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Case Study on Perennial Assam Floods and Innovations in Shelter Ecosystems

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It is aimed at aggregating and helping co-create knowledge and information on environmentally responsive behaviours and concurrently pursuing result-oriented social media campaigns to encourage people and specifically the youth, to take proactive actions in promoting sustainable lifestyle and creating a positive impact on the environmental ecosystem in their surroundings

By: _VO**IS Planet**

Executive Summary

The Brahmaputra river has proven to be a lifeline for northeastern India since ages. Brahmaputra serves as an important source for irrigation and transportation in the state of Assam. Originating in a great glacier mass in Kailas range of the Himalayas (elevation 5300 m) with around 2900 km long and about 38 m deep flowing through China, India and Bangladesh covering a total distance of 2800 km before merging into the Bay of Bengal, the mighty Brahmaputra is prone to catastrophic flooding when Himalayan snows melt (3).

Due to frequent flood havoc, Assam loses huge amount of cultivation on lakhs of hectares of land. In addition, the river bank erosion has taken place in hundreds of hectares of land. Failure of embankments at various regions has caused major destruction indirectly affecting several thousands of population. The worst affected districts due to failure of embankments are Dhemaji, Lakhimpur, Dibrugarh, Sonitpur, Nagaon, Morigaon, Nalbari and Barpeta (3). The flood and the erosion experienced in Assam is singularly distinct from other states as the extent and duration of flooding as well as the magnitude of erosion is probably the most unique in the country (5).

Owing to the damage and destructions that these floods bring along with Assam government and other non-profit organizations such as SEEDS with their partner organizations are in constant effort to provide innovative shelter solutions loaded with all necessary facilities to the flood affected people in Assam.

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1. Introduction

India being a vast nation with huge diversity encounters many water led woes owing to shortage and abundance of water. On one hand where the western region of India generally faces scarcity of water, the eastern part encounters frequent floods (1). The north eastern India (especially Arunachal Pradesh, Assam and Meghalaya) since May 13 2022, have been experiencing heavy rainfall and triggering landslides. This is resulting in the river overflow and the flood water is causing causalities and damage (2).

Assam and its neighboring states comprise the northeastern part of India. Every single year Assam encounters large amount of losses owing to devastating floods caused by the river Brahmaputra and its tributaries (1). The major tributaries of Brahmaputra river include Dihang,

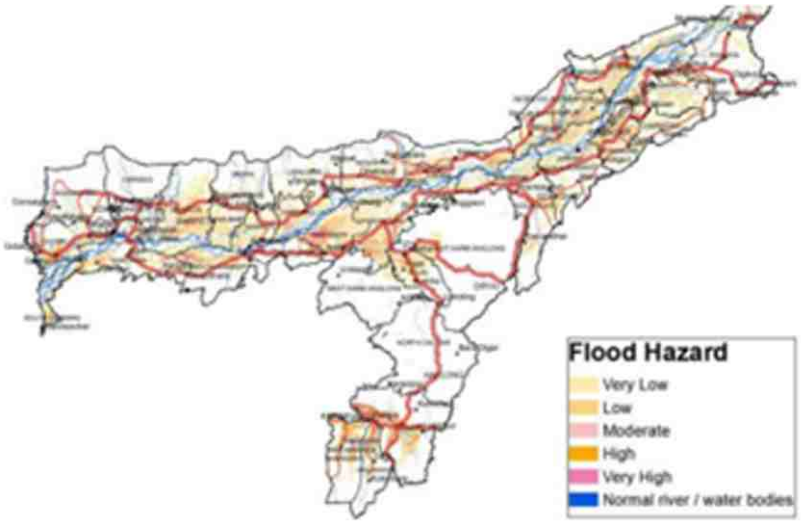

Fig 1 - Map of Assam marking the flood areas (Source: IRJET)

Subansiri, Dibang, Luit, Manas, and the subtributaries include Jiadhol, Ranganadi, Gainadi, Simenn Nadi, Burhidihing, Kopili, Dudhnoi, Krishnai, Bolbola, Beki and Pagladia. All these pass through the Brahmaputra valley and is a major factor causing periodic flood havoc in monsoon seasons in these regions (3).

