledge is the key to passing on one’s culture. There are two methods through which this transmission may occur—either in oral or written forms. “In all societies, traditions are valued for the continuity that they symbolize between the past and the present.”<sup>326</sup> These traditions are expressed through “settlement organization and orientation, rites of dedication, building types, structural systems and roof forms, technologies and techniques of construction, specialized and gender roles of builders, the relationship of significant spaces, and the elements that are decorated or have symbolic value.”<sup>327</sup>

One key term associated with the transference of knowledge from one generation to the next is *tradita*. Tradita is considered to be “building types, technologies, [or] skills from the past which persist to the present.”<sup>328</sup> The strong connection between the built environment and continuity of culture in illiterate populations that use mainly oral traditions is underscored by literate cultures’ lack of reliance on their built environments for ensured continuity. Literate cultures won’t lose their societal values if their built environment is destroyed as these traditions and technologies manifest themselves in other forms.

There are many sustainable aspects embedded in the construction of vernacular

323. Warnoq, Christopher. “Astrological Geomancy.” Renaissance Astrology Christopher Warnock Horary Astrology Electional Astrology Astrological Magic Traditional Astrology. 2006. Accessed September 13, 2011. <http://www.renaissanceastrology.com/astrologicalgeomancy.html>.

324. Warnoq 2006

325. Zwerger, Klaus. *Vanishing Tradition: Architecture and Carpentry of the Dong Minority of China*. Bangkok: Orchid Press, 2006. 10.

326. Oliver 1997, 117

327. *Ibid.*, p.117

328. *Ibid.*, p.117

architecture. Many communities believe in creating harmony between built and natural environments. Local building techniques utilize natural materials found on site, ephemeral materials that pose no harm to nature. Some nomadic communities' migrations are based on an understanding of renewal, never entirely depleting one location of its natural resources.

Nomadism is defined "in reference to populations (human and other) who effect periodic or cyclical displacements in space to pursue economic, religious, political or military activity, in contrast to sedentary societies whose dwellings are fixed in space over their lifetime."<sup>329</sup> Nomadism operates in a number of ways including migration, pastoralism, transhumance, semi-nomadism, semi-sedentarism, ambulance, and itinerancy. No matter the mode, the basic principle behind it is survival and an ensured continuity of culture and lifestyle. These lifestyles, in combination with cultural beliefs, are also subject to wildlife patterns that dictate travel. Nomadic cultures usually consist of "hunters, gatherers, herders, or fishermen" who follow their game from either season to season or year to year; their movements are ultimately determined by environmental elements such as "climate, water resources, or topologies."<sup>330</sup>

All nomadic architecture shares similar design qualities. All have to be quickly constructed, most containing simple layouts of a single space. Nomadic builders also share a similar understanding of location and the home. Although the home is erected at different locations, it is situated in the best orientation and is intended to create a home environment. This sense of "home" is thus disconnected from any geographic location and retained more through a mental understanding.<sup>331</sup>

There is also a distinction between transportable and temporary structures. Transportable structures are constructed with the same amount of attachment as permanent structures, containing the "same [amount of] investment in time and energy."<sup>332</sup> Temporary structures don't hold the same value that transportable structures do and are usually abandoned during migrations. Transportable structures can then be categorized into either demountable or portable structures. Demountable structures are defined as "those which must be dismantled for transportation such as the tent and the yurt."<sup>333</sup> All demountable structures

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329. Ibid., p.95

330. Ibid., p.95

331. Ibid., p.811

332. Ibid., p.810

333. Ibid., p.811

have an internal organization relating to religious or symbolic beliefs that are dictated by the environment. For example, most doors are oriented towards the cardinal points in order to avoid prevailing winds and each contains defined spaces for sleeping, cooking, and storage. Also, a building that must consistently be rebuilt at each site contributes to the longevity and continuation of a culture with the regular practice of assembly. <sup>334</sup>

### Case Studies

#### Hadza

The Hadza community is one of the last remaining hunter-gatherer societies. Some have settled in towns, but nearly 1/4 of the population still remain as true hunter-gathering societies, following traditions of their past. This includes about 21 tribes roaming Tanzania, with about 30 people per clan. <sup>335</sup> They wander a land area of about 2,500 square kilometers (km<sup>2</sup>) with an estimated population density set of 0.24/km<sup>2</sup> per person. <sup>336</sup> The Hadza have been able to survive without much interference from outside sources thanks to their harsh desert environment, which features briny soil, scarce fresh water, and intolerable bugs. Their traditions and way of life have not changed much for thousands of years, and their ability to navigate these harsh lands have kept them, in most part, from the threat of modernity. <sup>337</sup>

They hunt and eat everything except for snakes and own very few possessions beyond a cooking pot, water container, and ax. Gender roles are broken up into hunting versus gathering with the men doing all the hunting and the women gathering and cooking the meat. Each role is equally important and contributes to their overall survival. The women gather berries and baobab fruit while the men hunt birds, wildebeest, zebras, elephants, buffalo, and baboons. <sup>338</sup> *Figure 48* Although gender roles are clearly defined, women have a somewhat equal say within the group. Anthropologist Michael Finkel described the Hadza women he met as “some of the loudest, brashest members” of the camp. Hadza women do not tolerate bullying, and those who marry outside the camp often return because they do not agree with the subservient roles

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334. Ibid., p.811

335. Finkel, Michael. “The Hadza — National Geographic Magazine.” National Geographic Magazine. Accessed April 1, 2011. <http://ngm.nationalgeographic.com/2009/12/hadza/finkel-text/1>.

336. Ember, Carol R., and Melvin Ember. *Encyclopedia of Medical Anthropology: Health and Illness in the World's Cultures*. New York: Kluwer Academic/Plenum Publishers, 2004. 690.

337. Finkel 2009, 1

338. Ibid., p.1

in which they are placed. It is also the women who initiate breakups, taking on a new husband who proves himself a superior hunter. <sup>339</sup>

The Hadza live truly autonomous lives and free to come and go as they please with no leader residing over each tribe. Family relations are also described as having loose ties to one another with few social obligations. The Hadza do not have funerals, birthdays, or even religious ceremonies. Even their concept of time is different, and people tend to sleep whenever they want, sometimes during the hot day. The only defined times of work are dusk and dawn when the hunting takes place; other everyday work is in preparation for the hunt. This includes “straightening arrow shafts, whittling bows, making bowstrings out of the ligaments of giraffes or impalas, [and] hammering nails into arrowheads.” <sup>340</sup>



Image 79: Hadza man.

The group tends to sleep outdoors near a campfire during the dry season, May through October, when the wind helps to keep the mosquitoes and tsetse flies at bay. During the rainy season, the women construct small domed shelters <sup>341</sup> of interwoven twigs and long grasses described as “upside-down bird’s nests.” <sup>342</sup> These huts measure 6 feet tall <sup>343</sup> and 1.8 meters in circumference <sup>344</sup> and are constructed by bending and weaving *oldapai* stalks into a round, dome shape. Once the structural frame is set, it is covered with clumps of long grass. <sup>345</sup> The construction takes only a few hours and occurs roughly once a month when the camp moves locations due poor hunting, or if a sickness or death occurs. <sup>346</sup>

339. Ibid., p.6

340. Ibid., p.1

341. Oliver 1997, 810

342. Finkel 2009, 1

343. “Millett, Katherine: The Hadza Tribe of Tanzania.” NTZ: An Information Resource for Northern Tanzania. Accessed April 7, 2011. <http://www.ntz.info/gen/b00479.html>.

344. Oliver 1997, 810

345. Millett 2001

346. Finkel 2009, 1



In recent years, the Hadza territories have been invaded by pastoralists, farmers, and hunters who assume their lands are empty, “unused” and in sore need of development.<sup>347</sup> The Hadza are described as “gentle stewards” of their land and have always avoided conflict, having little reason to fight as moving to new land always served as an amicable solution.<sup>348</sup> The influx of people has resulted in soiled watering holes, trampled vegetation, destroyed berry groves, and the migration of game animals to national parks where the Hadza cannot hunt. The Hadza have lost nearly 90% of their land due to these invading forces. They can sense changes, but do not worry about such issues. They never consider the future and live on a day to day basis.<sup>349</sup>

Although the Hadza do not worry about their future, the Tanzanian government does. As “a future-oriented nation, anxious to merge into the slipstream of the global economy,” the government views the Hadza as a primitive society, one that prevents development. Thus, it is looking to teach them to work in and contribute to society.<sup>350</sup> However, all attempts to date have been unsuccessful. In 1964, many of the Hadza were forced to settle in Yaeda Chini where schools and health clinics were built in an attempt to “modernize” them.<sup>351</sup> Many of them



Image 80: Hadza huts

died within months of the relocation due to respiratory and diarrheal infections; their immune

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347. Ibid., p.8

348. Ibid., p.8

349. Ibid., p.8

350. Ibid., p.9

351. Ember, Ember 2004, 690

systems were not equipped to battle such diseases. Needless to say, the Hadza soon returned to their nomadic lives. Their lifestyle is one that consists of living in “open, low densities and mov[ing] frequently, they are less vulnerable to many of the contagious diseases that spread among their farming and herding neighbors, who live indoors.”<sup>352</sup>

Richard Baalow, a spokesperson for the Hadza who has been educated and who has taken on an English name, agrees with the government’s efforts to educate the Hadza and suggests that they “become politically active, to fight for legal protection of their land, and to seek jobs as hunting guides or park rangers.”<sup>353</sup> He wants the children to attend boarding school and to then return to the bush lifestyle when the academic year ends. However, Hadza children do not wish to attend these schools because they worry that they will not obtain the skills necessary for their survival and that they will become outcasts in their own society. Entering the modern world would only lead to degrading jobs as maids and laborers. They view living in the modern world as being trapped and living in their bush world as being free. In recent years, many of the Hadza have moved to Mangola, an area located just at the edge of their bush lands, and have taken up jobs demonstrating their hunting skills to tourists. These communities have seen an increase in alcoholism, tuberculosis, and domestic violence, issues not prevalent in Hadzas living in the bush.<sup>354</sup>