The districts of Assam - Dibrugarh, Sivasagar, Jorhat, Golaghat, Darrang, North Lakhimpur, Nalbari as well as the river island Majuli - are some of the worst affected regions due to the flood caused by mighty Brahmaputra (1, 2). The first wave of floods hit the state in May this year; by the third July, it had already affected around three million people in nearly 3,000 villages in 27 districts of the state (6). The media coverage on 16th May 2022, reported seven fatalities, one in Itanagar city (Southern Arunachal Pradesh) and three in Dima Hasao district (Central Assam) due to landslides and three more in Central Meghalaya due to floods. Moreover, 70 houses were completely destroyed; hundreds of them were severely damaged affecting approximately 25,000 people across several districts of Assam (4).

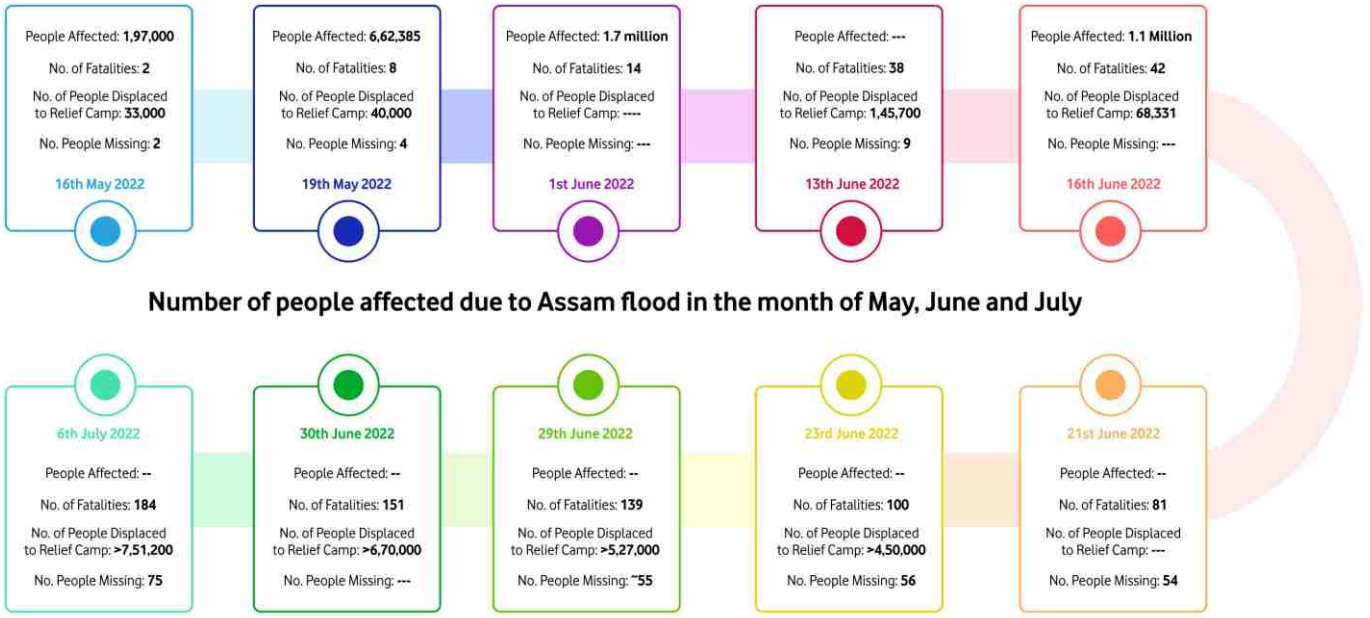

Fig 2 - Number of people affected due Assam floods in 2022

2. Period and Causes of Flood in Assam

Floods are an annual occurrence in Assam which occur every monsoon from July to September (11).

Almost every single year three or four waves of floods ravage the flood prone areas of Assam (5).