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352. Ibid., p.690

353. Finkel 2009, 9

354. Ibid., p.9

## Mbuti Pygmies

The Mbuti pygmies of the Ituri Rainforest in central Africa are composed of semi-nomadic tribes who are thought to be the earliest inhabitants of Africa. Their lineage dates back to as early as 2500 BCE, and they were documented by the Egyptians as well as Homer and Aristotle. They eventually fell out of written texts and were thought of as mythical creatures until the 19<sup>th</sup> century when they were rediscovered by traveling explorers. They are a people who have adjusted their nomadism to fit modern times. They are primarily hunters and gatherers, but are occasionally willing to work for nearby farming villagers, the Bantu people, with whom they hold a symbiotic relationship.<sup>355</sup> Both rely on the other for goods, the Bantu on the Mbuti for bushmeat and the Mbuti on the Bantu for outside products and garden vegetables such as cassava and plantains.<sup>356</sup>

The Mbuti are described as a peaceful community whose culture centers around strong cooperation required for the hunt and thus their survival. With a dependency on the social harmony of the group, an emphasis is placed on mediation practices. Conflicts are quickly resolved with "laughter, jokes, and ridicule."<sup>357</sup> Mimes are also employed to re-focus the attention on them, absorbing much of the dispute. Women and men are considered equals in this community, but when gender disputes arise, a simple game of tug-of-war is implemented to ease tensions between the genders. The game is structured with men on one side and women on the other. When one side begins to dominate the other, a member from the winning team will join the other side, altering his/her voice to match the opposing team's gender. For example, if the men are in the lead, one of the men will join the women's side all the while speaking in a falsetto voice, getting everyone to laugh. This game evens out the battle field, and encourages everyone to "ridicule aggression, competitiveness, and conflict itself."<sup>358</sup>

The Mbuti also honor nature and value their rainforest as a sacred place, one that provides them with all the necessities of life. The love for their forest is expressed through songs showing an appreciation for the care it provides them. They believe when bad fortune falls upon them, it is because their forest is asleep and they must sing songs to awaken it.<sup>359</sup>

355. "Mbuti." Peaceful Societies: Alternatives to Violence and War. Accessed March 25, 2011.

<http://peacefulsocieties.org/Society/Mbuti.html>

356. Lee, Richard B., and Richard Heywood Daly. Introduction. In *The Cambridge Encyclopedia of Hunters and Gatherers*, 211. Cambridge, U.K.: Cambridge University Press, 1999.

357. Peaceful Societies: Alternatives to Violence and War.

358. Ibid.

359. Ibid.

Social considerations also extend into spatial layouts during migration. Diplomatic layouts are used in order to ensure maximum fairness and cooperation. If any serious disputes arise, the camp risks splitting up, thus limiting its chances of successful hunting. It is during the honey season, June through August, that most camps tend to split into several smaller ones. This distance and time apart helps to relieve tensions within the group, enabling them to congregate once again during the hunting season.<sup>360</sup>



Image 81: Mbuti men

During their sedentary months, the rainy season occurring from April through November, the Mbuti reside near farming villages, and provide labor for the Bantu. The dry months, from December through March, allow them to wander their forest. Villages are designed in the form of a female womb and represent the rebirth of one's self through the mother and forest as one enters and exits the village. This play between female and male representation of space represents sexual intercourse in their daily lives. "The village and physical use of the space is thought to be male and the exact layout, shape of the huts, and actual utilization of space is female."<sup>361</sup>

Homes are tiny, circular, and temporary, lasting only a few days<sup>362</sup> and take about an hour to construct.<sup>363</sup> These structures are present all throughout their forest and have been in existence since the birth of their forest.<sup>364</sup> The Mbuti will trace a circle on the ground and build accordingly. The structural frame is composed of sticks that are driven into the ground to form a dome. Vines are then woven through the sticks ensuring structural stability.<sup>365</sup> Large

360. Ibid.

361. Coffey, James. "The Mbuti of Central Africa: The Only Known Egalitarian Society (with Rare Video)." Share Knowledge & Earn Passive Income | Factoidz. Accessed March 30, 2011. <http://factoidz.com/the-only-known-egalitarian-society-the-mbuti-of-central-africa/>.

362. Salopek, Paul. "Mbuti Pygmies." National Geographic Magazine. September 2005. Accessed March 29, 2011. <http://ngm.nationalgeographic.com/2005/09/mbuti-pygmy/salopek-text/10>.

363. "Bambuti (Pygmy Groups) -- Britannica Online Encyclopedia." Encyclopedia - Britannica Online Encyclopedia. Accessed April 11, 2011. <http://www.britannica.com/EBchecked/topic/51218/Bambuti>.