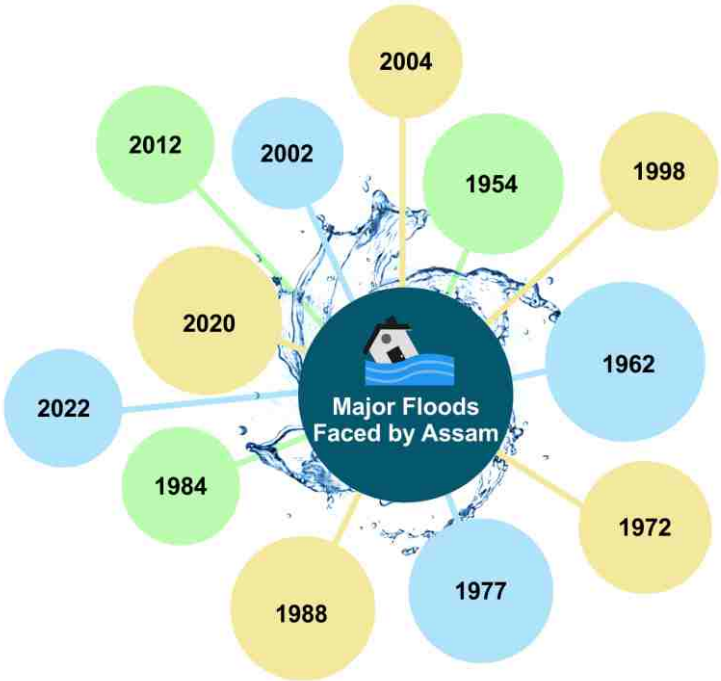

Fig 3 - Major floods faced by Assam post independence period

2.1 Causes

Topography of the region is an important factor and natural vulnerability, since most of the rivers flow downstream in the Assam. Moreover, the current is so high especially during incessant rainfall that it breaches the embankments. Flooding from the Brahmaputra and the other rivers causes a deluge in Assam during the monsoon. 40% of the entire state is flood prone (5). The inundation is seen to increase every year and there are many factors that lead to it.

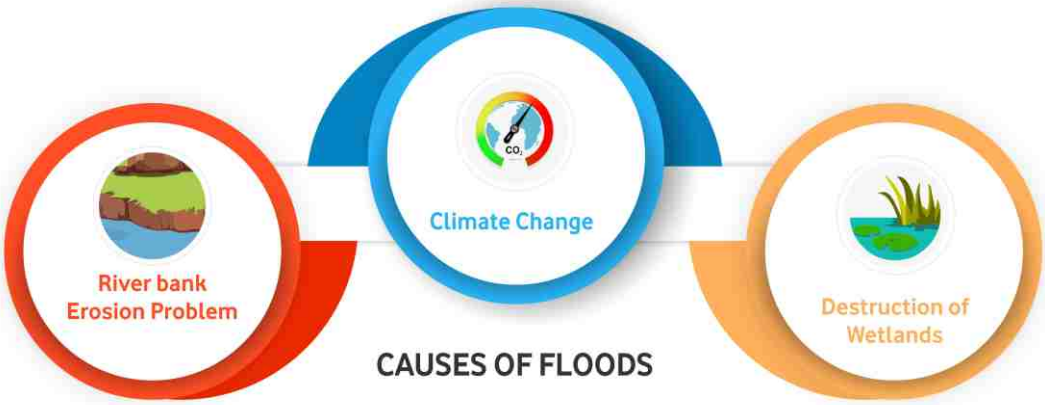

Fig 4 - Causes of floods

Brahmaputra's, Barak's and its tributaries' bank erosion is one of the major reasons behind Assam floods. The soil, sediments or rock fragments along the banks get washed away due to the heavy water flow. As a result, the course of the river changes and it gets wider. Reports say, that around 8000 hectares gets eroded every year. According to a study by the State Government around 8% of the Assam's total land has been eaten up by the Brahmaputra since 1950 (10). In Assam, floods also occur due to the seismicity and landslide, the Brahmaputra valley falls under Zone-V, which means high risk of flood, compounding to it - Brahmaputra valley is subjected to frequent tectonic activity. In 1950, Assam witnessed a deadly earthquake that may have altered the course of Brahmaputra. This is also seen as a reason in the annual deluge. The earthquake increased the amount of silt in the river and its tributaries. The silt gets deposited on the river bed every year changing the course of the river (10).

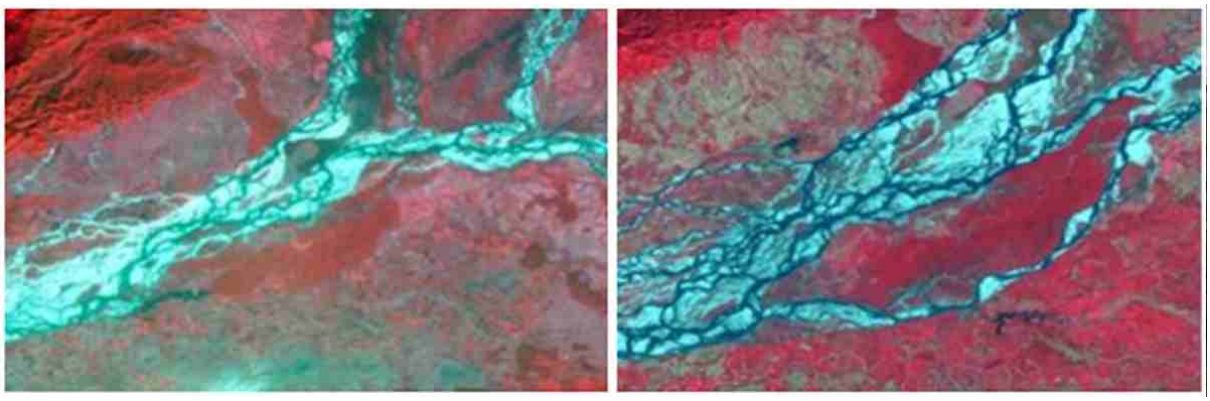

Fig 5 - Satellite image of River Brahmaputra in 1997 and 2007 (Source: IRJET)

According to a climate change study published by the Assam government climate change will result in more severe and frequent floods. The increase in global temperature will result in heavier rains. This is expected to cause flash floods. The climate change study also says that by 2050, the average annual run-off of the Brahmaputra will fall by 14%. But there is also a risk of glacier melting leading to flash floods (10).

Assam is home to more than 3000 wetlands. They act as reservoirs by taking the excess water. The destruction and encroachment of these wetlands means the overflow remains unabsorbed leading to floods (10).

3. Flood Havoc Caused in the State

The flood prone area of the state as assessed by Rashtriya Badh Ayog (RBA) is 31.05 lakh hectare against the total area of the state 78.52 lakh hectare. This implies that around 39.58% of the total land area of Assam is vulnerable to flood water which is about 9.40% of the total flood prone area of the country (5). Reports show that around 9.31 lakh hectare of area is annually affected due to the floods occurring in Assam. The flooded areas in India on the whole range around 10.2% of the total land area in India and the flooded area in Assam is 39.58% of the area of the state. It simply signifies that flood prone area of Assam is four fold the national mark of the flood prone area of the nation (5).

Fig 6 - Children sitting under umbrella over wrapped tarpaulin during Assam floods 2022 (Source: eastmojo)

In many areas of the state, be it rural or the urban areas, shoals of water drove a majority of population from their homes and forced a major section to seek shelter for their livestock. At a number of places, people were not able to protect their standing crops, granaries were destroyed and mud houses were filled with sand that the river water brought along with it (7).

The flood hit area of Silchar city witnessed people's struggle to access food, medicines and clean drinking water as the flood water all over the streets had made travelling near-to-impossible (8). People were looking desperately for boats, rafts or any mode of travel that could easily help them reach out to the government shelters. However, the condition in the shelters is no better as most of the families were crammed into little spaces, often around 30 people into a single room. Generally, these shelters are houses or schools that have been turned into temporary relief camps to provide shelters to the people affected by the floods (8).

4. Steps Taken by the Government

Embankments formation is one of the main methods to check flooding of the rivers, adopted, but almost every year the banks are breached causing inundation. Desilting of Brahmaputra is also seen as an effective method.

The government believes that it will not only increase the water carrying capacity of the Brahmaputra but will also make the river more navigable for bigger cargo ships. Experts believe that the best way to deal with this situation is with a plan that focuses on water and soil conservation. This plan will also have to maintain geo-environmental, eco-biological and socio-cultural integrity of the basin (10).

4.1 Flood management system of Assam

In 1954, after the disastrous flood in the nation, government of India had set up national policies for flood in three phases: the immediate, the short-term and the long-term measures.

Activities to control floods in Assam began basically after the Indian government's announcement of National Water Policy. Consequently, "outlined plan for flood control in Assam," in addition to several others comprehensive plans, were put under preparation and the priority areas, which needed sudden and urgent attention (12).

Until now, the Water Resources Department (WRD) is not only working primarily for the general development of the rural sector but also in ways to protect the major townships in Brahmaputra as well as in Barak valley.

However, there are no long-term measures that have been implemented till date for mitigating the flood and erosion issues of the state. The immediate and the short-term measures as implemented by Assam's WRD are mentioned above (17).