364. Salopek 2011, 10

365. Peregrine, Peter. "233. The Baseline Scenarios -- Part 9: Beehive Huts." Music 000001. Accessed September 14,

*mongongo* leaves are then used as sheathing and woven between the structural frames. <sup>366</sup>  
Once the camp moves on, the huts are either abandoned, left behind for others to use, or to decompose. <sup>367</sup>

The Mbuti face many challenges living within their location. During the 1998-2003 DR Congo Civil War, they found themselves caught in the middle between the DR Congo government and rebel forces as their forest is located right on the border between Uganda, Rwanda, and the DR Congo nation. It was during this civil war that many inhumane crimes were committed against the Mbuti. They were hunted down and eaten as food by many of the Bantu and rebel forces. The Mbuti are regarded as possessing “magical” powers, and the rebel forces believed that if consumed them they would absorb these magical powers themselves. Both sides of the war regarded them as “sub-human” due to their tiny stature. They have also been enslaved by both Ugandan-backed movements in the past, forced to hunt the forest for bushmeat, and often killed and eaten when they returned unsuccessful. Rebel forces consumed mainly the sexual organs of the pygmies believing that doing so would give them strength. There were also reports of pygmies forced to consume the remains of their own cooked cohorts. Eastern Congo is controlled mainly by the Mayi Mayi, “a loose grouping of tribal militias united by their magical beliefs and taste for human flesh.” <sup>368</sup>



Image 82: Mbuti hut

The Mbuti are the largest group of people to have felt the aftereffects of the war. It is estimated that 10,000 Mbuti are displaced throughout camps located around the area because of the fighting still persistent in their forest.

This large displacement may lead to a

2011. <http://music000001.blogspot.com/2009/11/233-baseline-scenarios-part-9-beehive.html>.
366. Watson, Rupert. “The Forest Is Everything: Mbuti Pygmies of Zaire’s Ituri Forest.” World and I.com. September 1995. Accessed April 7, 2011. <http://www.worldandi.com/specialreport/1995/september/Sa14030.htm>.
367. “Bambuti (Pygmy Groups) -- Britannica Online Encyclopedia.” Encyclopedia - Britannica Online Encyclopedia. Accessed April 11, 2011. <http://www.britannica.com/EBchecked/topic/51218/Bambuti>.
368. Astill, James. “Congo Rebels Are Eating Pygmies, UN Says | World News | The Guardian.” Latest News, Sport and Comment from the Guardian | The Guardian. January 9, 2003. Accessed March 20, 2011. <http://www.guardian.co.uk/world/2003/jan/09/congo.jamesastill>.

loss of culture as new adaptations to a modernized world are now integrated into their vocabulary. The UNHCR hopes to successfully integrate the Mbuti people into neighboring towns, but they are met with prejudice and degrading work for very little money, roughly less than 1 USD a day. The only benefit that the Mbuti see in this situation is the opportunity for their children to attend school. It is their hope that one day a Mbuti may serve as a leader in this struggling nation. <sup>369</sup>

### !Kung Basarwa

The !Kung Basarwa people of the Kalahari Desert are a community whose perception of home varies significantly from that of most cultures. The home is where the hearth rests, for it is the fireplace “that each nuclear family builds in front of its dwelling.” <sup>370</sup> Thus, the exact location of their shelter holds no significance to them as they are not permanently tied to the land. The !Kung Basarwa’s concept of space refers more to a cultural relevance than to any “constraints of the environment.” <sup>371</sup>



Image83: !Kung Basarwa man

369. Schmitt, Celine. “UNHCR - Looking for Solutions for North Kivu’s Vulnerable Pygmies.” UNHCR The UN Refugee Agency. May 21, 2010. Accessed March 30, 2011. <http://www.unhcr.org/4bf6570e6.html>.

370. Crouch and Johnson 2000, 61

371. Ibid., p.61

The Kalahari Desert is home to extreme weather conditions with temperatures ranging from 110 to 115 degrees Fahrenheit (°F) during summer to as cold as 30°F in winter. The !Kung Basarwa's acclimation to the heat but intolerance to the cold frigid winter nights is one of the reasons for their migration. A lack of food and water also contributes to their migration, which can take place every few weeks to every couple of months.<sup>372</sup> Their migrations also stem from their religious beliefs and practices. They believe that God could be angered by "belittling or wasteful behavior, as well as by overharvesting that leaves no plants to grow again and replenish the store."<sup>373</sup> The !Kung Basarwa have no beasts of burden and thus utilize local materials to build their shelters.

The process of settlement also differs during summer and winter months. Summer months, November through July, are spent with families gathered together forming larger camp sites; they use this opportunity to "arrange, trade, and [intermarry]."<sup>374</sup> It is a shortage of water during winter months that separates the families into "smaller, wide-ranging family groups."<sup>375</sup> Settlement patterns tend to revisit past sites but never to the exact same spot for sanitary reasons. Everyday debris is disposed of by mixing it with leftover ashes from the fireplace. Defecation takes place on the ground in an area adjacent to the camp site. This area usually attracts flies and can lead to various infections, but during summer months, the degree of exposure is lessened in large thanks to the dung beetle.<sup>376</sup> It is after 10 days of settlement that sanitary issues begin to arise and 3 weeks when "pollution reaches the level of discomfort."<sup>377</sup>

A migrating family group consists of at least 10 members, with a mean of 19, composed of siblings, cousins, spouses, and spouses' relatives. Individuals are welcome to join other related bands, which often helps to reduce tensions and food shortages.<sup>378</sup> Each band is led by a head male, often the eldest and most skilled hunter. It is his job to determine the best route of travel and to ration the water and food supply.