According to the district administration, the Central Water Commission is responsible to set control of all the rivers in Assam. The CWC issues the warnings to the Assam State Disaster Management

Management Authority (ASDMA) which further forwards it to the respective District Disaster Management Authorities (DDMA) for carrying out the immediate precautionary measures. The state government has also developed mechanism for community participation, whereby one person from each village is nominated as a leader responsible for spreading the early warning during the flood situation (12).

4.2 Assam Water Research and Management Institute Society (AWRMIS)

Assam government has formed a new agency in the sector of Water Resources and Flood/Erosion Management. The total financial layout for this is Rs 1500 crores and it will be funded by the World Bank under International Development Association (IDA) Credit Financial Agreement. It would be covering the entire Brahmaputra Basin having duration of around 4 years (13).

Implementing Agency

The primary implementing agency for the project would be AWRMIS. The secondary implementing agencies as well as the partner departments would be North East Space Application Centre (NESAC), Indian Meterological department (IMD), Science and Research institutes having specialization in remote sensing, geomorphology and flood modelling. In addition NGO's for community mobilization will also be included in this (13).

The Central government through Ministry of Water Resources (MoWR) would provide coordination and technical support as well as include representatives from CWC, Brahmaputra board etc.

5. Innovative and New Technologies for Flood Management

5.1 River Atlas

WRD in collaboration with NESAC has prepared a district wise river atlas map for the state of Assam. The river atlas is said to be useful for studying the various watershed features of the river basin (14).

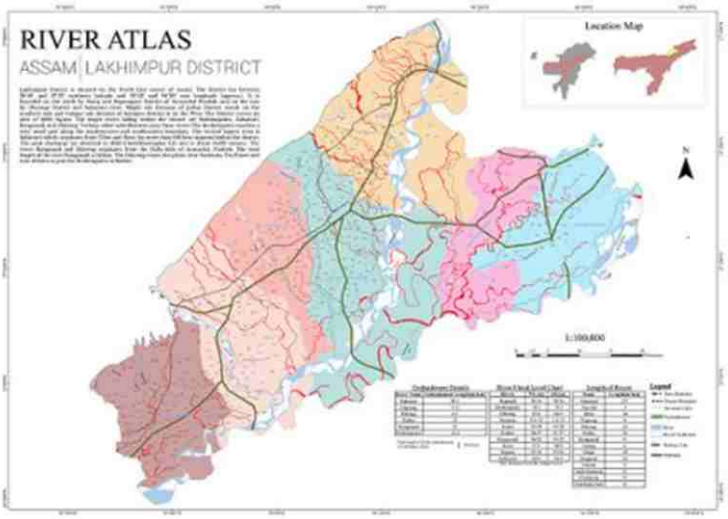

Fig 7 - River Atlas (Source: assam.gov.in)

5.2 GIS Mapping:

Assam's WRD by the use of remote sensing and GIS technology is mapping the embankment system of all the rivers in Assam utilizing satellite imageries. This provides a synoptic view of the whole of embankment system of Assam as well as allows taking precautionary measures if any sort of breach occurs at any of the embankments (16).

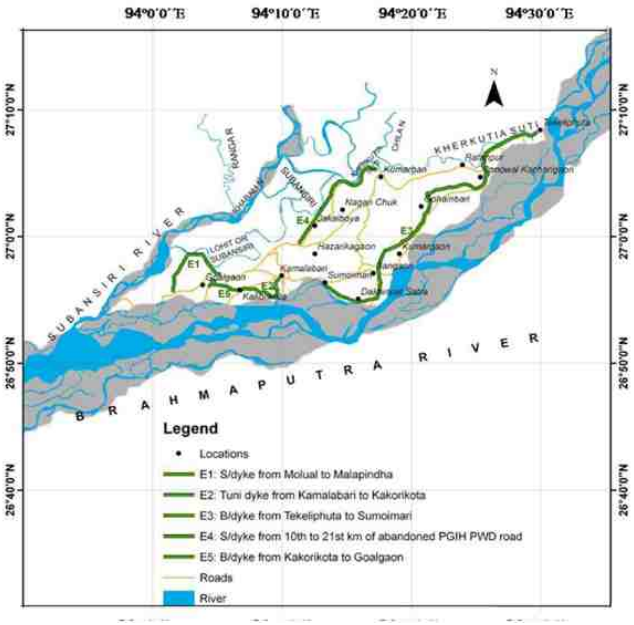

Fig 8 - GIS Mapping (Source: assam.gov.in)

In addition, the multi-temporal satellite data is used to study the migration, erosion and deposition caused by the river Brahmaputra and its tributaries. Thus, this technique makes it much more feasible to study the morphological behavior of the river and the possible future changes in its pattern (15).