The roles of women and men differ. The women are in charge of constructing the family homes using natural materials found on site. They are also in charge of gathering food within a radius of 5 miles of the site while concurrently tending to the children. The men are in charge of

372. Crouch and Johnson 2000, 59

373. Ibid., p.61

374. Ibid., p.59

375. Ibid., p.59

376. Ibid., p.61

377. Ibid., p.61

378. Ibid., p.59

hunting in areas further away. <sup>379</sup>

Their homes consist of two designs, one for the dry months and one for the rainy months. The dry season home is designed as a windbreaker, consisting of branches that denote inside space and grass that in turn denotes outside space. Construction begins with holes dug into the ground where sticks are inserted. The sticks are then woven at the top and tied with a fiber cord. The exterior sheathing is composed of thatched grass attached to the structural frame. All homes can be constructed within an hour or less, and these methods are passed on orally from mother to daughter. <sup>380</sup> Sometimes, when the women does not wish to build a home—a common occurrence during the dry season, she arranges two sticks in the ground to represent the entrance, allowing family members to properly orient themselves around the fire; men on one side and women on the other. <sup>381</sup>

Wet season homes are much more complex and require more time and materials to



Image 84: !Kung Basarwa hunters

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379. Ibid., p.59

380. Ibid., p. 59

381. Oliver 1997, 2142





Image 85: !Kung Basarwa hunters

construct. A wet season home can take a woman up to 15 hours to build, and she will also need to devote 5 minutes every day to repairing the shelter. The weather-resistant home has a circular floor plan and a domed roof structure. The domed roof is constructed of branches interwoven with twigs, described as similar to a basket. The home has the

dimensions of “4’ - 5’ wide on the open side, 5’ tall and 3’-4’ deep.”<sup>382</sup> Similar to the dry season home, the exteriors are composed of thatched grass or grass mats designed to “protect the inhabitants.”<sup>383</sup> The homes are used mainly for storage or for a “temporary escape from the [elements], not living spaces.”<sup>384</sup> It is also designed to be portable and easily moved, oriented with the open side “away from the prevailing winds.”<sup>385</sup> A typical layout for a family band consists of a living area, two dance circles, and a larger initiation circle that are then all connected by a single pathway.

The !Kung Basarwa concept of material possession also differs from that of westerners. Since they have no animals to carry their items, they take few possessions during migrations, and all tools are shared to limit the items they have to carry. As a result, material possession does not indicate wealth or status. The few items of great value are shared between all members; “prized objects [are] slowly circulated throughout the group.”<sup>386</sup> This concept of ownership also extends to the !Kung Basarwa’s understanding of land ownership.

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382. Ibid., p.59

383. Ibid., p.59

384. Ibid., p.59

385. Ibid., p.59

386. Ibid., p.59

Today, there are only 3,000 remaining !Kung Basarwas that follow the traditional hunter-gatherer lifestyle. They now deal with issues of trespassing onto private land, a concept still foreign to them. <sup>387</sup> There has also been a notable shift in their concept of material wealth. They are now beginning to support themselves through cultural tourism, which brings revenue into their community. !Kung Basarwa tours take people on hunting trips, teach outsiders how to gather food, and expose native trails while educating outsiders about their culture. Luxurious tents may also be rented for the full cultural experience. Camps include the Nhoma Safari Camp, Kalahari Desert.com, and Bushmanland Kalahari Adventure. <sup>388</sup>

### Bedouin

Unlike the !Kung Basarwa, the Ruwala people of Arabia have camels to carry their loads, which translates to more mobility, yet their reasons for moving are similar to the !Kung Basarwa; their environment requires their migration in search of food and water. The fall months are spent close to the Mediterranean Sea while the winter months are spent near wells, and during spring, they head south towards the temporarily blooming desert and use resources from various oases. During the summer months, “they return to the coast to exchange surplus camels for grain, clothing, guns, and tent cloth.” <sup>389</sup>

Camels in the Bedouin community represent wealth, and are used as a labor force as well as a source of milk and meat. Camels are a sign of luxury, and a rich family may “own fifty or more camels: some for the family to ride, others to carry food, and a few for guests.”



Image 86: Bedouin Tent

387. “The San Bushmen (Basarwa): Kalahari Desert, Namibia and Botswana.” Africa Travel. Accessed February 25, 2011. [http://goafrica.about.com/library/bl\\_san.htm](http://goafrica.about.com/library/bl_san.htm).

388. “Nhoma Safari Camp Tsumkwe Area.” Africa Travel. Accessed February 25, 2011.

<http://goafrica.about.com/gi/dynamic/offsite.htm?site=http://www.namibweb.com/nhomacamp.htm>.