5.3 Utilization of Geosynthetic Reinforced Wall (TRAP BAG)

Fig 9 - Geosynthetic Reinforced Wall (Source: assam.gov.in)

GRW or TRAP Bag is a 3-D form of a hydrostatic pressure distribution diagram. It is developed as a chain that could extend upto a standard length of 32m and when it is elevated, it forms an elongated shoe. This technology has been recently adopted by the WRD in North Lakhimpur WR Division in Ranganadi dyke. This technology has shown to be efficiently working against heavy erosion against Ranganadi dyke (16).

6. Innovations in Shelter Ecosystem

Currently, when millions of people are affected by the deluge and more than hundreds have lost their lives in Assam flood, a village in Assam is bracing the floodwater through some traditional and resilient techniques. Golaghat, one of the districts that are affected by Assam's flood every year, was one of the worst affected sites in Assam during 2017 and 2020 floods (23).

The unavailability of toilets in the flood ridden regions compelled people to defecate in the same flood water which was being utilized for the daily needs including drinking. The streets were water logged and not a single habitant could reach out even to the nearest health centre (18). The swollen Dhansiri River had inundated Nikori village in the Golaghat district in Assam.

6.1 Initiatives of Assam government

Assam government, in addition, had built some multi-purpose flood shelters in the state. With the purpose to aid the Assamese residents living in flood-prone areas. These shelters are constructed in the Lakhimpur district. A three-storied building is laid with an area of around 5,000 sq. feet on each floor having a cost of Rs 2.51 crore. The finance was outlayed by Assam State Disaster Management Authority and Lok Nirman Bibhag (23).

The Assam government had also constructed three multi-purpose flood shelter homes, one in Karatipar in Majuli district, the second in Kanaragaon near Mandia in Barpeta district and the third one in Bangarah village in Lakhimpur district in the year 2020.

These buildings are equipped with generators on every floor and solar system for continuous electricity supply. In addition, these shelters also have a provision to receive food supply by helicopters during floods.

These buildings provide a permanent and scientific solution to the state's flood and erosion related problems.

6.2 Shelter for animals

Not only humans, but the animals too are negatively affected by flooding. The negative impacts of floods on wildlife include drowning, disease proliferation and habitat destruction. In 2012, hundreds of animals which also included many vulnerable one-horned rhinos were killed in the floods that swamped Kaziranga National Park in the Indian state of Assam. Floods can also be harmful to aquatic life. For an instance, fishes can be displaced in floods and their nests can be destroyed.

The 2022 floods in Assam, till June 28, have washed away over 2,700 animals in Guwahati, alone. Owing to this, the Assam Forest Department has built around 40 highlands in order to provide shelter to animals amid the ongoing floods in the Kaziranga National Park and Tiger Reserve (KNPTR) and other National Parks and Wildlife Sanctuaries of the state.

The new highlands have been designed scientifically with provision for adequate grass and plants yielding fruits such as elephant apple and Indian gooseberry. Shifting of animals to these highlands has enabled reducing animal casualities.

KNTPR has around 144 man-made highlands which include 33 large areas for housing animals during floods (25).

7. Sustainable Traditional Houses for Flood Prone Areas in Assam

7.1 Stilt houses: A switch

Stilts are posts, shafts or support points that are designed to be build on flood-prone terrain. These houses allow individuals to remain at a specific height over the level of the ground (20). These houses are usually made of wood, stone, cement or bamboo and find support by these pilings to withsatand during floods (20). Stilt houses found in Assam are called as "chang ghar" that is adapted from indigenous Mising Tribe of Upper Assam.

Fig 10 - A newly designed stilt house withstands flooding in Nikori Village, Golaghat district, Assam (Source: SEEDS)

Fig 11 - Local craftsmen using bamboo in the construction of stilt house (Source: SEEDS)

7.1.1 Duration needed to built a stilt house

A basic period of 4-5 months is required to build a stilt house. However, various factors such as local climate or stockpile of the work and the development materials can alter the period of construction to upto 8 months (21).