389. Crouch and Johnson 2000, 62

Housing is arranged in two parallel rows for both protection and camaraderie. The Bedouin tent is composed of “1 foot wide strips of woven or felted hair or wool sewn together,”<sup>390</sup> and is usually made of black wool which “cast[s] a dense shade and [helps] to insulate against radiant heat.”<sup>391</sup>

As in the !Kung Basarwa culture, it is the women who construct and own these tents. Tent construction begins with the structural frame, 6 to 8 poles that form a frame on the ground. Stretched over this frame is the wool material that then forms the roof of the tent. At every pair of cords, a stake is attached “except at the center of the tent, where each pair has three stakes.”<sup>392</sup> All of the poles are then raised vertically and the stakes pounded into the ground. The dwelling is designed to “resist strong blasts of wind,” be easily transported, constructed, and expandable.<sup>393</sup> The layout is then divided into two spaces; the eastern section is designated for the men and the western section is designated for the women. All living takes place on the floor level with a few basic furnishings, including rugs for the floor, a few backrests, quilts, cushions, and saddlebags which serve as armrests. Family activities and animal care occur outdoors.

### New Vernacular Architecture

“Ethnic origin is increasingly becoming one of the most important criterion for selecting architects for buildings of national significance. In this search for ‘authenticity,’ it seems that architecture cannot be regarded as having any ‘true’ meaning unless the designer has roots in the culture.”<sup>394</sup>

Contrary to this current trend, the Tjibaou Cultural Center in Noumea, New Caledonia was designed by Italian architect Renzo Piano in 1998 and dispels any criticism of his ethnic origins. The center was designed for the Kanak people of Noumea, as a tribute to their late leader, Jean Marie Tjibaou who was assassinated in 1989. During his term in office, he fought for indigenous rights and the restoration of the Kanak culture. Prior to his assassination, the French government promised New Caledonia a cultural center that would reflect and *develop*

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390. Ibid., p.64

391. Ibid., p.65

392. Ibid., p.65

393. Ibid., p.65

394. Richardson 2001,105



Image 87: Tjibaou cultural center site plan.

the Kanak culture; this also served as an act of contrition by the French government which delayed the promised independence of New Caledonia. A competition was held for the Tjibaou Center design, which was

supposed to reflect the “complexity” of the Kanak rituals, customs, 28 languages, and desire for independence. <sup>395</sup> Piano, an architect known for his sensitivity to place, won the competition for two reasons: he had the best design and was not an oppressive *French* architect. <sup>396</sup>

Piano immediately began work on the project, first hiring Alban Bensa, an anthropologist and specialist in South Pacific culture. <sup>397</sup> Even and perhaps especially as an outsider, Piano understood the importance of place and cultural context. He is quoted as saying, “A true acceptance of the challenge took courage. It meant taking off the mental clothes of the European architect and steeping myself in the world of the people of the Pacific.” He wasn’t looking to simply imitate the existing vernacular but rather by immersing himself in the locality, to capture the spirit of the Kanak culture. The existing local architecture was composed of ephemeral building materials, and as such, did not create a strongly defined existing vernacular. Thus, Piano was able to design without much limitation, a defined form to represent New Caledonia.

The design addressed the “Kanak’s belief in harmony and nature” <sup>398</sup> and therefore,

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395. Ibid., p.132

396. Ibid., p.132

397. Ibid., p.136

398. Ibid., p.136

the emphasis was not on the singular, but rather community, which was reflected in a sequence of buildings set in a sprawling landscape connected by pathways, creating a “village” structure. The abstract forms are based on Piano’s explorations of texture and local climate, and he addressed passive cooling needs through the use of both modern and natural building materials including laminated wood, concrete, coral, steel castings, glass panels, tree bark, and aluminum.<sup>399</sup> The natural wood used is *iroko*, a wood resistant to rot with the ability to withstand cyclone-force winds.<sup>400</sup> The design features horizontal wooden slats constructed of iroko on the outer layers while the inner layer is made of glass louvers that help to filter winds from the ocean. This double layer system also helps to direct warm air upwards, similar to a chimney.<sup>401</sup>

In conclusion, Piano understood his position as an outsider, and rather than try to disguise himself as a Kanak, he embraced his western knowledge of architecture and combined this with a compassion for the Kanak culture.

Culture is only sustained when it evolves, and the evolution of a culture is subject to a



Image 88: Tjibaou cultural center.

combination of different factors: climate, building materials, history, and beliefs. According to

399. Ibid., p.136

400. “Marie Tjibaou Cultural Center New Caledonia by Renzo Piano.” Galinsky. 2006. Accessed March 21, 2011. <http://www.galinsky.com/buildings/tjibaou/index.htm>.

401. Glinksy 1998-2006

R. Waterson,

tradition, like history, is something that is continually being recreated and remodeled in the present, even [though] it is represented as fixed and unchanging...There is no architecture without inviolable rules of construction and interpretation that are formed in the course of history for every people by means of a more or less complex convergence and superposition of elements... and associations. <sup>402</sup>

Therefore, the char people will need to adapt to future changes, changes that are rapidly approaching and threatening their lifestyle. Studying a range of vernacular architecture has helped me to understand the char people and their predicament.