7.1.2 Reasons stilt houses are built above the ground

The stilt houses are of various designs, which are not only built in just one location but people all around the world, use these houses for various purposes. For instance, in Arctic regions stilt houses protect the residents from permafrost. Thus, the heat that radiates from the house does not tend to cause a lot of frost to melt (21).

In the state of Assam, local people built stilt houses in the areas where flooding from the River Brahmaputra, Barak and their tributaries are at high risk during monsoon season (21).

Fig 12 - Foundation of a stilt house (Source: SEEDS)

7.1.3 Materials utilized in making stilt houses

The raw materials that are utilized in making stilt houses are cement, wood, stone, bamboo or at times even mud, depending completely on the sites where the houses are being built (20).

7.1.4 Specialties of bamboo stilt houses

The stilt houses constructed out of bamboo are best suited for the regions that are flood-prone (21). Assam, in 2017, witnessed one of the most devastating floods (20). The community in collaboration with the local people got together to revive the place and the first thing they did was erecting bamboo stilt houses. Most suitable for the flood-prone areas, these stilt bamboo houses are seen primarily in the Golaghat district in Assam (20). Bamboo is grown in abundance in Assam, and the quality of these bamboos is very-high (21). The locals learned to craft things out of bamboo that also included sturdy housing shelters. These stilt bamboo homes have almost become a necessity in Golaghat, which witnesses almost three waves of floods every year. Nowadays, modern technology has been integrated with the local knowledge to construct bamboo houses suitable for this region (20).

Following are the major advantages of bamboo stilt houses:

1. Stilt houses can be built at nearly all the regions. Be it the flood-prone areas, hilly regions or the snow covered regions in the Arctics.

2. Stilt houses provide very good ventilation. This is due to the increased airflow from both below the floor board as well as from its elevated structure that helps in creating a cool surrounding during hot climates thus providing a pleasant atmosphere inside the stilt house.

Fig 13 - The bamboo walls are not plastered allowing natural ventilation in Assam's humid climate (Source: SEEDS)

3. The elevated section of the stilt house gives the residents a grand view.

4. The dry spaces are retained underneath a stilt house during rainy season. The owners of the stilt house can use this particular space for storing daily chore items, tending and keeping animals, hanging certain things and conducting other useful activities.

Fig 14 - A woman weaving under the higher space of stilt house (Source: SEEDS)

Fig 15 - Children playing in the space under the stilt house (Source: SEEDS)

5. Owing to its elevated structure, stilt house offers privacy and also protects from animals.

6. The stilt houses in addition also provide a better visual opportunity to residents who look forward to hunting to keep an eye on the surrounding terrains (20, 21).

Fig 16 - Stilt houses around the world (Source: housing.com)

7.2 Wattle and Daub house

Fig 17 - wattle and Daub house (Source: Mother Earth News)

The major components of these houses are organic renewable resources which include bamboo, mud, grass, straw, cane leaves and cane. The foundation of the house is laid on consolidated earth adding timber or bamboo posts. The walls are constructed using bamboo mats, split bamboo framing, grass as well as cane leaves which are plastered with dung or dung and mud mixture. The roofs of these houses are thatched utilizing wheat or maize straws in combination with split bamboo framing. The major structural component of these houses is bamboo. Nowadays, to resist the flood water a brick wall of around 1m is raised from the plinth for providing support to the wattle and daub panels (25).

7.3 Ikra house/ Ekra house

These houses are generally single dwelling unit which are named after the available reed 'Ikra' (elephant grass). The house is composed using wood and other light weight materials. The walls are made out of bamboos which are filled with ikra reed shoots. They are then planted on both sides with mud-dung mixture and painted with lime. The roof is pitched with high gable to cater a heavy rainfall (25).

Fig 18 - Traditional ikra house (Source: Research gate)

7.4 Bangla button houses

The colonial version of Ekra styling could be seen in 'bangla button house' of Sylhat, a part of Assam till 1947. It was then added to Bangladesh. The name has originated from its timber framing and show cases few western decorative elements such as an articulated column and bay window (25).

8. Organisations/NGOs Involved

8.1 SEEDS (Sustainable Environment and Ecological Development Society)

SEEDS a non-profit organization has provided housing support to many communities and families that have been affected by the floods. In collaboration with NEADS (North-East Affected Area Development Society) they have, so far, built around 181 houses that are strong and elevated enough to withstand the floods. This is an attempt at sustainable means of flood control utilizing conventional knowledge of bamboo craft. This method has also been one amongst a source of livelihood for the rural community.

With funds from Godrej Group, the Indian Multinational conglomerate, and a local field partner SEEDS trained the local builders in Nikori village of Golaghat district. SEEDS had built 80 houses within one year (till 2018) of the disastrous flood in 2017 (19). The houses rest on rubberized bamboo columns set in a concrete base. A flexible joinery system allows the residents to raise the floor even higher if needed, while the cross bracing bamboo support makes the structure capable of withstanding movement caused by floods as well as earthquakes (19).

The house/ building cover a core area of about 23 sq. meters. The purchase price of these bamboo stilt houses in India is estimated to be around 10 lakhs. It takes around 7 days to construct the main framework of the house.

Although SEEDS Chang Ghar 2.0 have resisted over seven floods since there construction, they are categorized under Kutcha houses (or temporary houses) by the government. This categorization is done on the basis of materials used for constructing walls/ roofs such as un-burnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones etc. Also these houses have a lower social cachet than the 'modern' concrete houses. This is another challenge since these houses cannot be used as collateral for bank loans (19, 21).

Responding to this issue, SEEDS collaborating with its donor partner Pricewaterhouse Coopers India Foundation is in continuous efforts in building a model community relief shelter in Nikori village. Since, it is a larger structure meant for the community, the NGO, continuing with the same bamboo superstructure design has replaced the bamboo stilts with reinforced concrete columns to provide the building a greater stability and load-bearing potential. This new design holds amenities like piped water and is also replicable in other flood-prone geographies (19).

8.2 Caritas India

Caritas India, founded in 1962, is the official development arm of Caritas churches in India. The word Caritas comes from a Latin word meaning, Love in Action. The team of Caritas India is determined to bring the life of flood-affected people of Assam back to normal.

Taking funds from United Way of Bengaluru and Wells Fargo, Caritas India is carrying out shelter and livelihood restoration of flood affected people in Morigaon district of Assam.

In the first phase, the organization had constructed 35 resilient houses with toilet facilities. In the second phase, 39 houses with toilets were built during 2018 Assam floods. These houses have kitchen gardens and have benefitted around 200 flood affected families (26).

8.3 JHAI Foundation

An innovative technique called plinth raising, which includes construction of a raised platform to build a house. This method of constructing a house involves utilizing the earth in the nearby areas to raise the ground level. The platform is raised at least 3 to 5 feet above the level of water of the previous year's flood. The earth collected is then compacted and grasses including other shrubs are planted on the slopes of the platform to hold soil together. The local people are encouraged to start vegetable plantation and grow other trees to prevent soil erosion.

This technique is being followed by a small islet called Tapajuli Patthar in Barpeta district of Assam. This technique was initiated by Abdul Kalam Azad, secretary of Jhai Foundation under the Char

Development Program (CDP). The plinth in addition is also being utilized to grow vegetables for selling purpose which would earlier perish due to the floods (26).

9. Conclusion

Most people in Assam every year since last few decades lose their land to floods and erosion. The vulnerability of Assam houses owing to the multiple disasters the city faces is yet to be addressed holistically. While the conventional knowledge systems and continuous innovation in their lifestyle is enabling a number of communities to tackle floods, the picture is not all rosy. With the frequency of floods increasing because of climate change and man-made actions adaptation has become way harder and expensive than before. Modern high intensity floods require concrete structures with many cannot afford. As climate change causes more extreme precipitation events, impacting some of the poorest geographies on the planet, inexpensive sustainable houses offer a solution to make low-lying communities more resilient to its impacts (20, 21). Since, at the end of the day, it's not just about creating homes but building the community together.

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11. Abbreviations

- **RBA**: Rashtriya Badh Ayog
- **NESAC**: North East Space Application Centre
- **WRD**: Water Resource Department
- **CWC**: Central Water Commission
- **ADM**: Assam Disaster Management
- **DDMA**: District Disaster Management Authority
- **AWRMIS**: Assam Water Research and Management Institute Society
- **IDA**: International Development Association
- **IMD**: Indian Meterological Department
- **KNTPR**: Kaziranga National Park and Tiger Reserve

_VOIS PLANET

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