By using local materials, communities are able to strengthen their economies while sustaining a regional identity. Bamboo is readily available all over Bangladesh as well as char lands. It is a highly sustainable building material commonly used for construction in South-East Asia, profound for its typhoon resistance. There are over 700 different species, many of which reach their full height and diameter within a few weeks, but are not harvested for a few years because of the moisture levels contained in the young bamboo. The material is used as either a full cane or split longitudinally. Bamboo ranges in size for 5 to 12 centimeters in diameter and grows up to 115 feet tall. It contains a high tensile strength and is commonly used to make floor joists, wall frame columns, and roof structures. <sup>403</sup> It can be easily worked and is abundantly available. Connections are made using rope binding or bamboo pegs as most bamboo cannot be nailed down, except for one species known as *Guadua Augustifolia* located in Colombia. The downside of using bamboo is that it decays easily, attracts insects, and is prone to fires. <sup>404</sup>

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402. Crouch and Johnson 2000, 3

403. Oliver 1997, 22

404. Ibid., p.22

### Conclusion

I selected these case studies based on their similarities with the char people. After sifting through many examples, I narrowed my selections to migratory and aquatic cultures. The char people will benefit from the invaluable knowledge acquired over thousands of years, perfected through trial and error, and passed down through many generations. Beginning with aquatic stilt architecture, it is clear that the use of local building materials as well as floating and stationary techniques will form the basis of an ideal dwelling/vessel for the char people. While water-resistant materials will create durable, sustainable structures, considering how frequently the char people travel between different chars—an estimated 50 times in one's lifetime—knowledge of nomadic cultures will also prove beneficial.

Stilt communities developed a solution to keep water out of their homes, which have a clear separation between inside and outside, and wet and dry spaces. Although the char people have adapted to similar conditions by opting to live with water, there are still elements of stilt communities that may benefit the chars. A hybrid solution of both transportable (floating) and stationary (stilt) design might provide an optimal solution. Most stilt communities are also constructed from local materials found on site with the help of the entire community. This method of construction may serve as a model for the chars to follow, and in the process establish a sense of community and order not prevalent in the existing char lands.

Nomadic cultures are categorized by those with either temporary or portable structures, which in turn greatly influence societal values. These differences correlate directly to literate and illiterate cultures, with literate cultures containing transportable structures and illiterate cultures containing temporary ones. The !Kung Basarwa, Hadza, and Mbuti are all illiterate cultures that rely on oral traditions to build their temporary structures. All three nomadic cultures retain few material possessions and egalitarian societies. It is these factors that contribute to the groups' overall survival.

As previously discussed, transportable structures have the same amount of value as sedentary societal architecture. Therefore, societies that contain transportable structures are more closely related to sedentary societies. The Bedouin (a transportable architectural society) perception of land use also differs from that of the !Kung Basarwa (a temporary architectural society) who do not have any beasts of burden. The !Kung Basarwa view their lands as a store

house while the Bedouin use their lands as a pasture for their animals. <sup>405</sup> The !Kung see land, indoors and out, as one giant “home” while the Bedouin have a clear delineation between “inside” and “outside” space. Indoors translates to civilized while outdoors equates barbaric. Transportable structures therefore equate modernity with the emphasis placed on the shelter. The chars relate more closely to transportable structures as with each disaster, the home is relocated rather than deserted. The home provides a sense of permanence in their otherwise unpredictable lifestyle, which may provide a few clues into the type of lifestyle the char people desire.

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405. Crouch and Johnson 2000, 62



# D ARCHITECTURE OF BANGLADESH

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The architecture of Bangladesh contains examples of modern, historic, vernacular, and monumental pieces. All of which reflect Bangladesh's rich culture and history.

Throughout Bangladesh's history, many groups have been drawn to this rich land, contributing to its diverse culture and religious practices. Therefore many of Bangladesh's monumental architectural pieces are religious buildings attributed to these different influences.

One early historic structure is the Buddhist Vihara at Paharpur. This structure was important to the rise of Mahayana Buddhism in Bengal beginning in the 7<sup>th</sup> century. It was a "renowned intellectual centre until the 12<sup>th</sup> century,"<sup>406</sup> and is located in the small village of Paharpur, 5 kilometers west of Jamalganj. It was constructed in the late 8<sup>th</sup> century by the Pala emperor Dharmapala<sup>407</sup> and is "the second largest single monastery south of the Himalayas."<sup>408</sup> Built in a quadrangle shape with each side measuring 281 meters, it contains 177 monastic cells set within the four outer wings. It is constructed of burnt bricks and terracotta plaques depicting daily life such as snake charmers, various animals, and musicians.<sup>409</sup> The floor plan and decorative features reveal Buddhist architecture influences from Cambodia and Java. It is currently listed as a UNESCO protected site.<sup>410</sup>

Other religions such as Christianity are also visible in the historic architecture of Bangladesh. The Armenian Temple built in 1781 is a testament to the large group of Armenians present in Dhaka during the 12<sup>th</sup> century. The church reflects the close relationship Armenian traders had with Mughal Emperor Akbar. This Orthodox Armenian church is famous for housing Mother Teresa during her stay in Bangladesh. One of the oldest buildings in Dhaka,

406. "Ruins of the Buddhist Vihara at Paharpur." UNESCO World Heritage Centre. 1992-2011. Accessed September 15, 2011 <http://whc.unesco.org/en/list/322>.

407. UNESCO 1992-2011

408. "Buddhist Studies: Bangladesh, Paharpur Buddhist Vihara." BuddhaNet - Worldwide Buddhist Information and Education Network. Accessed April 5, 2010. <http://www.buddhanet.net/e-learning/buddhistworld/paharpur.htm>.

409. Buddhist Studies 2008

410. UNESCO 1992-2011

this structure sits on a hectare surrounded by ornately carved gravestones. <sup>411</sup> It is currently threatened by the loss of followers as only one Armenian man, Michael Joseph Martin, still resides in Dhaka. <sup>412</sup>

The St. Thomas Church is an example of the influence of Catholicism in Bangladesh. Located in Dhaka, it was built in 1819, and in 1821, it was consecrated by Bishop Reginald Herber. It is a combination of different architectural styles with the windows and doorways built in the Gothic style while the rest are modeled after contemporary Indian churches of the time. <sup>413</sup>

Some modern architecture buildings include the National Assembly Building by architect Louis Kahn. The design of the building reflects both the existing vernacular and monumental architecture of the time. A typical Kahn building, light served as a main design tool. The heart of building is the assembly chamber, capable of seating 300 people and standing 30 meters high. The building holds a library, numerous courtyards, and a restaurant. It is constructed of poured-in-place concrete with walls inlaid with marble tiles. <sup>414</sup> This building stands as a symbol of democracy and commemorates the country's 1971 fight for freedom. Kahn's belief in monumentality is strongly evident and relevant to this project as his aim was for "men [to] come to assemble to touch the spirit of community." <sup>415</sup>

More common to Bangladesh architecture can be represented in the vernacular built traditions of rural neighborhoods scattered throughout the country side. Two types of settlement patterns exist in Bangladesh, the amorphous and the elongated-linear. The amorphous settlement pattern consists of a clustering of scattered settlements arranged on high grounds and the elongated-linear type is built on high grounds located near a natural levee of rivers or water channels. Within these two settlement patterns, the village or *gram* arises. It is built on a raised piece of land and composed of a number of neighborhoods of *padas*. These *padas* are then made up of several households known as *ghars* which are several buildings

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411. Ahmed, Ershad. "Churches of." Dhaka. November 6, 2006. Accessed April 5, 2010.

<http://dhakadailyphoto.blogspot.com/2006/11/churches-of-dhaka.html>.

412. Aliastair, Lawson. "BBC NEWS | South Asia | The Mission of Dhaka's Last Armenian." BBC News - Home. January 10, 2003. Accessed April 5, 2010. [http://news.bbc.co.uk/2/hi/south\\_asia/2645617.stm](http://news.bbc.co.uk/2/hi/south_asia/2645617.stm).

413. Lawson 2003

414. "ArchNet." National Assembly Building. Accessed April 5, 2010

[http://www.archnet.org/library/sites/one-site.jsp?site\\_id=134](http://www.archnet.org/library/sites/one-site.jsp?site_id=134).

415. Choudhury, Tanita. News Today :: Most Popular Daily Newspaper. Accessed September 15, 2011. <http://www.newstoday.com.bd/index.php?option=details>.

grouped together and shared by an extended family. <sup>416</sup>

These neighborhoods stress an emphasis on the extended family, with three to four families living together under several buildings arranged around an interior courtyard. The buildings that form this courtyard are the individual sleeping units and the shared buildings which include the kitchen, granary, livestock shed, and latrine. All circulation between buildings is accessed through this courtyard. The purpose of the interior courtyard is to create a sense of privacy and seclusion from the outside world. This formation is important to maintaining *purdah*, the muslim practice of the seclusion of women. <sup>417</sup>

There are several different building styles of a traditional Bangladeshi home. Construction depends on locality and availability of local materials. The two most common home types are either of earth construction or bamboo. In flood prone areas, bamboo is more likely employed for its durability to sustain against water. Bamboo homes are first constructed with a bamboo plinth. This plinth can vary in height from 15cm to 120 cm depending on its susceptibility to flood levels. Bamboo poles also provide the structural frame for the home. Sheathing for the walls can be made of bamboo or other organic material that are woven together to create a thin porous screen, that allows for cross ventilation. Openings in the home are also kept at a minimum to prevent rainwater from entering the space. Pitched roofs are often employed and can be constructed from various types of materials including bamboo, corrugated metal, or an organic material similarly employed for the sheathing of walls. <sup>418</sup>

Bamboo is a common building material used in Bangladesh construction. It is renowned for its durability and wide availability. In Bangladesh, this material is available in two types, a thick-walled species and a thin walled typed. The thick walled bamboo is used for structural purposes such as columns, beams, roof rafters and purlins. The thin walled species is split and woven into mats and screens which are then used for walls, roof sheathing, and interior partitions. Other organic products such as jute sticks, reeds, timber, and palm leaves are also employed in a similar fashion when the availability of bamboo is scarce. <sup>419</sup>

Whether represented by monumental or vernacular pieces, Bangladesh is a country whose architecture understands the importance of preserving a sense of place. As its culture

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416. Banglapedia 2006

417. Ibid.

418. Ibid.

419. Ibid.

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continues to evolve, adjusting to conditions relative to time, it will still retain a strong sense of place through its respect for nature and history.

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